OULUN SEUDUN
AMMATTIKORKEAKOULU

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ROBOT COMPETITION, DESIGN OF LABYRINTH AND ROBOTDEMO

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Alfonso Antonio Reyes Jaramillo
Bachelor's Thesis
Spring 2013
Tietotekniikan koulutusohjelma
Oulun seudun ammattikorkeakoulu

TIIVISTELMÄ

Oulun seudun ammattikorkeakoulu
Tietotekniikan koulutusohjelma,

Tekijä: Alfonso Antonio Reyes Jaramillo
Opinnäytetyön nimi: Robot Competition, Design of Labyrinth and RobotDemo
Työn ohjaaja: Juha Räty
Työn valmistumislukukausi ja -vuosi: Kevät 2013
Sivumäärä: 85 + 8 liitettä

Tämä opinnäytetyö sai alkunsa tuntiopettaja Juha Rädyn ehdotuksesta. Ehdotettu teema oli robottikilpailu, labyrinttiradan suunnittelu kilpailua varten sekä robotti, joka nimettiin RobotDemoksi.

Labyrintin malli perustui esikolumbiaanisen ajan Perun muinaiskaupungin palatsin rakenteeseen. Tästä rakenteesta ovat peräisin palatsin L-muoto, pihan U-muoto, toisen pihan suorakulmainen muoto sekä labyrintin pyramidi. Nämä arkkitehtuuriset elementit jaettiin kolmeen alueeseen.

Kilpailua varten oli laadittu tietyt säännöt. Näihin sääntöihin kuului ohjeita joukkueille ja järjestäjille. Säännöissä oli lisäksi tekniset määritelmät kahdelle robottikategorialle. Myös säädökset pisteiden jakamisesta määriteltiin. Pisteitä jaettiin roboteille jotka selvittivät labyrintin nopeimmin. Tämän lisäksi robotit saivat myös tietyn määrän pisteitä jokaisesta tehtävästä jonka ne suorittivat. Tämä järjestelmä mahdollisti sen, että robotti saattoi voittaa kilpailun, vaikka se ei olisikaan kaikista nopein. Pistejärjestelmän tavoitteena oli saada osallistujat miettimään roboteilleen tehtäviä, jotka vaativat mekaanisia ja elektronisia ratkaisuja, jotka ovat myös mahdollisesti sovellettavissa oikean elämän tilanteisiin kuten pelastus operaatioihin tai vaarallisten paikkojen tutkimiseen.

Alunperin tarkoituksena oli rakentaa RobotDemo kierrätetyistä osista, mutta ajanpuute johti ideasta luopumiseen. Lopulta RobotDemo rakennettiin Arduino-osista. RobotDemon ohjelmointiin käytettiin Arduino IDE-ohjelmaa. Tämänkaltainen kilpailu kannustaa mekatroniikan, elektroniikan ja tietotekniikan opiskelijoita kehittämään robotiikkaan liittyviä projekteja.

Asiasanat:
Kilpailu, Robotit, Arduino

ABSTRACT

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Title of thesis: Robot Competition, Design of Labyrinth and RobotDemo
Supervisor: Juha Räty
Term and year of completion: Spring 2013
Number of pages:85 + 8 appendices

This thesis was born as a suggestion of Teacher Juha Räty. The suggested theme was a robot competition, designing a labyrinth for the competition and a robot called RobotDemo.
The labyrinth design was based on a palace of an ancient city of the Pre-Columbian Peru. From this city's structure were taken the "L" shape of the palace, a yard with the U-shaped structures, another yard with rectangular structures and a pyramid. These architectural elements were distributed into three sectors.

There were rules elaborated for the competition. These involved regulations for the teams and organizers. In these regulations was defined the technical specifications of the two categories of robots. Also the scoring system to determine the winner of the competition was determined.
The system awards points to the robots that go through the labyrinth quickest. The robots will also receive a certain amount of points for each task they carry out. This scoring system allows a robot to win the competition without it being the fastest, as each task they execute will add up the points quickly. The scoring system is made this way so that the participants will consider tasks for the robot that require mechanical and electronic solutions which can be applied in real-life situations such as rescuing or exploring dangerous places.

It was intended to build the RobotDemo with recycling parts but a lack of time caused to abandon this idea and resulted in building the RobotDemo with Arduino components. For the programming of the RobotDemo the Arduino IDE program was used.
It is important that this type of competition will motivate students of mechatronics, electronics and computing to participate and to develop projects in the area of robotics.

Keywords:
Competition, Robot, Arduino

ACKNOWLEDGEMENTS

I would like to thank to my Teacher Juha Räty, supervisor of the project and Jori Karppinen, for his constant availability to answer questions, exchange ideas and refer to scientific resources that greatly aided the development and writing of this thesis. I will also thank all my teachers who guided my studies.

Special thanks to Juan Carlos Cardozo, Edgar Hernández, Jussi Kiianmies and Janet Talledo. My thanks to Hugo Espinoza who introduced me in the robotics.

I want to show my gratitude to my friends and fellow colleagues for their company and friendship specially to Pauli Hyytinen, Minna Lahtinen, Yang Li, Pekka Aatamila, Arto Kyngäs, Petri Eilola and Maria Immonen.

Finally, I want to dedicate this thesis to my parents and sisters, to all my family in Peru for their unconditional support, dedication, aid and understanding. To my children Yákill, Willká, Illárek and Sirpa Paukkeri-Reyes, who have been and are the inspiration of my life. You were always there for me and I will never forget it.

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1 The Labyrinth

1.1 What is a Labyrinth

The labyrinth has been analyzed from several disciplines such as archeology, linguistics, history, religion, iconology and historic-literary, giving to the labyrinth countless interpretations, as stated by Ramon Espelt: "What for me unveils the labyrinthic matter: not, what it is? neither how many of them there are?, and not even how to go out? The matter for me is in where starts a labyrinth?". (Espelt, 2008, 30).

The labyrinth is a physical space and symbol (religious and cultural), as well as a set organized and complex that since ancient times was built perhaps on simple schemes, basically with a religious meaning or pre-religious meaning, that held the natural weakness inherent to the human being. The ones of making the path difficult to building nooks and to breaking the straight roads to then give an explanation to each one of the stretches and to its set, offering with it a civilizing value, transformer. Human beings are often facing situations in which it is easy to go in, but difficult to go out. There are few the situations in which is harder to go in and easier to go out. The involved idea in the labyrinthic design, the circles and crossroads to get lost, in ancient times perhaps were an scenification of Hazing, walking the labyrinth as a metaphor and symbol of hazing into the religious mysteries.

The labyrinth is "... mythologem of religious origin, made in form of story and image within the oldest civilizations..." (Kerenyi, 2006,9).

1.2 The etymologic issue

The word labyrinth has many and discussed explanations, although the origin of the words is not as important as the interpretation done about them through the history. During the Middle Ages it was common to think that the word Labyrinth came from “Labour” (work) and “Intus” (closed place).

Labyrinth could come from the word Lábrys. During the archeological excavations done in Crete at the end of the XIX Century it was found the sign of the double ax (Lábrys) in the Palace of Cnossos. Because of this, it was suggested that the Palace could be the mythic labyrinth of the Minoic culture. Other more ancient researchers have purposed that the labyrinth could be a grotto where the Minotaur lived. This is the reason why many others argued that labyrinth came from the word “labra”, which means cave with many corridors and galleries. In light of the work of Evans in the 20th century, this proposal lost value, due to the fact that “ax” (during the time in which the Palace was built) was called peleky.

P. Santarcangeli proposes that the etymology of labrynda being the game of the cave, in Greek language exists the suffix “inda” which would have relation with “inthus”. This word was used to name children´s games and means “play”. Consequently labyrinthos would be a better proposal. (Santarcangeli, 1997, 64.).

1.3 The meaning of the word Labyrinth

The meaning of the word labyrinth from several dictionaries and encyclopedias: The Oxford Dictionary: “a complicated irregular network of passages or paths in which it is diffi-cult to find one’s way”. (Oxford Dictionary. Date of retrieval 6.1.2013).

The “Diccionario of Símbolos” by Juan Eduardo Cirlot defines it as: “Architec-tonic construction without aparent purpose, of complicates structure in which once inside, is impossible or quite difficult to go out. ”.(Cirlot, Juan Eduardo. Date of retrieval 6.1.2013).

The Encyclopædia Britannica: “labyrinth, also called maze, system of intricate passageways and blind alleys. “Labyrinth” was the name given by the ancient Greeks and Romans to buildings, entirely or partly subterranean, containing a number of chambers and passages that rendered egress difficult. Later, espe-cially from the European Renaissance onward, the labyrinth or maze occurred in formal gardens, consisting of intricate paths separated by high hedges”. (En-cyclopædia Britannica. Date of retrieval 6.1.2013).

In accordance with Jean Chevalier & Alain Gheerbrant Dictionary of Symbols we can read: “Originally the labyrinth is the Cretan Palace of Minos in which is bounded the Minotaur. Is the place from where Theseus cannot go out without the help of Ariadna´s strand. Essentially we remark the complexity of its plan and the difficulty of its route”.

Jacques Attali in “The labyrinth of Information” states (Attali, Jacques. Date of retrieval 6.1.2013): “Informatics is labyrinthic: the microprocessor is like a chil-dren´s labyrinth in which the sequences of binary codes in informatics program us be read as a succession of choices to take a certain route. In classic video games, the strategy is to run in a labyrinth without fall in countless hidden traps. In latest versions, are connected to the social networks in which players can have virtual teams and competitions; labyrinths of labyrinths. Furthermore if we think in deep about it, almost all elements of modern life refer to them. The city is a labyrinth, the networks of power and influence, the hierarchical organiza-tions, the university programs, the companies paths are elaborated by series of traps and binary possibilities. Even genetic manipulations are presented as the creation of labyrinths with codified series. The fingerprints are as well labyrinths in each individual. Even the psychoanalysis that defines the unconscious as a monster lurking in the background of a labyrinth, to establish as an object of study the understanding of the dreams in which the one who sleeps is facing the distressing choice of taking a path in the middle of a labyrinth of prohibi-tions. It´s necessary for us to learn how to think in the labyrinth”.

1.4 Chronology of the Labyrinths

The classic labyrinth

Usually has seven concentric paths. However, it is necessary to mention that many of the labyrinths that were drawn in the Bronze Age do not belong to this typology and are more related to the denominated “Baltic”. These labyrinths of the Bronze Age can be found in the known Europe, from Galicia till the lands in the far north of the continent.
To the classic style belongs the known “Minotaur´s Labyrinth”. Although the references of this labyrinth do not come from the Cretan age but from later times, and even the coins with the Cretan labyrinth are of Hellenic times. Several historians state that the Minotaur´s Labyrinth would be the Palace of Knossos, which had a very complex structure in its patios and terraces (Laberintos. Date of retrieval 6.1.2013).

FIGURE 1. The classic labyrinth found on a stone in Mogor, Galicia

The Roman Labyrinth

The Roman culture took the role of spreading the symbol and the myth of the labyrinth. Before the Roman Labyrinth, the designs had been quite simple to draw, therefore it was not necessary to keep a written register about how labyrinths were drawn, during this age the designs started to become more complex while keeping one path patterns. Due to the complexity of the designs started the need to have written records of how the labyrinths were built. The most common design is the one of four sections “symmetric” (Laberintos. Date of retrieval 6.1.2013).

These representations of labyrinths were not planned to be crossed by walking, They were done only for decorative purpose in some places and for protection in other places. As a protection can be found in the tiles of the entrances of houses and public and private buildings. Although these kinds of labyrinths can be found in the graves to confuse those that wanted to disturb the ones lying in there (Jeff Saward. Labyrinthos. Date of retrieval 6.1.2013).

Below we can see a Roman Labyrinth in Pompeya

FIGURE 2. The Roman Labyrinth

The Christianization of the symbol

Among this typology of labyrinth and the Middle Age labyrinth that will arrive centuries later, there is an intermediate link in which the symbol and the thematic is materialized.
The Roman typology continues, but starts to crystallize the central motifs substituting the images of the Minotaur for religious motifs. One of the first examples is the labyrinth found in Algeria, St. Reparatus Basilica, where the central motif is substituted by a serial of lyrics in which it is possible to read “Sancta Eclessia”.
In the 12th Century the labyrinths are accepted and are found mainly in religious buildings, as an example of this, is the Cathedral de Chartres (Labolab. Date of retrieval 6.1.2013).

The Expansion

Labyrinths started to become more popular in civilian spaces. The most well-known shape is the multiple-path labyrinth, with only one entrance but with multiple inner paths that may lead to the center, to a deadlock or to another path that may not be the right one.

In the north of Europe the rise of labyrinths was in the 16th and 17th centuries. The vast majority of them was built in stone (Labolab. Date of retrieval 6.1.2013).

The labyrinths made in gardens started to become more popular at the end of the middle-age, having already in 1450 a documental evidence that were not one-path labyrinth. They had lost their ornamental component, playfulness and in some cases eroticism.

During the 17th and 18th centuries, due to the influence of colonialism, labyrinths were extended to other continents, while in some parts of the New World and Africa existed in ancient times equivalent structures with their own traditions (Labolab. Date of retrieval 6.1.2013).

From the boom to present day

Since the colonial period the interest in labyrinths decayed, becoming less the number of Garden labyrinths and than any other kind of labyrinth. During the

20th century, with the so called “Tourism of Labyrinths” new labyrinths were created and old labyrinths started to be restored.

1.5 Classification of the labyrinth

It´s possible to make a classification of labyrinths in accordance with their shapes. Because we have a diversity in shapes of the labyrinths, just to mention some, such as: circular, square, irregular, architectural, fortress, symmetric, cave, hedge, number, color, lyric, etc.

In accordance with the classification of Paolo Santarcangeli (1997, p.64): “The labyrinth is not always man-made. There are natural labyrinths as well as mixed ones Carnal labyrinths, secondary labyrinths and intentional labyrinths. single-path and multiple-path labyrinths. Geometric and irregular labyrinths, made with a fixed scheme, irregular or mixed. Labyrinths made with round corners, curved or mixed. Rectangular, circular or with square shapes. Compacted, fuzzy. Acentric, mono-centric and polycentric. Centripetal and centrifugal. Bi-dimensional, tri-dimensional. A labyrinth may have simple and complex ramifications and the last ones can have, one or several entrances.

From all the classifications of labyrinths, perhaps the simplest is Umberto Eco´s classification (1997, p.15), establishing three main fundamental models: one-path, mannerist and rhizome.

The first one is the labyrinth called “single-path”. Its route is generated in a simple manner. His nothing more than coiled rope, with its two tails. In this way, if someone enters it, they will find the way out by walking the single-path route. it is the classical labyrinth which will not have Ariadne Thread. because the route is itself is Ariadne Thread.

In order to make such a labyrinth less boring, there must be the Minotauro in the centre. The problem is not where to go out, but is it possible to go out alive from it. The one path labyrinth is the image of a cosmos with a complex habitability, but ultimately, organized. A human mind is conceived. There is no need to take any decision because there is only one possible route.

The second type of Labyrinth, is the “Mannerist”. It has a structure similar to a tree, to spin it im-plies to delve into a boundless luxuriance, with infinite ramifications, in which almost every path go to a deadlock; only the solution to a binary dilemma leads to the exit. Such labyrinth is difficult because it can force us to come back infinitely after our steps, and it can condemn us to err permanently. The overcome of a labyrinth with multiple paths like this one, with cross roads in which we have to discover which is the right path, will demand that our best tools are the intelligence and memory, or alternatively, the fortune. Sometimes there are not included a creature inside.

Last, the “rhizome” labyrinth or infinite network, in which every point can be connected with every other point, giving rise to a succession of connections that have no end. The main characteristics of a rhizome are such that unlike the tree schemes or branch networks, the rhizome connects every point with any other point, teach one of its features leads us to features at the same nature. Rhizome labyrinths set in play sign regimes quite different and even states of no-signs. The rhizome cannot be reduced to the unity or the multiplicity. It has no beginning and no end. It has always a means by which it grows and flows.

In this labyrinth, there is no center and there is no periphery, no inner and nor outer. In this kind of labyrinth even the mistakes can give place to solutions that makes the problem more complex; the connections make it bigger but as well transform it. We cannot lose time in trying to find a logic that rules it. This labyrinth does not have any logic, neither can we look for the monster, because the monster is the labyrinth itself. There is no way out, because it is potentially infinite.

The most basic classification for the labyrinths are one-path and multiple-path labyrinths. In English language it is used the word "Labyrinth" to refer the one-path labyrinth and the word "Maze" to refer the multiple-path labyrinth.

1.5.1 One-path Labyrinth

One-path Labyrinth is the labyrinth with such a layout in which from the entry-point till the center (or point of destination) it is not necessary, neither possible to make a decision during the route. In this kind of layout regardless in which point of the route we are, we know that the walls are side of us, we pass by the perimeter of the labyrinth and through the inner part as well, without the need of taking any decision.

Within this kind of labyrinth we have (Laberintos. Date of retrieval 6.1.2013; Labolab. Date of retrieval 6.1.2013; Origen e Historia de los laberintos. Date of retrieval 6.1.2013; Saward, Jeff . Labyrinthos. Date of retrieval 6.1.2013) :

1.5.1.1 Classic

Classic Labyrinth wich is also called as well "Cretan"; although this is not entirely right. It has seven concentric circuits. Which are built so that they all are based on the same structure (Saward, Jeff . Labyrinthos. Date of retrieval 6.1.2013).

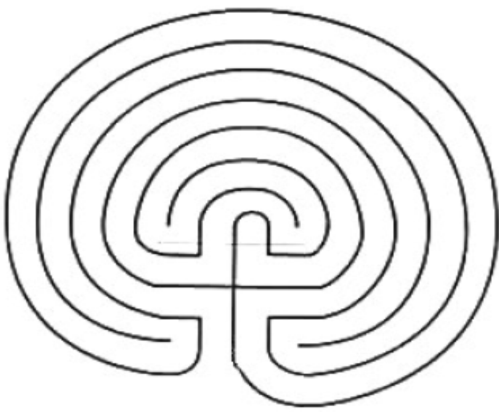

FIGURE 3. Classic Labyrinth

1.5.1.2 Baltic Classic

Baltic classic labyrinth has two entrances and one center. Although it has two entrances, is considered “Single-path” due to the fact it that has only one-way to the center. Once arrived to the center, it´s necessary to keep walking from the inner part to go to the opposite entrance from where it started the route(Laberintos. Date of retrieval 6.1.2013).

FIGURE 4. Baltic Classic

1.5.1.3 Roman Style

Roman style labyrinth is divided in quadrants. The seed is the route belonging to one of the quadrant that is joined through a stroke to another equal seed. The most common ones have a square configuration. In accordance with the seed used, they are subdivided in three types; spiral, meander and serpentine (Saward, Jeff . Labyrinthos. Date of retrieval 6.1.2013).

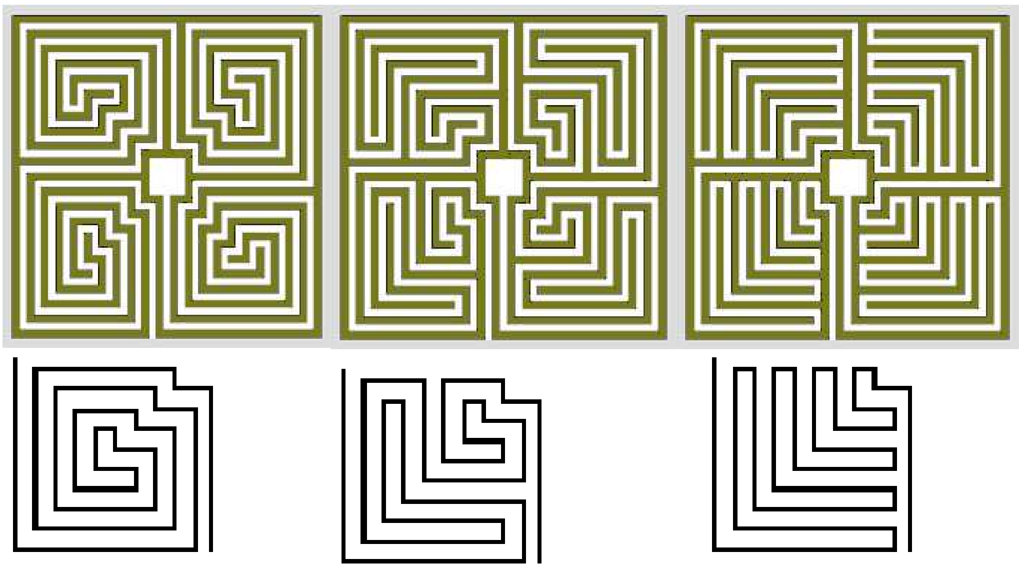

FIGURE 5. The Roman Style

1.5.1.4 Medieval Style

These labyrinths can be squares, circulars or polygonals, regarding the number of circuits (the most common shapes have between 6 to 11 circuits). The number of circuits and the the external configuration may vary. In those times the "bastions" were introduced, they consist of in somehow a modification of the four opposite corners in the layout of the labyrinth and to make figures apart from them while at the same time keeping the route of the circuit (Labolab. Date of retrieval 6.1.2013).

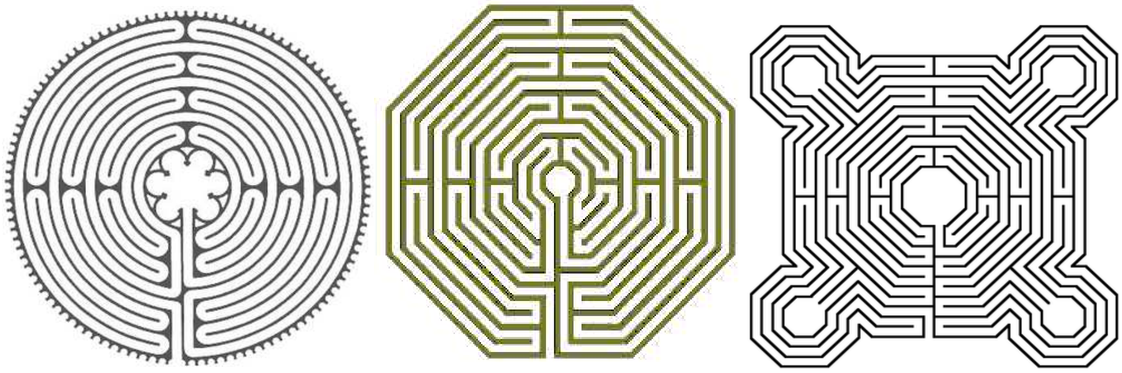

FIGURE 6. The Medieval Style

1.5.1.5 Current Labyrinths

Current labyrinths are also called contemporaries. There exists a great variety of designs, with spiritual purposes are ornament purposes. The Figure 7 is the "heart Labyrinth" by Marty Kermeen and Jeff Saward, which is a clear example of a thematic aesthetic combined with the labyrinth ().
This labyrinth has a double entrance (Saward, Jeff . Labyrinthos. Date of retrieval 6.1.2013).

FIGURE 7. The Heart Labyrinth

Leaving out creative trends, other actual stream is focusing more on Labyrinths "Type Chartres", as well as with its eleven circuits, or reducing the number of circuits. There are labyrinths with a very medieval style. The stream, generally uses labyrinths as a "spiritual technology".

FIGURE 8. Others Labyrinths

1.5.2 Multiple-path Labyrinths

A multiple-Path labyrinth is the labyrinth the lay out of wich is multiple paths and possibilities to choose among different paths that may lead us to deadlocks or different paths from those paths that may lead us to the right path. In multiple-path layouts are are called "islands" (sections within the layout of the labyrinth that are not connected with the perimeter). It is a labyrinth in which any person can get lost. This labyrinth does not have a single path, and the decisions taken in the junctions and crosses may lead to the exit or not. These labyrinths, due to their basic structure, can be of a single connection or a multiple connection (Laberintos. Date of retrieval 6.1.2013).

1.5.2.1 Multiple-Path Labyrinths of simple connection

A very easy form of finding the way out is to put a hand in one of the walls and to walk always without taking the hand away from the wall, to arrive to the center or objective.

The center or objective is surrounded by a section of the wall that earlier or later, and through the connection with other walls leads to the perimeter, it is not the same as the single-path labyrinth due to the fact that in this labyrinths we are not talking about the same wall during all the routes. It includes different walls "sections). An example of these labyrinths is the Palace of Justice of (Hampton Saward, Jeff . Labyrinthos. Date of retrieval 6.1.2013).

FIGURE 9. The Palace of Justice of Hampton

1.5.2.2 Multiple-Path labyrinths of multiple connections

The strategy of the hand in the wall is useless in this kind of labyrinth, because it includes islands and sections of the layout that are not in the perimeter. This would make us turn around its own layout or even to lead us back to the entrance of the labyrinth. The layout of the Leeds Labyrinth is a clear example. The zones are “islands” as we can see the wall that surrounds the central zone that has no connection with the perimeter. The first labyrinth of this kind was the Chevening House, built in 1820 (Laberintos. Date of retrieval 6.1.2013).

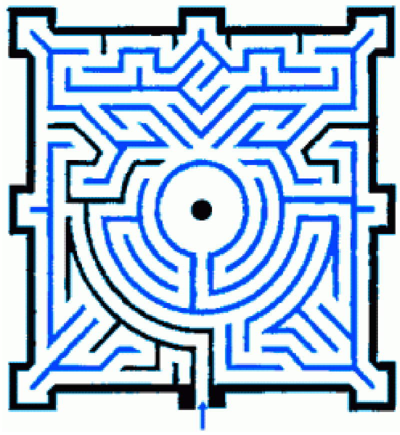

FIGURE 10. The Labyrinth in Leeds Castle

1.5.2.3 Labyrinths of conditional movement

These labyrinths have a layout in which the next step of the walker is not given by the layout of the labyrinth but by the instructions that are found in the same (Saward, Jeff . Labyrinthos. Date of retrieval 6.1.2013).

1.6 The design of the Labyrinth

Reviewing Robot competitions are currently organized in almost the same pattern used in the design of the competition track, I would say that is so simple that it is boring, in all as it starts at one point and ends at the same or another point. But the subject is just to follow it and find out that it is the same or another point. I preferred to develop a theme for this competition and this labyrinth could be another that I proposed. This issue would be the burial of a king. The rulers of ancient cultures when they died, were buried in their palace or in some sacred place. Burial ceremonies were developed complex religious and mythical ones and they could take several days. As already mentioned in above paragraphs, examples of these labyrinths are found in ancient Greece, or in Roman times. The old civilzations of America are no exception, so we also have that in ancient Peru. Many of these cities are a real labyrinth it is hard to get out of them if visitors do not know how or are not guided by their inhabitants. An example of this is the city called Chan Chan, the largest adobe city in the world, which has 9 palaces and more living areas for which they served and developed various tasks in the running of this city, the capital of this kingdom. These palaces have similar patterns. One of them is the shape L in almost all the palaces. This shape would be associated with some myth or religious belief. Each palace has a tripartite division, clearly distinguished three sections, each dedicated to various tasks of the palace. These palaces were decorated with designs of high relief. The decorations were: marine animals and birds, representations of the moon and the sea, as the “chakana” geometric symbol of the power of rulers (Ravines. 1980).

In the design of the labyrinth to the robot competition track I used as a model the Tschudi palace of the city Chan Chan (Apumarka. Date of retrieval 18.1.2013 see figure 11) see figure 11.

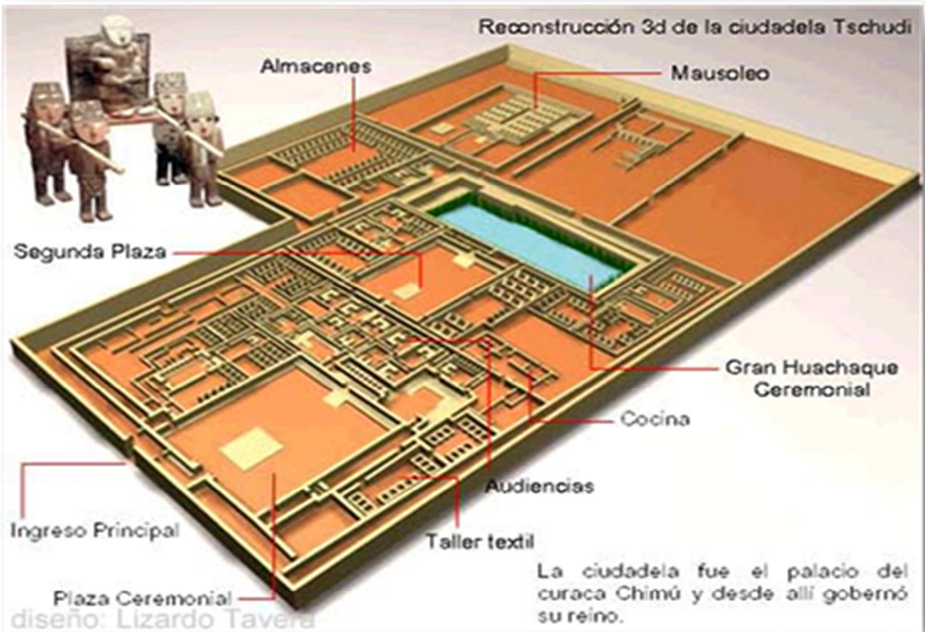

FIGURE 11. The Tschudi Palace in Chan Chan

I have taken from this palace the following architectural elements:

-The calls “Audiencias” with the U-shaped structures that are attached to a ceremonial courtyard (see figure 11). Each of these U-shaped structures has five niches. They are grouped and have high relief decorations like seabirds, circles and lines representing the moon and the sea respectively.

-The call “24 Hornacionas” room, which has been suggested for various uses, from miting area state officials and deposits, but in recent years the finding of idols in situ, in other palaces, confirms the theory that each “Hornacinas” contained an idol.

-The corridors are long and narrow, with 90 degree corners.

-And for the royal mausoleum I used a typical pyramid of the Lambayeque culture with a circumferential ramp (zig-zag). These burial platforms were designed for the ruler who lived in this palace. Here also buried his wife and other family members, with their servants.
The combination of these architectural elements make up the labyrinth to the competition.The idea of keeping the L-shape is that in this space on the right angle of the L is locate the places of the judges of the competition (see Appendix 1,2).

The labyrinth to the competition keeps the tripartite sectorization, 3 sectors (see Appendix 3), each sector to develop a specific task. The sectors will intercommunicate through corridors and ramps in the case of the burial platform. At the entrance of the palace, a sensor will detect when the robot enters beginning to count its time, it will stop when the robots leave and time will be shown on a digital display to the judges.

The sector A is the burial platform, which you will access through corridors and ramps. I chose the zigzag ramp because a direct ramp would require a lot of space. With the zigzag ramp the platform will get more height. At the top of the platform the RobotDemo should take the mummy of the ruler and put it in his burial chamber, after this, it will catch the idol and take him to leave the second sector. The platform has 2 ramps located on both extreme, one going up and the other going down (see Appendix 3).

The sector B is the courtyard of the idols based on 24 Hornacinas room. In the center there is a small altar (see Appendix 3) where the robot must leave the idol taken from the funeral platform. Then it travels through the corridors reaching the next area.

The sector C is the “Audiencias” with U-shaped structures, similar to the Tschudi palace, each U-shaped structure has 5 niches (see Appendix 3). In any of these niches, there is located a candle that the robot should seek to turn it off. After making this task, the RobotDemo tours the perimeter corridors of the labyrinth to get out, ending it is turn in the competition.

2 The Regulation

Chapter 2 refers to the regulation, which will govern the competition of robots. in which the participation of the organizers and the equipment will be regulated, by defining the rights and obligations of the participants, the track type of competition, the technical specifications of the robot as well as the scoring system to establish the winner of the competition

Regulation of the Competition of Robots in a labyrinth

The present event will consist of a competition of robots, which will have to cover a labyrinth. In their trip the robots will have to execute certain tasks, for which they will get extra points. The competition will be regulated by the following rules:

Article 1. The Organization of the Event

- The robots competition will be organized by the department of Information Technology of Raahe Campus of Oulu University of Applied Sciences, School of Engineering which will appoint the Organizing Commission. This one will be shaped by 3 teachers of the department Information Technology, and a student of the same department.

- The members of the Organizing Committee will be appointed by the Department of Information Technology at Oulu University of Applied Sciences Raahe Campus.

-The Organizing Committee, shall appoint a committee of claims for possible claims of the participants.

Article 2. The responsibility of the team

- At the time of registration each team will report the name of the person responsible for the team, that person will exercise this responsibility throughout the competition. The team manager may not be changed without causes of force majeure to justify it.

- A player may only be responsible for one team, and he/she will have the responsibility to get the robot ready according to the rules specified in this Regulation.

- The person responsible for the team may ask for a withdrawal from the competition when the robot has had a failure or certain inconvenience that does not allow it to continue in the competition. It shall be left to the discretion of the jury to accept the request and terminate the robot’s participation, or if it is eliminated from the competition by the failures mentioned above.

Article 3. The Team

- The team consists of one or several participants presenting a robot. The maximum number of participants per team is 4 people.
- The members of the teams should have to carry their identification card as a responsible or a member of each team in a visible place.

- A team may represent a School, University of Applied Sciences, State or Private Company. It can also be representing a person or a group of people.

- No member of any team can be part of another team that competes in this category.

- A team may participate with a maximum of three robots.

Article 4. The Registration

- Teams must register one month before the start of the competition of robots.

- The registration may be done via email, postal mail, or in the record offices of the competition of robots. In order to do this, a registration form must be completed.

- Once the registration is made, any change or modification, must be done via email or postal mail addressed to the organizer of the competition of robots. The request for modification will have to be explained.

- The subscription form will contain:
First and last name
Address
Telephone number
ID Number of each team member.
Place of origin
Team name
The names of the robots (maximum 3 robots)
Name of the educational institution / Company / team or affiliation to which it represents.
Robot’s history (if it has taken part in other competitions).

Article 5. Confirmation of Registration

- The Organizing Committee of the competition of robots will communicate through electronic mail to each team its acceptance to the event.

- Each team must submit a document signed by his representative which claims to have read the rules of the competition and is committed to respecting it. The document will be sent by electronic mail or post.

- The Organizing Committee of the competition of robots reserves the right to select the participating teams, and set the number of teams.

Article 6. Team's Behavior

- During the development of the event the participating teams must show an exemplary sportsmanship, respect for other participants, judges and the general public.

-It is forbidden participants to invade the area where the competition is taking place..

- Teams must respect and follow the rules and indications of the judges, who may disqualify a robot if the team does not comply with the rules.

Article 7. Changes in the Rules

- The organizer of the event is authorized to do modifications in the regulation of the competition, in case of being necessary. The changes will be communicated in writing to the teams.

- If during the development of the event there is a need to modify some norms of competition, this will be a decision of the judges.

- In order to keep a competitive environment these changes will try to have a minor affect to the functioning of the robots.

Article 8. Claims and Power of the Judges

- The team will be able to present its claims to the judges, within 30 minutes after finishing the competition of its robots.

- Of existing doubts in the interpretation and application of the regulation during the development of the event, it will be the judges who decide on it.

- If some team is not in accordance with the decision of the judge, the person in charge of the team, will be able to present in writing his claim, which will have to be presented on the same day. The claim will be seen by the Committee of Claims of the organization of the event. They will bear in mind the arguments of the involved teams and the video material of the competition. After reviewing all information the Committee of Claims will make a final decision, which is non appealable.

Article 9. Expulsion of the Competition

- The judges are authorized to a some participant, who is breaking the regulation of the competition. The expelled team will be able to present its claim in writing to the organizing commission. In case that the order of expulsion of the judge had not been respected by the team, this one would lose its right to claim.

Article 10. Categories of the Competition

The competition will contain two categories, which will be:

Category A
In this series there will compete robots which have components such as engines, wheels, sensors, which come from material of recycling. The electronic badge will have to be constructed by every team.

Category B
In this series the teams will have freedom to choose their components. they can able be new or secondhand.

Article 11. The Competition Area

- The area of the competition is formed by the labyrinth where the robots will compete and a zone of 1 meter around the labyrinth, which will be delimited by a line of white colour.

-In this space of the competition the judges will be located.

- At the beginning of the competition, only the persons in charge of the team will be there allowed to enter this area, when the robot is placed, and in case of disadvantages that the robot may suffer to complete the competition..

- Close to the area of competition there will exist an area of technical maintenance will exist, where the teams will conduct the maintenance and repair of the robot. In this area the use of hardware will be allowed, as well as PC, laptops, or some sort of device to conduct the required maintenance.

- Every team must take care of bringing to the competition all the necessary hardware for the maintenance and/or repair of the robot.

- The organization will provide a table and electricity supply for every team.

Article 12. The Circuit

- The labyrinth is shaped by 3 sectors, which the robot will have to journey until the finish line. The walls of the labyrinth will be identical with red colour and the floor of white colour. To the center of the corridor there will be painted a black line of colour of 1.5 cm wide, through which the robots continue to cover the labyrinth and cross the finish line.

- The labyrinth presents curves of 90 grades.

- The floor surface will present in some sectors aberrations, which will help increasing the friction of the wheels of the robot.

- At the beginning the labyrinth will have a sensor, which takes into account the time needed for every robot in the development of the competitions. The time will be showed on a digital panel

Article 13. The Competition

- All the teams will have to present their robots 1 hour before the beginning of the competition. The team that fails to present its robot will remain discredited, without rights to make any claim.

- The judges will verify if the robots taking part comply with the technical restrictions (measurements, weigh, etc.).

- The robot that does not meet with the technical specifications will be discredited, without rights to make any claim.

- The competition will take place with a robot per turn inside the labyrinth.

- No player will be allowed to invade the area of the competition with the exception of the person in charge of the team when the needs, conditions of the case and the regulation allows it.

- The person in charge of the team will place his robot on the starting point until the sign of the judge. Thereafter he/she is allowed to press the switch of the robot and begin its round.

- The robots are not allowed to be functioning before giving the start sign.

- Before the start of the event, the candidates will be given the layout of the labyrinth.

Article 14. Rounds of Classification

- There will be a draw from the participant teams, to determine the turn of participation.

- Depending on the number of participants, they will be split into 2 or 4 groups. Every group will have a minimum of 3 robots taking part.

- If the competition starts with 2 groups, the first 2 robots with the best scores from each group will move to the semifinal. The robots that obtain the best scores in the semifinal will move to dispute the final. The losing robots will define the third and the fourth position.

- If the competition starts with 4 groups, the first two robots with the best scores from each group will go on to an intermediate round. 4 robots that obtain the best scores in this intermediate round will move to the semifinal. 2 robots that obtain the best scores in the semifinal will move to dispute the final. The losing robots in the semifinal will compete for the third and the fourth position.

Article 15. Punctuation System

- The robots will have to cover the labyrinth, their used time will be verified by the judges. The first best times will receive the following punctuation:

1 ° -----------50 points
2 ° -----------45 points
3 ° -----------40 points
4 ° -----------35 points
5 ° -----------30 points
6 ° -----------25 points
7 ° -----------20 points
8 ° -----------15 points
9 ° -----------10 points
10° ----------05 points

The Labyrinth is divided in to 3 sectors. In every sector the robot will fulfill a task:

- In the first sector it will have to rise to a pyramid across a system of ramps. In the top part of the pyramid it will find in a vertical position the mummy of an Inca with its sacred idol and the robot will have to take the mummy and deposit it in his mausoleum (rectangular cavity). The robot will have three attempts to complete its tasks. The punctuation granted to the robot will be the following:

1st attempt ---------35 points
2nd attempt ---------30 points
3rd attempt ---------25 points

Later it will have to take the sacred idol and go to the ceremonial court.
If after three attempts the task cannot be completed, it will be penalized by 3 points less and it will have to continue its trip towards the next sector.

- The second sector is represented by the ceremonial courtyard, the central part has a small rectangular altar, here the robot must leave the sacred idol, I take the first sector. The robot will have three attempts to fulfill this task, the score given to the robot is the following:

1st attempt ---------35 points
2nd attempt ---------30 points
3rd attempt ---------25 points

If after three attempts the task is not completed, it will be penalized by 3 points less and it will have to continue its trip towards the next sector.

- In the third sector which we have named “Hornacinas” (Niches), it will have to extinguish a candle. Then the robot will have the freedom to decide how it will complete the task, by using a fan or simply by means of the blow of flame with some mechanical arm. The robot will have three attempts to complete its task. The punctuation granted to the robot will be the following:

1st attempt ---------35 points
2nd attempt ---------30 points
3rd attempt ---------25 points

If after three attempts the task is not completed, it wil be penalized by 3 points less and it will have to continue its trip towards the finish line.

- The robot that scores most points will be the winner. In case of a tie, the robot that obtained the best time will be considered the winner. Should the tie remain, the robot that has completed all tasks with less attempts will be considered the winner.

- if no robot will obtain any points, the competition will not have a winner and it will be declared empty.

Article 16. Specification of the Robots

- The robots will have to display their name and the team's name in a visible place.

- If the teams are sponsored by a company, they will have the right to add publicity on the robot. The use of offensive words or phrases to participants or to the public attending the eventis prohibited.

- The maximum dimensions of the robots will be 15 ± 0.5 cmof width wide, 15 ±0.5 cm of length and 10 ± o.5 cm of height.

-The robot will have to weigh a maximum of 1 kilogram, including the batteries.

- In the construction of the robot any type of basic electronic element will be allowed (floodgates, transistors, operational, etc.). It is also allowed to use of microcontrollers, microprocessors, programmable relays, PLC's, etc.

- The source of energy must be contained inside the robot and it will be based on the usage of batteries is allowed rechargeable batteries. During the whole competition the use of several batteries or. In case one decides to use rechargeable batteries, the team will be provided with the possibility of recharging them when the robot is not in the competition. Each team must have its own source of power.

- The robots must be completely autonomous, they cannot be manipulated and/or connected to any external device such as Radio Control, Wireless, Bluetooth, Power supplies, Computers or any other external device.

- Due to the possibility of change in the luminosity of the labyrinth, the sensors of the robots will be adjusted before beginning the competition.

- The robot should have a switch of ignition placed in a visible place.

- The limitation on the quantity and types of sensors that the robots will use is inexistent.

- There will not be restrictions as for the system of locomotion of the robot.

- The robot must not include parts that could damage or deform the track.

- It is not allowed to design a Robot so that when it begins its competition it separates into different pieces, that is to say, in into 2 or more independent robots or it leaves scattered pieces.

- The robot must not include dangerous, corrosive, inflammable or explosive substances with the exception of the batteries that are sealed.

Article 17. Selling of Robots

- At the end of the competition, the robots taking part in the competition can be bought by the teams taking part in the competition or the general public

- The teams compromise to accept the buying offer.

- The minimal price to purchase a robot will be 80 euro.

- If 2 buying offers are placed, the robot will be sold to the person of the highest offer.

- A robot cannot be bought by any member of its own team.

- If a team refuses to accept the buying offer, the organizer of the event will disqualify the team and all its taking part robots. The disqualified team will not be able to take part in similar events in next 3 years.

Article 18. Prizes

- The Organizing Commission will determine what types of awards will be granted. It will be announced in the call of the competition.

- The first three robots will be rewarded. In case a team has to more than one robot in the podium, the team will receive only one award. The prize that will be awarded will be the biggest.

- The awards will be delivered at the end of the event.

- The organizer of the event will designate the person who will be giving the awards in the closing ceremony.

- The award will be delivered to the person in charge of the team.

- Once the award is delivered to the person in charge of the team, the organizer of the event does not have any responsibility on the use of that particular award.

- At the end of the event, the organizer of the competition will make public the final scores.

Article 19. Date and Place of the Event

- The event will take place the days … … … … … at the … … … … … …..

- Description and facility of the place where the event will take place.

- In case of motives preventing the organization of the event, the organizer is authorized to suspend and modify the date of the event.

3 The Robotics

3.1 What is Robotics

According to Brady1985 (Carrelli, 2009, 7) ”it is the intelligent connection between perception and action”.

“The science that studies the robots as systems that operate in a real environment, establishing some kind of intelligent connection between perception and action” (Esteve, 2001, 1/1).

A simpler definition would be "Science of Robot" (Esteve, 2001, 1/1).

3.2 What is a robot

When people think of the word robot they usually think of the idea of a character with human characteristics, with a force much greater than that of a human and other features that make it "better" than a human. Although in some science fiction movies we see that robots are able to perfectly imitate a human being having besides extra skills, this is not yet possible. Let us see some definitions:

The Robot Institute of America defines a robot as “a reprogrammable and multifunctional manipulator designed to move materials, parts, or specialized devices through variable programmed motions for the performance of a variety of tasks (Schlussel, 1985)” (Carrelli, 2009, 7)
The British Association of Robotics (BRA) defines a robot as "a reprogrammable device with a minimum of four degrees of freedom designed to handle and transport parts, tools or specialized manufacturing implement through programmed motions for the performance of a specific task of manufacturing" (Ruiz del Solar, Salazar, 2).

"Any device that replaces human labor (Sosa, 1985)" (Carrelli, 2009, 7).

The ISO 8373 (International Organization of Standardization) defines it as: “an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes” (Industrial robot. Date of retrieval 7.2.2013).

3.3 Background of robotics

Greek mythology tells how Prometheus created the first man and the first woman with mud giving them life with the fire of the gods. The human being has always wanted to be like the god and has played with the idea of creating life and to creating nonhumans, machines that could imitate men, developing mechanisms and systems that have facilitated his work in scientific activity in the production of articles or things for their welfare, as well as in the production of their food.

We all have an idea of what robotics is. In a general way we know its use and its advantages, but we have been surrounded by a lot of fiction from literature and cinema. The background of robotics was found in very remote times when they were called "automata". The word robot suddenly appeared a few decades ago and it was used in industrial production. At present it is found in multiple areas of medicine, space research, risk tasks and domestic tasks. The advances of technology in the areas such as electronics, mechanics, computer science, the cheapening of hardware and the new conception of plant of flexible fabrication for a varied production, which requires ease of movement of materials between any points of the factory, has driven to the development of robotics (Robotica Origen y Antecedentes Historicos. Date of retrieval 3.1.2013).

3.4 History of Robotics

Here is a chronology of Robotics, (the dates and facts have been collected from: A Brief History of Robotics. Date of retrieval 21.1.2013; Bredin & Marshall, Date of retrieval 21.1.2013; Ortiz, Date of retrieval 20.1.2013; Historia de la Evolución de los Robots. Date of retrieval 21.1.2013; Historia de la Robotica. Date of retrieval 19.1.2013) :

A first hint of automata in ancient times comes from the 1500 BC when Amenhotep the son of Hapu commanded to build a statue of Memnon, the mythological king of Ethiopia. It was said to be in contact with sunlight emiting sounds. From that period dates the water clock.
The Greeks built statues which were made with a system of pulleys and hydraulic pumps. The philosopher, mathematician and Greek politician Archytas of Tarentum is considered the father of mechanical engineering and robotics precursor. To him is owed the inventions of a screw and a pulley, the first rocket self-propelled for military use (400 BC), and a wooden pigeon that turned by one action of a jet of water or steam.
The magpie flying wood and bamboo from China, as well as a wooden horse that was jumping, were created by King-Your Tse in 500 BC.
In the book "controller" of Heron of Alexandria (62 dc) designs are toys that move unassisted, like birds flying, warbling and drinking; blades of windmills generating a driving force and boiling water circuits, which are considered as precursors of the steam turbine. Examples of automata were seen in the imperial Rome during private parties. In 770 AD Wu Yang-Lien built a monkey begs for alms, and guard in a bag after reaching a certain weight.

The watches contain the idea of automatism and therefore we can associate them to robotics. An example of this is the clock of the cathedral of Munich and the Anker Clock in Vienna. El Gallo de Strasbourg, is one of the oldest automata which is preserved till today. It worked from 1352 until 1789. It was in the Strasbourg Cathedral. When giving the hours it moved the beak, wings and crowed three times. The Flycatchers of Burgos Cathedral, built in Spain in the sixteenth century, is a mechanical man that moves when the time changes. It is still operating today.

As The Renaissance landed to western Europe in the fifteenth and sixteenth centuries, there was a renovation in literature and science. Leonardo da Vinci with his studies of human anatomy, made important contributions to the development of a mechanical robot, mainly anthropomorphic, allowing the construction of superior mechanical joints, thus promoting the development of modular complex machine, resulting in the development of a large number of machines with movable parts capable of writing and playing musical instruments. One of these machines is the one that Leonardo da Vinci built for King Louis XII of France. A mechanical lion that opened the chest with the claw and showed the royal coat of arms. Also in 1495 he designed one of the first humanoid robots of the Western world, a knight with armor, able to sit up, wave its arms, move its head and close and open its jaw.
The French Jacques Vaucanson is a famous builder of automata. In 1738 he introduced the automata flutist who played 12 baroque melodies. The most famous of his works is the Duck "Le Canard of Vaucanson", which was composed of more than 400 moving parts. It was able to move its wings, eat from the hand of the public and evacuate food just like a real living duck. Also in these years the Swiss watchmaker Pierre Jaquet Droz (1721-1790) and his son Henri-Louis Jaquet built various dolls which were able to write, draw and play different melodies with the organ. They are preserved in The Museum of Art and History Neuchatel, Switzerland.

In the late eighteenth century ingenious mechanical inventions used in the textile industry were developed, such as the rotating spinner of Hargreaves (1770), the mechanical spinning of Crompton (1779), Cartwright's power loom (1785) and the Jacquard loom (1801). Jacquard was the first to use punched cards. Choosing a set of cards, the tissue was defined. These machines were the first historical precedents of the numerical control machines.

In 1822 Charles Babbage presented the prototype of his Difference Engine. Then he presented the design of his Analytical Engine. Although these never came to be built he is considered the "Father of Computing". In the same year George Boole in 1847 and 1854 presents his two major works which we know as Boolean Algebra. In 1898 Nikola Tesla presented at the Fair of Electricity in Madison Square Garden the first manned boat prototype wireless remote, completely remote.

In the city of Prague in 1921 the Czech novelist "Karel Capek" presented his work entitled "RUR: Rossum's Universal Robots", In this work the novelist used for the first time the term "Robot", which comes from the Czech word "Robota" meaning servitude or forced labour. Despite this the word robotics is attributed to a novelist and mathematician Isaac Asimov. He used the word “Robotics” for the first time in his story titled "Runaround" published in 1942. After a series of short stories presenting the "Three Laws of robotics ", later he added the" Act zero. These are:

First Law: A robot may not injure a human being or, through inaction, allow a human being to come to harm.

Second Law: A robot must obey the orders given by human beings except where such orders would conflict with the First Law.

Third Law: A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

Zeroth Law: A robot may not injure humanity or, through inaction, allow humanity to come to harm.

The term "artificial intelligence" is coined in 1956 as a result of the conference organized by "The Rockefeller Foundation." The Artificial Intelligence Laboratory was founded in 1959 at the Massachusetts Institute of Technology (MIT).

In 1962 H. A. Ernst published the development of a computer-controlled mechanical hand with tactile sensors called MH-1. In the same year the first Unimate was installed on a trial at General Motors plant for assembly functions. It was converted into the first industrial robot. Devol and Engelberger later founded the first company dedicated specifically to manufacture robots, Unimation, Inc., short for Universal Automation. You can consider this as the beginning of the era of robotics, using programmed robots in manufacturing. Shakey the first mobile robot that can make decisions according to its surroundings, was created in 1966 at Stanford Research Institute (SRI).

In 1968 the Stanford Artificial Intelligence Laboratory (SAIL) published the development of a computer with "hands", "eyes" and "ears" (manipulators, TV cameras and microphones). The "Stanford Arm" was developed by Victor Scheinman. The "Stanford arm" remains influencing in the design of the robotic arms.

The first industrial applications were made during the years 1970 and 1971 when robots were used in automobile manufacturing.
In the 70's robotics research focused on the use of external sensors to be used in manipulation tasks. It is in these years that the presence of robots in assembly lines and industrial plants consolidated definitively worldwide.
In 1972 the Japanese company Kawasaki installed its first automated assembly line at Nissan, Japan, using robots supplied by Unimation, Inc.
The Swedish company ASEA (later ABB) in 1974 developed the first robot IRB 6-electric and in 1975 presented IRB 60 (of similar design to the IRB 6). This was given to the Swedish company SAAB for welding car bodies points.
Victor Scheinman (1975) developed the "Programmable Universal Manipulator Arm" (PUMA). The PUMA is the basic concept multiarticulated by most current robots.
In 1979, Japan introduced the robot “Scara” (Selective Compliance Assembly Robot Arm) and the Italian company DEA (Digital Electric Automation) developed the robot “Pragma” for General Motors.

In the 80's in the techniques of speech recognition, moving object detection and safety factors were advancing. The first robots for the field of rehabilitation, security, military purposes and to carry out dangerous tasks were also developed. An example of these is the robot Pedesco (1982) that was used to

clean up a fuel spill at a nuclear plant. It is important to note the contribution of companies like IBM, which in 1984 introduced the model 695 lite assembly, based on the Intel 8086 and 8087 microprocessor chips .
Robotics has evolved into autonomous mobile systems, being able to fend for themselves in unfamiliar environments without supervision.
Honda began its robot research program in 1986. The project was a premise that: "should coexist and Cooperate with human beings, by doing what a person can not do and by cultivating a new dimension in mobility Ultimately benefit to society." In this year LEGO and the MIT Media Lab collaborated to bring the first LEGO based educational products to market. In 1989 the Mobile Robots Group at MIT presented the robot named Genghis. It became known for the way it walks popularly referred to as the "Genghis gait".

For the decade of the 90’s we have the following important moments:
In 1992 Marc Thorpe in his attempt to build a radio-controlled vacuum, had the idea of a robot combat event. In this same year, Dr. John Adler had the idea of CyberKnife. A robot that would use x-rays to look for tumors and apply a pre-planned dose of radiation to the tumor.
The robot Dante descended on Mount Erebus, a volcano in Antarctica, to collect information, in a rugged geography, like what could be found on other planets. The mission failed when the Dante’s rope broke falling into the crater. A year later the Dante II, an enhanced version of its predecessor, descended into the crater of Mount Spurr volcano, to collect samples of volcanic gases. The mission was considered a success.
Marc Thorpe in 1994 started “The Robot Wars” at Fort Mason Center in San Francisco, California. “The Second Annual War Robots” was developed in 1995 in the same center. David Barrett presents the Robo-Tuna designed and built in 1996 for his doctoral thesis at MIT, used to study how a fish swim.
The Gastrobot of Chris Campbell and Stuart Wilkinson (1996) was result of an accident. This robot can digest organic mass to produce carbon dioxide (and alcohol). The pressure of CO2 would be used as energy to turn the wheels. They called it "the flatulence engine” and it was named after “chew chew ".
In 1996 was performed “The Second Annual War Robots” in Fort Mason Center in San Francisco, California.

In 1997 took place the first Robocup football tournament in Nagoya, Japan. In May the world chess champion Gary Kasparov lost to IBM's Deep Blue supercomputer. In July the Mars Pathfinder mission reached Mars, his robot Sojourner went down to the Martian surface. In September 1997 Honda finished the P-3, a humanoid robot capable of walking, climbing stairs and loading.
The first node of the International Space Station (ISS) was finished and next year it was put into orbit. In the coming years it was annexed more components such as a robotic arm designed by a Canadian company MD Robotics.

In 1998, Lego introduced the 1.0. LEGO, called MINDSTORMS. Furby Tiger Electronics introduced Furby, a toy which used 800 phrases in English. In the same year Campbell Aird received first bionic arm and in October NASA launched the autonomous space shuttle Deep Space 1 which would test technologies for future missions manned and conducted only by robots.

In 1999 the Robot Personal presented the Cye robot, which performed a variety of household tasks like delivering mail. It was created by Probotics Inc. In May, Sony builds a robot dog called Aibo .

In October 2000 the UN estimated that there are 742.000 industrial robots in the world. More than half of them are found in Japan. In these years the development of the entertainment and educational purpose robot was continued. Lego launched the MINDSTORMS second version in 2000 and in 2001 it launched the construction MINDSTORMS.
Sony revealed the Sony Dream Robot (November 11, 2000), in 2001 the second generation of its Aibo robot dog, and in 2003 the AIBO ERS-7 the third generation. Meanwhile Honda (2000) debuted a new humanoid robot Asimo. The following year they presented another version of ASIMO, It could walk independently and climb stairs and ring the bells of Wall Street. Honda was considered the first to build a walking robot, but Sony with Qrio (2003) was the first to build a running humanoid robot.
On April 30, 2003 Epson revealed Monsieur II-P and in 2004 they launched a smaller robot called the Micro Flying Robot. Measuring just 10 grams and 70 millimeters the Micro Flying Robot was the world's smallest and lightest helicopter robot. In the London Aquarium at County Hall three fish robots were shown (2005). These were designed by Professor Hu Huosheng from the Department of Computer Science, University of Essex. His work had many applications such as seabed exploration, detecting oil leak at sea, search for mines and improving underwater vehicles. In the field aerospace we have the Remote Manipulator System of Space Station built by MD Robotics of Canada, placed in orbit in 2001 to complete the assembly of the International Space Station. In 2003 he successfully sent Spirit and Opportunity as part of the mission Mars Exploration Rover.

Advances and innovations in robotics have continued in various fields like education, medicine, industry, rescue, in exploring inhospitable, dangerous environment to humans.

3.5 Classification of robots

Today there are robots with many different features. Some of them are very specific, making it difficult to establish a single valid classification. There is no agreement on how many and what types of robots there are.

We could classify them by their geometry (also called coordinates) (Esteve, 2001. 1/3, 1/4; Rover Ranch. Types of Robots. Date of retrieval 21.1.2013):

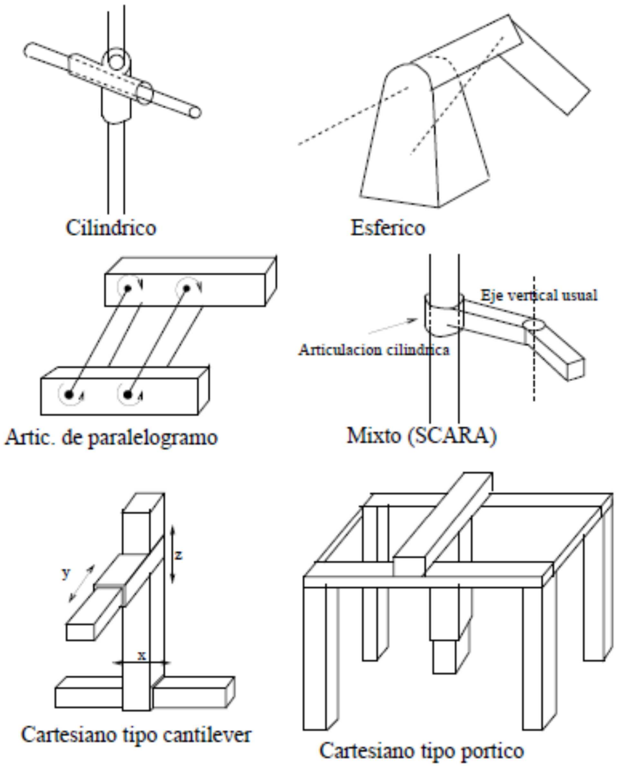

FIGURE 12

-Cylindrical: it has three axes of movement - two linear for moving along and one circular for rotate along.

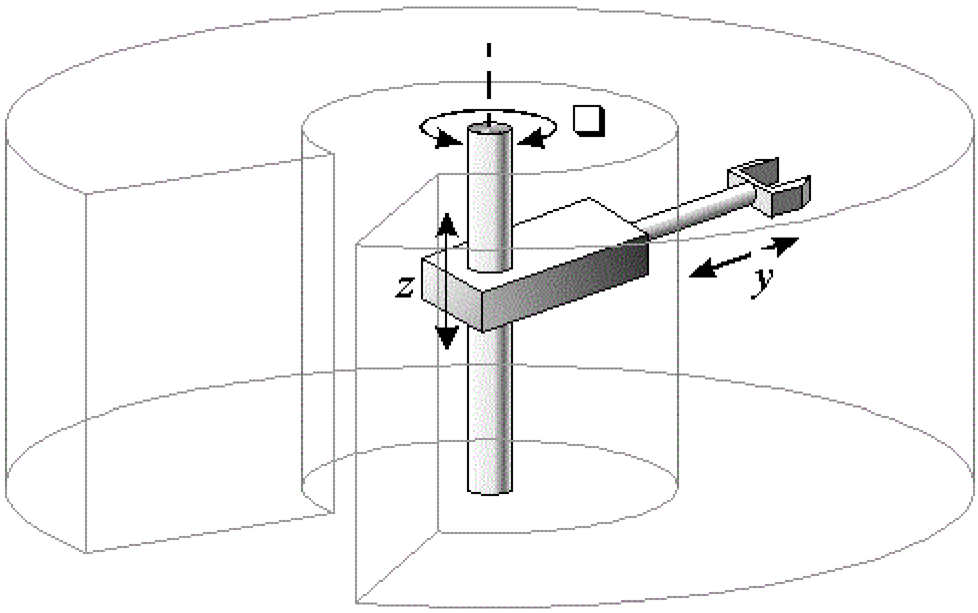

FIGURE 13

-Spherical: it has two rotary joints and one linear.

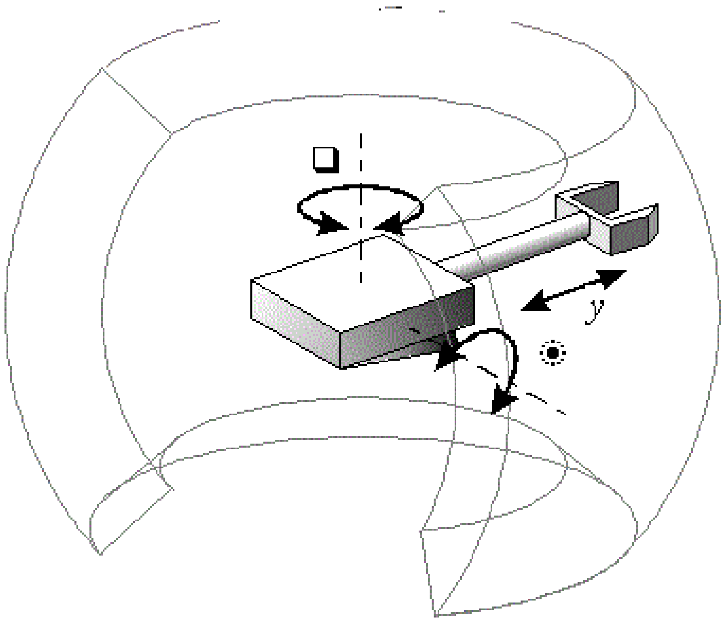

FIGURE 14

-Parallelogram: The joint has a double clamping bar.

-Mixed: possess various types of joint, as the SCARA.

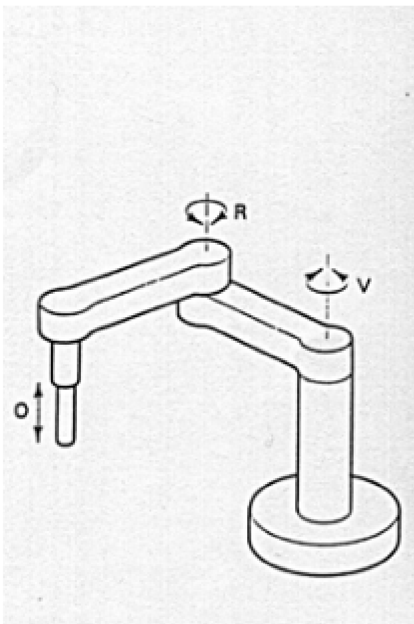

FIGURE 15

-Cartesian: it has 3 linear axes of freedom which are perpendicularly oriented at each other

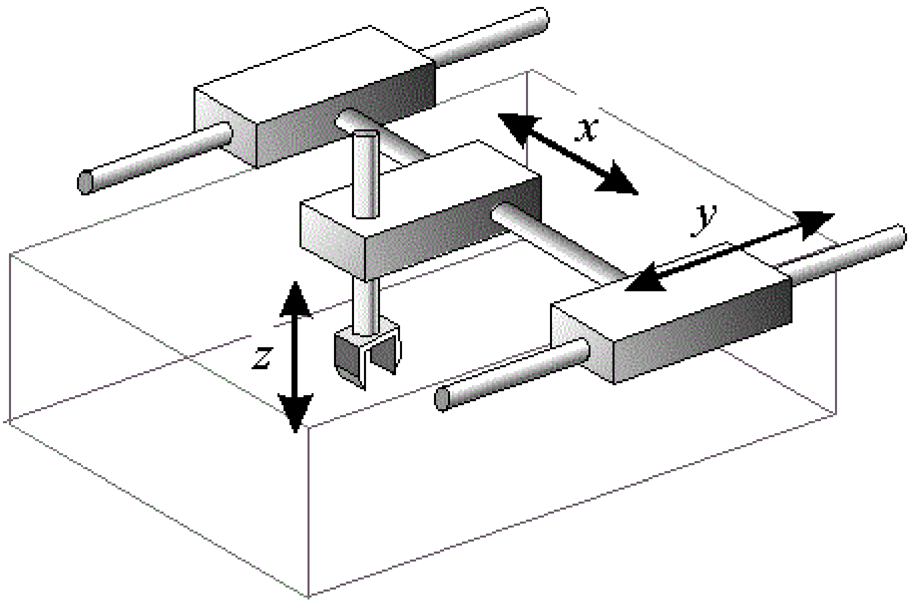

FIGURE 16

For the control method (Esteve, 2001.1/4):

-**No servo-controlled**: those in which each joint has a fixed number of (usually two) positions with stops. They are usually tires, very fast and accurate.

-**Servo-controlled**: in each joint they have a position sensor (linear or angular) which is read and this data is sent to the control system that generates power for the motor. It may well stop at any desired point.

-**Servo-controlled point-to-point**: To control them only indicate the start and end points of the path, the computer calculates the rest following certain algorithms. Normally can memorize positions.

Another way would be for the function (Esteve, 2001. 1/4):

-**Produced**: used in the manufacture of goods, can be be manipulation, manufacturing, assembly and test.

-**Exploration**: used to obtain data about the unknown terain. Can be terrestrial exploration, mining, oceanic, space, etc.

- **Rehabilitation**: used to help the handicapped, can be an extension of the anatomy or completely replace lost organ.

The Japan Robot Association JARA (previously JIRA, the Japan Industrial Robot Association) has defined six different classes of robot (Introduction to Robot Technology. Date of retrieval 7.2.2013):

-**Manual handling device**: This type of robot has multiple degrees of freedom, but all of its actions are performed under the direct control of an operator. Certain devices in this class may be referred to as co-bots (cooperative robots).

-**Fixed sequence robot**: This type of robot repeats a fixed sequence of actions without needing to be controlled by an operator. However, the sequence of actions it performs cannot be modified (i.e. it is not programmable).

-**Variable sequence robot**: This type of robot is similar to class 2, except that the sequence of actions can be reprogrammed easily allowing it to be quickly adapted to perform new tasks.

-**Playback robot**: This type of robot is first guided through a sequence of actions by an operator, then repeats the same actions automatically.

-**Numerical control robot**: This type of robot moves through a sequence of actions, which it receives in the form of numerical data.

-**Intelligent robot**: A robot that senses its environment and responds to changes in it in order to continue performing its function.

The Robotics Institution of America (RIA) does not consider classes 1 and 2 to be robots.

For The Association Francaise de Robotique (AFR) (Introduction to Robot Technology. Date of retrieval 7.2.2013):

-**Type A**: Manually controlled handling devices and telerobotics.

-**Type B**: Automatic handling devices with predetermined cycles.

-**Type C**: Servo controlled robots with programmable trajectories.

-**Type D**: Same as type C but able to respond to their environment.

Another classification might be as Generations, based on the history of Robotics (Clasificación de los Robots. Date of retrieval 21.1.2013):

-**First Generation, Play-Back**: They are multifunctional systems with a simple mechanical control system, manual, fixed sequence or string variable.

-**Second Generation sensorised Controlled Robots**: These have a closed-loop control of movements handled, and make decisions based on data collected by sensors.

-**Third Generation Robots with vision control**: The controller is a computer that gets information through a vision system and sends commands to the manipulator to perform the necessary movements.

-**Fourth-Generation Intelligent Robots**: Similar to the above, but can also automatically reprogram their actions on the basis of data obtained by the sensors.

-**Fifth-Generation Artificial Intelligence (AI)**: Currently in development, the IA would allow robots look more to the human conduct, providing more self-governance and sensations that can only perceive a person.

According to its architecture (Robotica. Date of retrieval 21.1.2013.):

-**Androids**: Robots are trying to reproduce the shape and kinematic behavior of human beings. Currently the androids are still very poorly developed devices and they are under study and experimentation.
One of the most complex aspects of these robots is the balance during bipedal locomotion.

-**Mobile**: moving through a wheel-based platform, these robots ensure the transportation of parts or their own movement from one point to another. They follow their path by remote control or guided by feedback from its environment through sensors. Among other functions, at the industrial level, these robots ensure the transportation of parts from one point to another in a production line. Guided by tracks materialized through electromagnetic radiation of circuits embedded in the ground or through bands detected photoelectrically they can even reach around obstacles and come with a relatively high level of intelligence.

-**Zoomorphic**: could also include the androids. Are mainly characterized by their locomotion systems that imitate the various living creatures. Can be grouped into two main categories: walkers and walkers.
The group of walkers no zoomorphic Robots is poorly developed. While robots are very numerous zoomorphic walkers. These Robots are used in the field of space exploration and the study of volcanoes.

-**Polyarticulated**: move their extremities with few degrees of freedom. In this group are the manipulators, industrial robots and Cartesian Robots. They are used when it is necessary to cover a relatively wide working area or elongated.

-**Hybrids**: These robots are difficult to classify because they are a combination of the above types, either by conjunction or juxtaposition. In similar situation are some anthropomorphic robots which do not qualify either as mobile or as androids, as in the case of personal robots.

In our case we will refer to wheeled mobile robots because that is the solution to give our RoboDemo

3.6 Mobile Robots

The development of mobile robots responds to the need to extend the application field of robotics, initially restricted to the scope of a mechanical structure anchored at one end. It is also of increasing autonomy everything possible limiting human intervention (Ollero 2001, 8).

The so-called "micro-mouse", created in the thirties to develop intelligent functions such as finding paths in mazes are precedents of mobile robots but these do not relate directly to autonomous vehicles of the sixties applied in industry , which were led by a cable under the ground or optical sensors to follow lines drawn on the ground.

In the seventies the mobile robots were equipped with greater autonomy, although the technology at the time could not allow an efficient autonomous navigation. In the eighties with the increase in computing power and the development of new sensors, mechanisms and control systems, the autonomy increased. In this decade, the mobile robots were developed for indoor and outdoor navigation, performed at the Carnegie Mellon University (Pittsburgh, USA). The robot had enough intelligence to react and make decisions based on observations of their environment, without supposing that this environment is well known.

The automatic navigation system is the basis of the autonomy of a mobile robot. These systems include tasks of planning, perception and control; the planning can be decomposed into global planning of the mission, of the route, of the trajectory and avoiding unexpected obstacles. Planning paths for mobile robots based on simplifying hypotheses: known and static environment, omnidirectional robots with slow motion and perfect execution path. To facilitate the search exist techniques to decompose the space in cells, use restrictions of various resolution levels and hierarchical search that allow a more efficient process for application in real time.
Dynamically in the trajectory planning will consider the current vehicle position and intermediate points defined in route planning. The trajectory is corrected due to events not considered, will consider the kinematic characteristics of the vehicle, for example in vehicles with wheel and traction conventional, is preferable to define continuous curvature paths that can be executed with the least possible error. The vehicle-terrain relationship is important and the planning of speed, taking account the terrain and the way it is intended to follow. Once the planning of the trajectory, we plan and control the specific movements to keep the vehicle on the planned trajectory, in the case of vehicles with wheels is obtained to determine the steering angle taking into account the current position and orientation of the vehicle with respect to the trajectory. It is also important to solve the problem of controlling and regulating the speed of the vehicle.
One method to integrate planning with the vehicle control is the potential field (Borenstein & Koren, 1990, 572-577; Vidal-Calleja, 2002), which consists in

determining the robot resultant of that attract to the target and repel to the obstacles.
To solve the problem of automatic control of a vehicle with wheels can be more complex than the manipulator for the holonomous restrictions. The vehicle control needs to know the position and orientation of the vehicle at sufficiently short intervals. For this we have the odometry, which requires data provided by sensors located on the axes of motion, optical encoders typically, although the sum of errors can be very large. We may also use inertial navigation systems with gyroscopes and accelerometers, but the sum of errors can be very large. However, the combination of odometer techniques with the measurement of the angles of orientation may give good results. Robots outdoors, with considerable distances, can use global positioning system by satellite. The position uncertainty is reduced with the system of perception, which uses special marks to estimate the position of the robot. The system of perception should consider the robot's speed, accuracy, scope, the possibility of misinterpretation of data and the structure of the representation of the environment.
The system of perception allows a mobile robot to use safe navigation, recognizing the obstacles and dangers, recognize their environment and build a map of its environment (geometric), and estimate the vehicle's position accurately. Furthermore, neural networks have been applied to generate the steering angle from the system of perception, video cameras, laser and ultrasound sensors which are inexpensive and simple to navigate. Determining is based on the so-called time of flight of a sound pulse (between 30 kHz and 1 MHz).

3.7 Robots autonomous and Telerobotic

We have 3 different types of robots by the degree of autonomy: teleoperated, repetitive operating and autonomous or intelligent.

3.7.1 Teleoperated robots

It is the task of human perception of the environment, planning and handling. The operator acts in real time and the sensors will provide data on the distances, forces and images of the environment where they are. The operator will receive data from the sensors about the environment (images, forces, distances). In handling anthropomorphic arms and hands are used with automatic controllers which reproduce the movements of the operator. Alternatively, the operator moves a scale replica of the manipulator reproducing the movements in this. One problem is in the design of man-machine interface, due to the limitations of man in numerical processing and in accuracy (Ollero 2001, 11-12).

3.7.2 Robots of repetitive operation

Are mostly used in industrial production. They normally work in predictable and invariant tasks with a limited perception of the environment. They are accurate, highly repeatable and relatively fast. They increase productivity and save people from doing repetitive, painful or even dangerous work.

3.7.3 Autonomous or intelligent robots

These robots can perceive and shape the environment in which they operate. They are able to plan for themselves (or with very little human intervention supervisors) and act to achieve their goals. Artificial Intelligence techniques have developed greatly in recent years.

3.8 The mobile robotics today

The mobile robot has become increasingly important in recent times. They have developed many research in the recent years, which has integrated mobile robots in industrial and domestic sector from vacuum cleaners to automatic autonomous vehicles. Most current research of mobile robots is focused on environments interiors, spaces of corridors and rooms.

3.8.1 Application of mobile robotics

The robot has many applications. Here are some of them:

3.8.1.1 Manufacturing

Industrial robots are probably the most common ones. They are used to perform specific tasks with a minimum reasoning. The most common work is the production of parts of different types of articles. The machines used to perform this type of work are called robot arms. These are also used to handle radioactive materials, thus the man does not come into direct contact with the material, but does so through the robot arm.

3.8.1.2 Medicine

Within the medical field robotics is used for long distance operations where the medical equipment is in one place and the patient in another. Robotic arms are also being applied in this. The medical team has a certain kind of remote control for sending the movement commands to the robot arm. The medical team can see what happens in the operation area by using cameras in the location. In the same way an operation in which both the medical equipment and the patient are in the same place can be performed for operations that require a lot of accuracy, as robot arms allow to carry out very precise movements and avoid human error.

3.8.1.3 Exploration (Research inaccessible places)

There are robots that are created to explore dangerous places for humans. They can also be used in the search for missing persons in an earthquake, fire or other catastrophic phenomenon in which the loss of life is inevitable and man is not sufficiently prepared to face. The explorers robot use in these areas increase the chances of rescue in situations like these. It is possible to build a robot with features that allow us to deal with situations such as an earthquake, fire or flood to perform the rescue. These robots are built with specific characteristics to pass through areas that have to be explored. Such robots are usually equipped with proximity, light or touch sensors, in order to avoid collisions. They also have cameras to get a perspective of the terrain explored. These robots are teleoperated by a human operator who sends instructions to the robot with a remote control and it moves in the direction indicated.

3.8.1.4 Entertainment

There are robots created to entertain children that imitate animals. An example of this is a dog robot which can follow a ball or perform some type of acrobatics. Good examples of these are the commercial models Aibo (The Sony robot dog), Poo-Chi, Bow-wow, I-Cybie, iDog (Sega's robot iPod music speaker). There are also robot competitions such as a football competition where the teams are representing a college, institution or private teams.

As we can see, these are just some of the fields in which robotics influences today. Robotics is a tool we can exploit even more for the service of humanity in many fields. Robotics is one of the technologies that have a bright future and they move at high speed as new discoveries and contributions are concerned. We can see robots as a new species of beings created by man, made to help man. We can entrust tasks for the robots that a man can't do for his limited strength, low resistance to fire or the limited time of being under water. We can list a set of features that we wish we had in our body, but the nature is limited. Such features could be implemented in to our new species and perhaps discovery of new planets can be done by robots, which would assist in the investigation of science. See figure 17 (Carrelli, 2009).

FIGURE 17 Application of mobile robotics

3.8.2 Locomotion of mobile robots

We will refer to the type of mobile robot that uses wheels for its displacement, as this will be the solution that we will give to our RobotDemo. The mobile robots with wheels are a simple and efficient solution to achieve mobility on land hard enough, allowing relatively high speeds compared to other means of mobility and locomotion using legs. The most significant limitation is the slip on the impulse.
Mobile robots employ different types of locomotion by wheels which confers different properties and characteristics regarding energy efficiency, size, and maneuverability. The best maneuverability is achieved in omnidirectional vehicles. An omnidirectional vehicle is able to move simultaneously and independently on each axis of the coordinate system and rotated by the perpendicular axis.

The following briefly discusses the most significant features of the locomotion systems more common in mobile robots (Ollero, 2001, 28-30; Sistemas de Locomoción de robots móviles. Date of retrieval 26.1.2013; Xiao. Date of retrieval 26.1.2013):

3.8.2.1 Ackerman

Is used in conventional four-wheeled vehicles. In fact, external robotic vehicles are normally the modification of conventional vehicles such as automobiles and even heavier vehicles. The inner front wheel revolves an angle slightly greater than the outside ($\theta_i > \theta_o$) to eliminate slippage. The extensions of the axes of the two front wheels intersect at a point on the prolongation of the axis of the rear wheels. The place of the points paths on the ground by the tire centres are concentric circles with center axis of rotation P1 in the figure 18 (Xiao, Jizhong. Mobile Robot Locomotion. Date of retrieval 26.1.2013). If the centrifugal forces are not taken into account, the instantaneous velocity vectors are tangent to these curves.

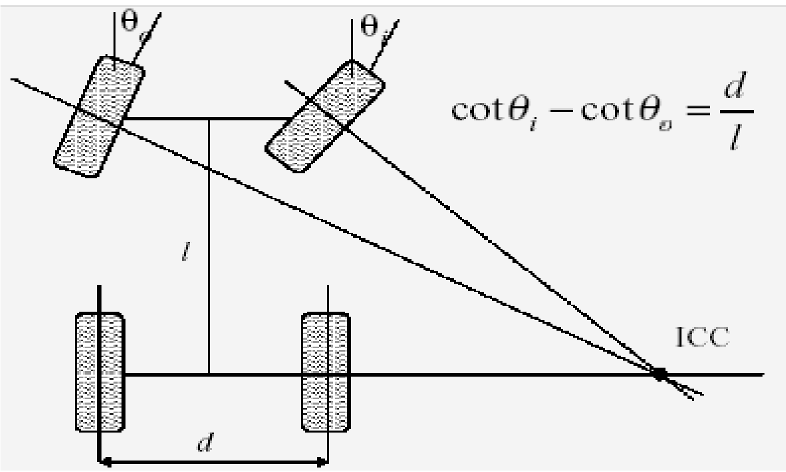

FIGURE 18 Ackerman System

where

d = lateral wheel separation
l = longitudinal wheel separation
θ_i = relative angle of inside wheel
θ_o = relative angle of outside wheel
ICC = Instantaneous center of curvature

3.8.2.2 Classic tricycle

This locomotion system is illustrated in figure 19. The front wheel serves both to traction as for addressing. The rear axle with two wheels, is passive and the wheels move freely. The maneuverability is higher than in the previous configuration but may have problems of stability on difficult terrain. The center of gravity tends to move when the vehicle is traveling down a slope, causing loss of traction.

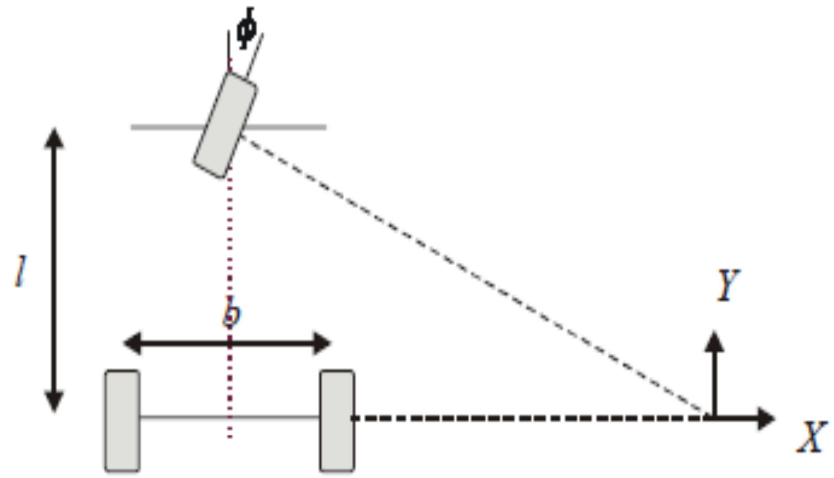

FIGURE 19 Classic Tricycle Locomotion

3.8.2.3 Differential Drive

A differential drive is the most basic drive, which consists of two sets of wheels that can be driven independently usually has one caster wheel. It’s the simplest and easiest to implement, to turn the robot left or right, wheels are rotated at "different" speeds or in “different” directions. If the wheels turn at equal speed, but in opposite directions, the robot turns on the spot.

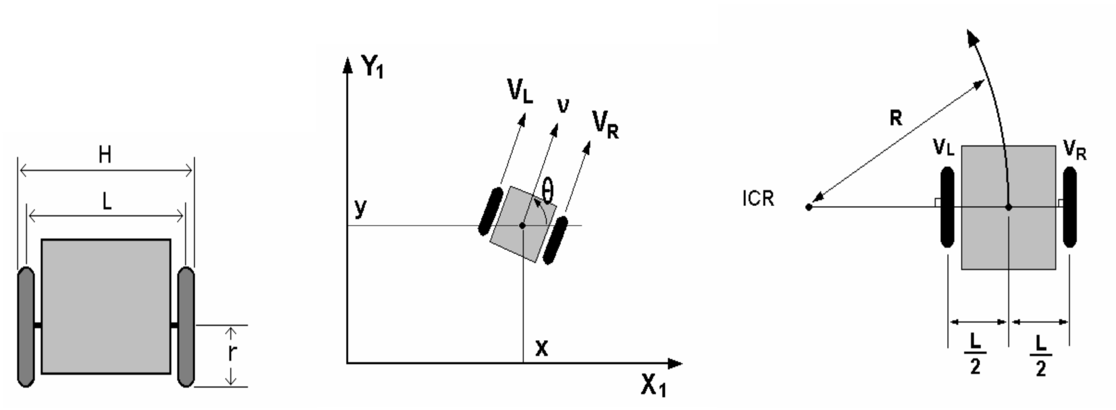

FIGURE 20 Differential Drive

Where

(x,y) :Position of the robot
θ :Orientation of the robot
v :Linear velocity of the robot
w :Angular velocity of the robot
V_R :Linear velocity of right wheel
V_L :Linear velocity of right wheel
r :Nominal radius of each wheel
R :Instantaneous curvature radius of the robot trajectory
ICR :Instantaneous center of rotation

3.9 Mobile robot architectures

Mobile robot architectures allows to build an intelligent control systems for robots determining what kinds of components or building blocks is needed for the system and how these elements are organized and how they interact with each other giving the control system its functionality.
There are several mobile robot architectures, depending on the relationship between sensing, planning and acting components inside the architecture. The most important types of architectures are deliberative, reactive and hybrid (Ruiz del Solar,Salazar. Date of retrieval 26.1.2013).

3.9.1 Deliberative architecture

Which is based on the schema of "sensing-planning-acting" where the robot's directives needed to reach the goal are planned considering a map of the environment. Acquired action can be took without planning. When the planning has been done the robot will carry out the first directiva. After this sequence the cycle begins again. Deliberative architecture works in a more predictable way. They have a high dependency of a precise and complete model of the world and they can generate optimized trajectories for the robot. An example of this type of architecture can be seen in the robot shakey (Ruiz del Solar,Salazar. Date of retrieval 26.1.2013).

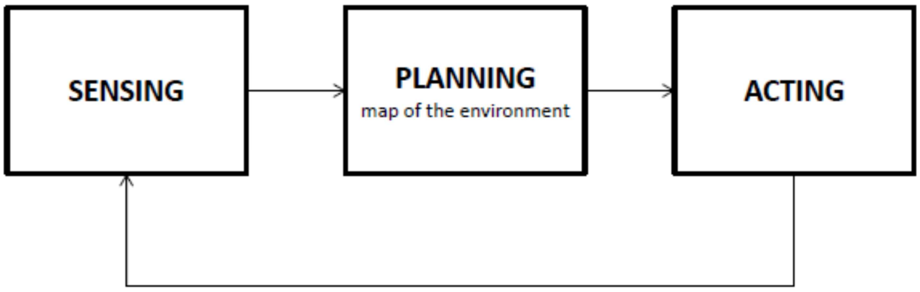

FIGURE 21 Deliberative Architecture

3.9.2 Reactive Architecture

This architecture is based on a direct connection between perception and action without the necessity of a world model. Usually considers a range of levels of behavior that perform different behaviors parallel. The sensing and acting components are closely linked in to behaviors and all robotic activities emerge as the result of these behaviors operating either in sequence or concurrently. Reactive Architectures have a faster response to dynamic changes in the environment, working without a model of the world and are computationally much simpler.
The sensors are connected to a central processing unit and based on the information provided by these sensors the behavior of the mobile robot changes to control the actuators (Ruiz del Solar,Salazar. Date of retrieval 26.1.2013).

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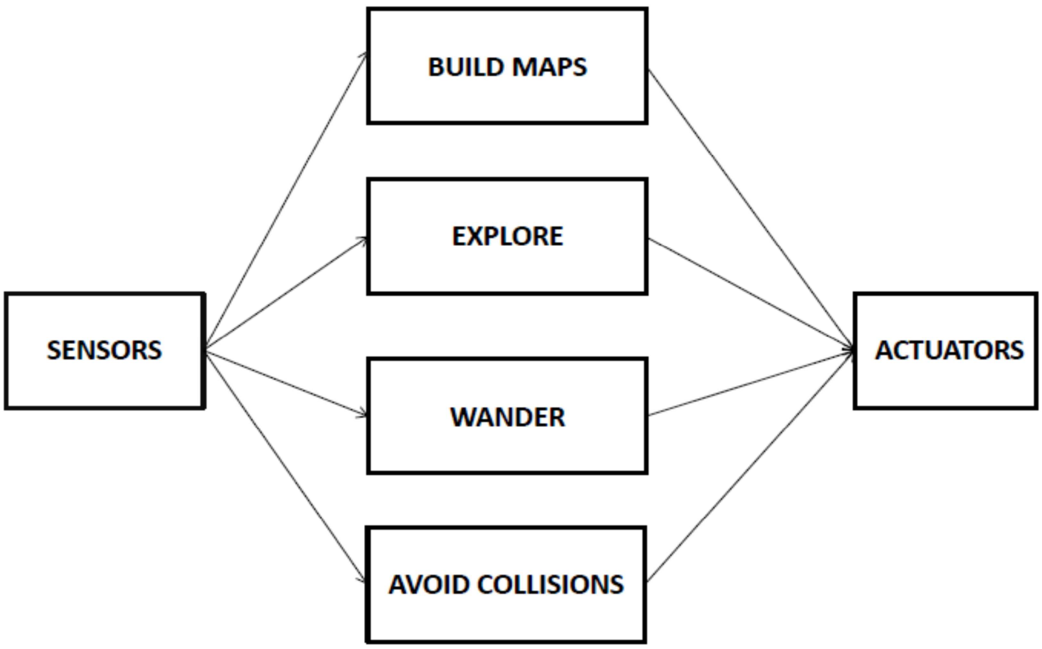


FIGURE 22 Reactive Architecture

3.9.3 Hybrid Architecture

A hybrid Architecture combines the advantages of Deliberative Architectures with Reactive architectures. Think slowly, react quickly. A hybrid system typically consists of three components; a reactive layer, a planner and a layer that outs the two together. It is composed by the following main components: sensing modules, mapping and localization modules, motion planner, reactive behaviors, input coordinator and actuator modules.
This architecture is applied in robots with complex tasks in uncertain environments.There are a variety of hybrid architecture designs (Ruiz del Solar,Salazar. Date of retrieval 26.1.2013).

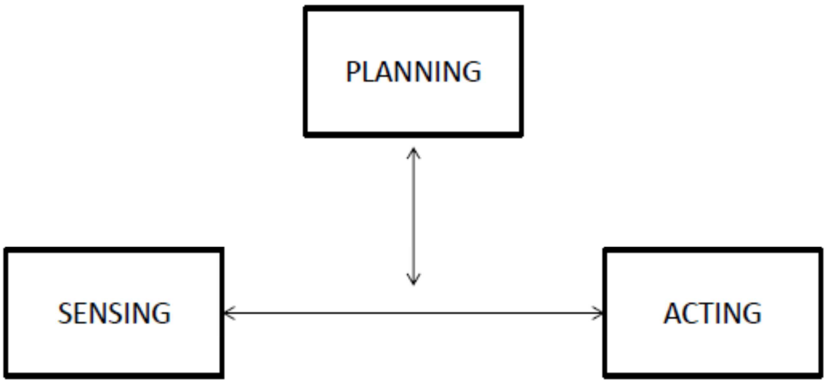


FIGURE 23 Hybrid Architecture

3.10 Requirements for the design of a robotic architecture

An autonomous robot is able to make decisions and react according to the environment and conditions and can carry out tasks in accordance with its objectives. The efficiency of its functioning depends on it's structured architecture, which must meet the following requirements(Ollero, 2001):

3.10.1 Programmability

The robot must be able to perform multiple tasks and actions to carry out the planned actions based on their current status and their environment. Depending on the functions of the robot, its architecture must perform different types of operations in a satisfactory manner.

3.10.2 Efficiency

A good hardware and software are required to be efficient in the performance of assigned tasks accurately and in good time. It is important to define the environment in which the robot operates and it's resources for optimizing them in order to get a good performance. It is also necessary to have consistent plans and goals.

3.10.3 Evolution capacity

This is important especially in projects with new and innovative proposals, those who will be apt for review and if necessary to adapt new technologies, equipment and components

3.10.4 Degree of autonomy

Intelligent control architectures have a high degree of autonomy, but it is possible a type of autonomy and teleoperated dual, for example in cases where it is difficult or teleoperation for security reasons.

3.10.5 Reliability

The reliability search may lead us to have more of a system to perform its actions. This can lead us to have a repetition of functions for carrying out the same task, which could lead us to duplicate hardware resources (sensors).

3.10.6 Adaptability

The system must have the flexibility to operate in different environments poorly understood. It is also the ability to change, to adapt their behavior taking the robot's location into account and what kind of changes may occur in the space in which it operates.

Some requirements can get to make contradictory, design the architecture will establish a compromise between reliability and adaptability.

3.11 General Structure of a Mobile Robot

The behavior of a mobile robot closely resembles a living being. It could be seen as a copy of it, as the mobile robot executes its actions with the same or even better effectiveness than people or animals. For this reason the structure of a mobile robot and a living being has many similarities that are almost equal (Galvez, Mauricio. Date of retrieval 25.1.2013), See Figure 24.

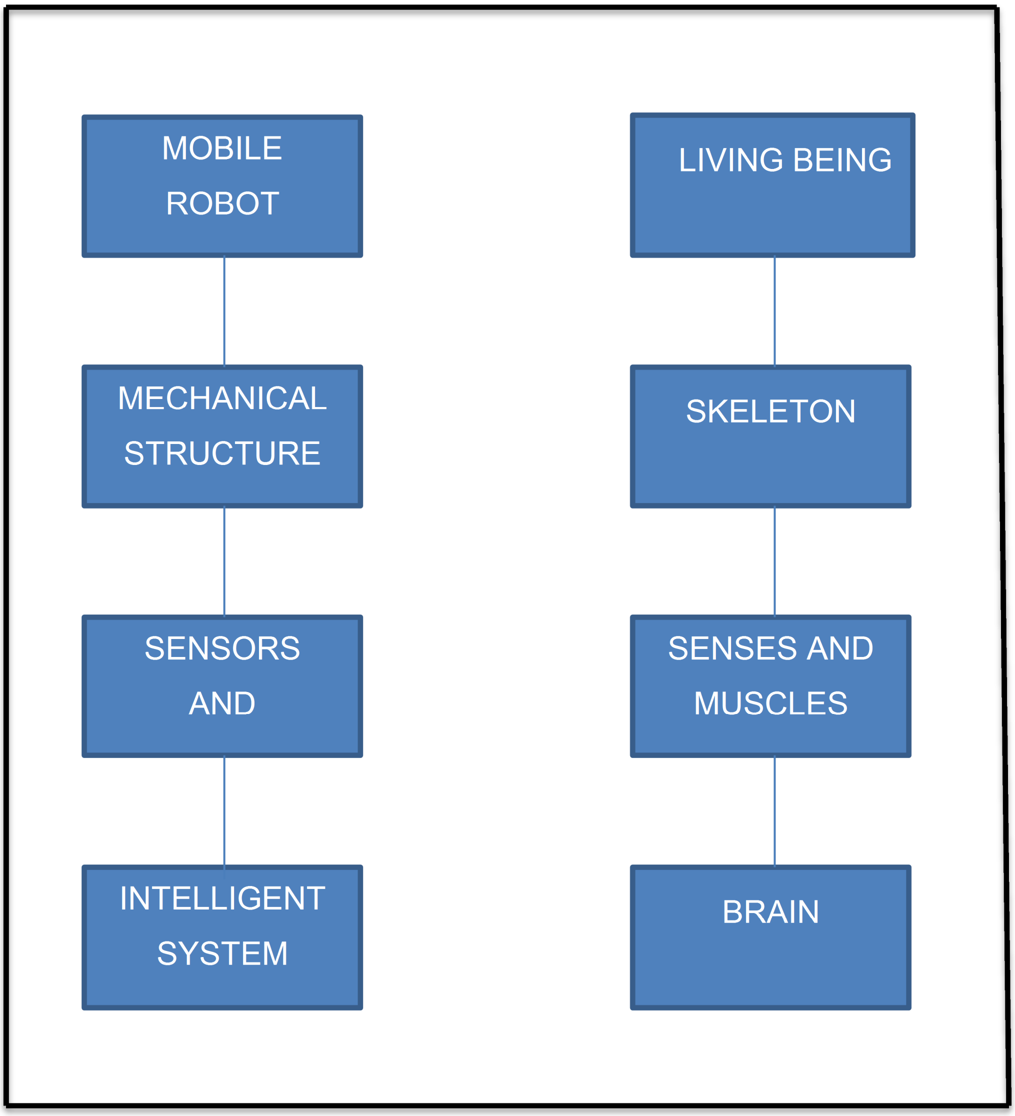


FIGURE 24 Structure of a Mobile Robot compared to a living being

As we can see in the figure the structure of a mobile robot which is composed by other substructures, wheels, legs or tracks will give you the movement, with the sensors will recognize their environment as are the senses for living beings, her intelligent system algorithms to process the data transmitted by the sensors, and execute the necessary actions to comply tasks assigned, such as the brain for people.The structure of a robot is comprised of subsystems with basic components as shown in Figure 25 (Vengateswaran,1999, 79)

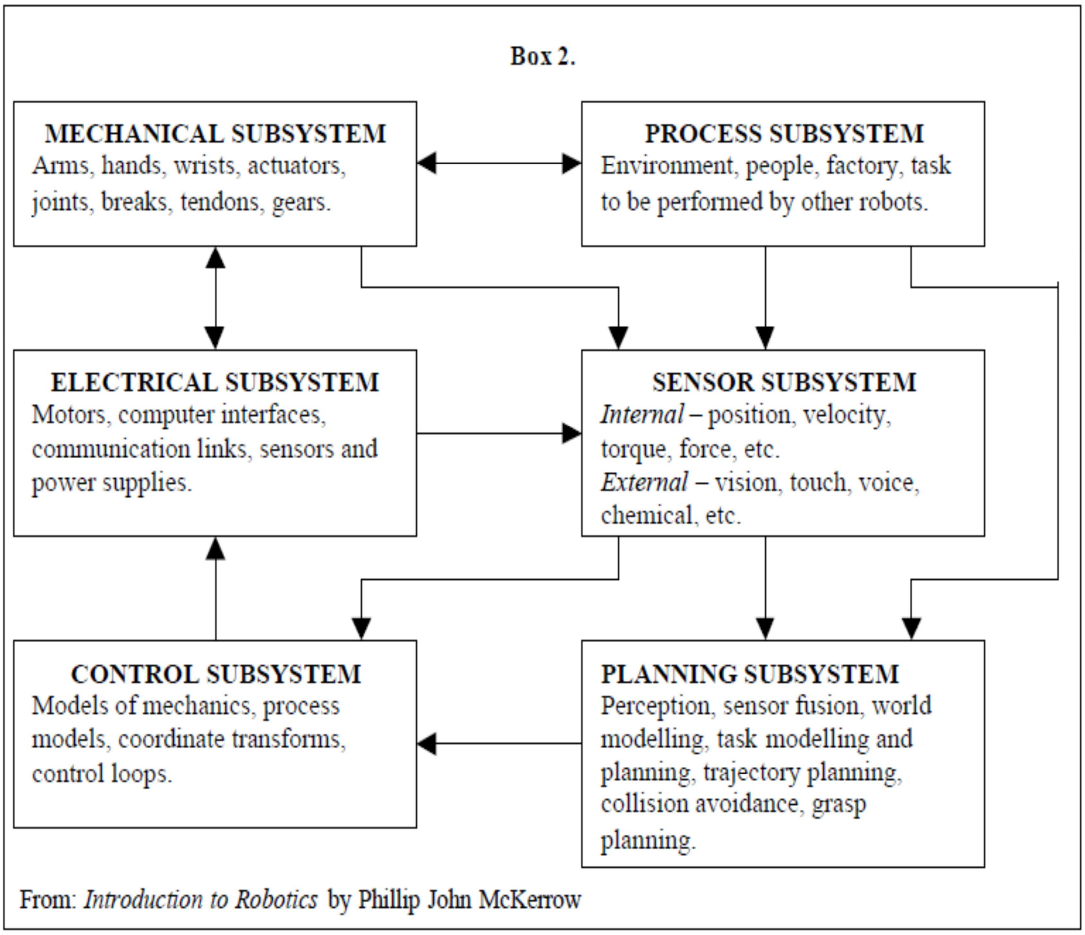


FIGURE 25 The Robot subsystems

How the robot behaves and performes their tasks is controlled by the control subsystem wich is fed by the subsystems of measures that will provide all the necessary data. The robot also needs a power source. Another important part is the robot software (Vengateswaran,1999, 79).
The robot has a base or chassis where all the mechanical and electronic components will be installed. According to the solution given is incorporated wheels, legs or tracks, is adapted their actuators as arms, tongs or other element with engines (DC, Step by Step, servo). These will give the movement to interact with their environment and sensors that can be ultrasound, infrared, CCD cameras or pulse to provide it with information of their environment.

4 The Hardware of the RobotDemo

4.1 Introduction

The interest in building robots as a hobby has increased greatly these days. This might be due to the cheapening of the microprocessors, mechanical components (motors, actuators, chassis) and electronics such as the sensors that are easier to acquire (for cost and availability), especially the infrared sensors (IR). There are also sensors modules pre-assembled as digital compasses, with simple vision cameras available today. These modules work independently of the main processor and are connected via serial interfaces. The educational kits that are available in the market such as the Parallax, Arduino have been helpful. The rise of hardware in robotics has facilitated the construction of robots, but although much of this new hardware is designed for amateurs the construction of "robots autonomous navigation" have many difficulties. By the lack of time has been used in the construction of the RobotDemo mechanical and electrical components ready from the market as a Arduino board (to test and write the program), Tamiya DC motors with wheels, and the L298N motor controller all those designed for use in the development of robots.

4.2 Mechanics of the RobotDemo

When designing the mechanics of RobotDemo the choice of the basic components is very important. This will take into account the tasks the robot executes and its relationship to the environment in which they are executed (Imahara. 2004).

4.2.1 Mechanical Components of the RobotDemo

An important part in the construction of the mobile robot is the propulsion system. The propulsion system for robots working indoors is based on electric motors. When selecting the engines one must take into account the size and weight of the robot, the environment and soil type in which it operates as well as the tasks to be assigned (Imahara. 2004).
In the case of our RobotDemo its engines will have a gear system which will provide certain advantages for example torque.The choice of mechanical components of the RobotDemo is performed taking into account the cost-effectiveness of each of its parts.
The mobile robot has the following basic mechanical components
-A chassis.
-Two DC motors with gear system.
-Two servo motors.
-Two wheels.
-A caster wheel.
-A mechanical arm to pick up objects..
-A fan.

4.2.1.1 Robot Chassis

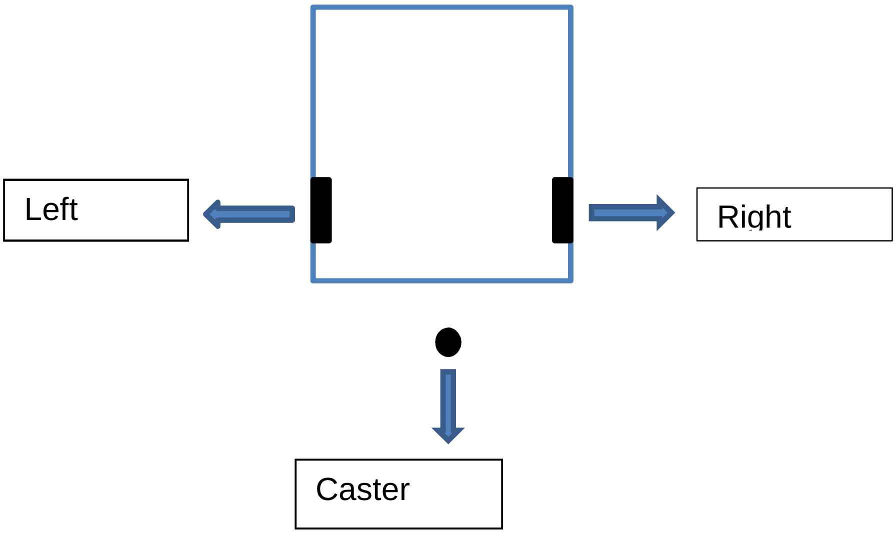


FIGURE 26 The Chassis of the RobotDemo Diferencial

The chassis of the RobotDemo is based on a differential robot that has two side wheels which provide the steering system and the traction of the mobile robot. In addition to having one or more wheels supporting, the RobotDemo has one caster wheel. See the figure 27. The propulsion wheel is carried by the two electric motors.

Figure 27 The Chassis and the wheels

The RobotDemo is a prototype of how one could build a robot for this type of competition proposed here. For that reason we have designed so that access to its components is easy, to be able make the necessary changes.
The following describes in greater detail how the chassis is made for the mobile robot. The lower platform rectangular is shaped 8.5 cm x 7.5 cm and made of aluminum. It contains the propulsion system (motor and gear system), two lateral drive wheels, a rear wheel (caster wheel) of 1 cm. in diameter which serves to maintain the balance of the robot.
There are infrared sensors (5) on the front underside of the chassis which allow to follow the black line. Above DC motors with gear system a battery is located. Above the battery there is a circuit containing the microcontroller Atmega328 and the H-Bridget L298N which is for the control of the engine and the thermistor temperature sensor. At the upper level separated from the circuit there is a fan and a servo motor. The servo motor is for the fan that will blow out the candle. There is also a mechanical arm that will be attached to the front middle part of the robot. It is responsible for picking up the objects (Appendix A4, A5, A6).

4.2.1.2 DC Motors with gear system

For RobotDemo it was chosen a double gearbox motor, Tamiya 70168, which comes with 2 motors Mobuchi FA-130-RA.
The Tamiya 70168 double gearbox is a compact unit with two independent motors and gear trains. The possible gear ratio configurations are 12.7:1, 38:1, 115:1, and 344:1. Although it is not typical, it is possible to assemble each side with different gear ratios. There are two possible output axle locations (Tamiya 70168. Date of retrieval 4.2.2013).

FIGURE 28 Tamiya 70168 Double Gearbox

General specifications

Typical operating voltage: 3 V
Gear ratio options: 12.7, 38, 115, 344 :1
Free-run motor shaft speed @ 3V: 12300 rpm1
Free-run current @ 3V: 150 mA2
Stall current @ 3V: 2100 mA
Motor shaft stall torque @ 3V: 0.5 oz·in3

The output shafts are 3 mm hexagonal axles that are 10 cm from tip to tip. The axles work with any of the four Tamiya wheels giving you many options for your robot speed. The low-voltage motors run on 3-6 volts and draw up to a few amps. Motor overheating can be caused by excessive stalling, even at very low voltages. It is recommended that you use stall-detection sensors, or just watch your robot, to make sure that it doesn't stall for more than a few seconds at a time (Tamiya 70168. Date of retrieval 4.2.2013), See the Appendix A7, A8.

FIGURE 29 The Mobuchi FA-130

The Basic specifications for The Mobuchi FA-130:

-Operating voltage: 1.5-3 V
-No-load speed at 3 V: about 12,300 RPM
-Stall current at 3 V: about 2.10 A
-Stall torque at 3 V: about 36 g-cm

4.2.1.3 The wheels

The RobotDemo uses Tamiya 70145, a pair of narrow tires for small and medium-sized robots that must make precise movements. With a 58 mm diameter and solid, rounded, 16 mm treads, these wheels will let the robot to turn with little friction, even on rough surfaces like carpet. These wheels are compatible with Tamiya 70168 Double Gearbox (Tamiya 70145. Date of retrieval 4.2.2013), see figure 30.

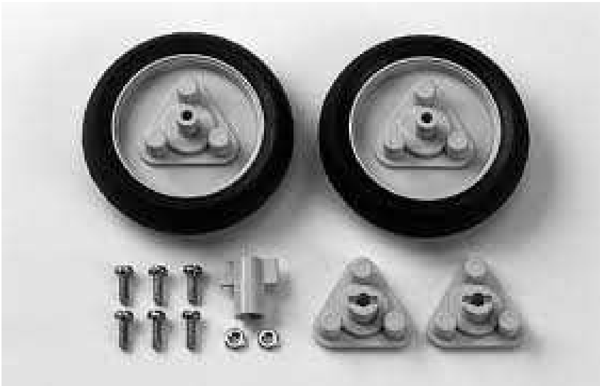


FIGURE 30 Tamiya wheels 70145

For a good balance one caster wheel is used on the rear, see figure 31

FIGURE 31 Caster Wheel

4.2.1.4 Servomotors (2)

Servos are used extensively in robotics and radio-controlled cars, airplanes, and boats. A servomotor is an electromechanical device in which an electrical input determines the position of the armature of a motor. The RobotDemo uses 2 servomotors, one for the fan and the other for the mechanical arm. Our Robot uses the Hitec model HS-81 Standard Micro Servo which is the most popular servo with a fine balance between speed and torque (The Servo HS-81. Date of retrieval 4.2.2013).

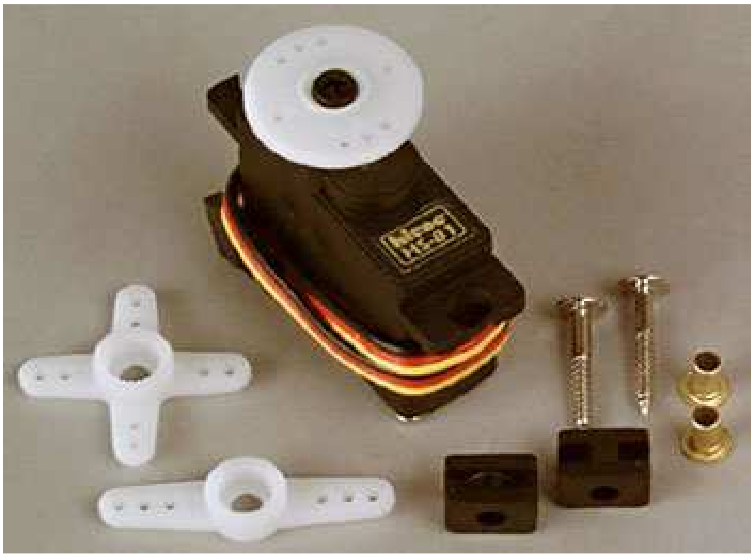


FIGURE 32 The Servo HS-81

This servo can operate 180° when given a pulse signal ranging from 600usec to 2400usec, see figure 33

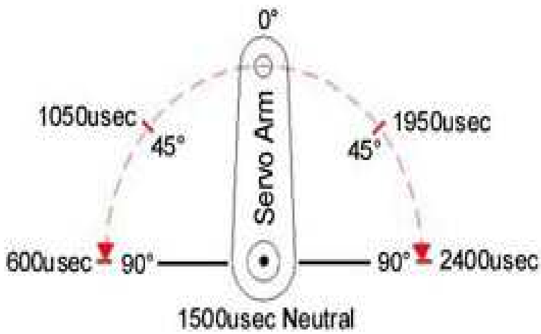


FIGURE 33 HS-81 operate 180°

The Basic specifications for HS-81 (The Servo HS-81. Date of retrieval 4.2.2013):

Control System:	+Pulse Width Control 1500usec Neutral
Required Pulse:	3-5 Volt Peak to Peak Square Wave
Operating Voltage:	4.8-6.0 Volts
Operating Temperature Range:	-20 to +60 Degree C
Operating Speed (4.8V):	0.11sec/60° at no load
Operating Speed (6.0V):	0.09sec/60° at no load
Stall Torque (4.8V):	36.10 oz/in. (2.6kg.cm)
Stall Torque (6.0V):	41.66 oz/in. (3kg.cm)

Operating Angle: 45 Deg. one side pulse traveling 450usec
Continuous Rotation Modifiable: No
Direction: Clockwise/Pulse Traveling 1500 to 1900usec
Current Drain (4.8V): 8.8mA/idle and 220mA no load operating
Current Drain (6.0V): 9.1mA/idle and 280mA no load operating
Dead Band Width: 8usec
Motor Type: 3 Pole Ferrite
Potentiometer Drive: Direct Drive
Bearing Type: None, outer case serves as bearing
Gear Type: All Nylon
Connector Wire Length: 6.29" (160mm)
Dimensions: 1.17" x 0.47"x 1.16" (29.8 x 12 x 29.6mm)
Weight: 0.58oz (16.6g)

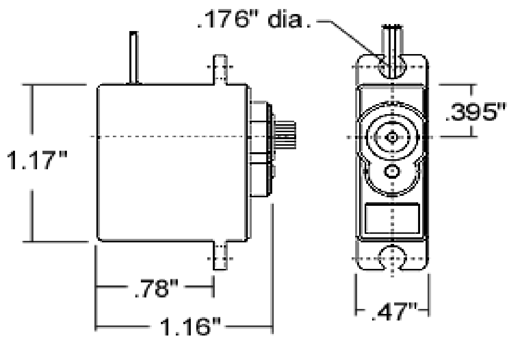


FIGURE 34 HS-81 Dimensions

4.2.1.5 The Fan

To blow out the candle the RobotDemo has a fan. The CY 420/A is a small and noiseless fan, see Figure 35

FIGURE 35 Fan CY420/A

Specifications (Fan CY 420/A. Date of retrieval 4.2.2013):

Width: 40 mm Millimeter
Height: 40 mm Millimeter
Depth: 20 mm Millimeter
Air Flow: 2 CFM Cubic Feet per Minute
Sound Level: 25.5 dB(A) Decibel
Speed: 4500 RPM Rotations Per Minute
Voltage: 12 V Volt
Voltage Type: DC
Current: 90 mA milliAmps
Bearing Type: Sleeve (Fans)
Fans: 1
Material: Plastic

4.2.1.6 The mechanical arm

The RobotDemo has a mechanical arm to take an object, it is moved for a servomotor. Two kinds of arms are planned to be tested. One is made of aluminum and its measures are 11 x 8.5 cm (see figure 36). The other one is made of lego pieces and its measures are 7 x 4 cm.(see figure 37).

FIGURE 36 Aluminum Mechanical Arm

FIGURE 37 Lego pieces Mechanical Arm

4.3 Electronics Mobile Robot

The electronic design of the mobile robot is based on digital electronics and is represented by high and low (or 0 and 1) which is processed by the microcontroller. One should also take into consideration the treatment of analog signals which have continuous levels that vary over time. A target for the design of electronics in general is to use the least number of components making the most of the features of the microcontroller.

4.4 Electronic components of the RobotDemo

The electronic components of the mobile robot are designed to provide a conditioned signal to the central processor of the mobile robot. These are:

Arduino Duemilanove (1)
Atmega 328 P (1)
L 298 N
Battery (1)
Infrared Sensors (5)
Thermistor Temperature sensor (1)

4.4.1.Arduino Duemilanove

The protoboard Arduino Duemilanove (Figure 38) is used for testing and writing the program for the microcontroller. The Arduino is a libre hardware and

software project. It is fexible, offers various digital and analog inputs, SPI, I2C, a serial interface and digital and PWM outputs.
It is easy to use, it connects to a computer via USB and communicates using the standard serial protocol, runs in standalone mode and as an interface connected to PC/Macintosh computers
It is cheap and comes with free development environment
It is backed up by a growing on-line community. Lots of source codes are already available and ready to be used (Arduino Duemilanove. Date of retrieval 6.2.2013).

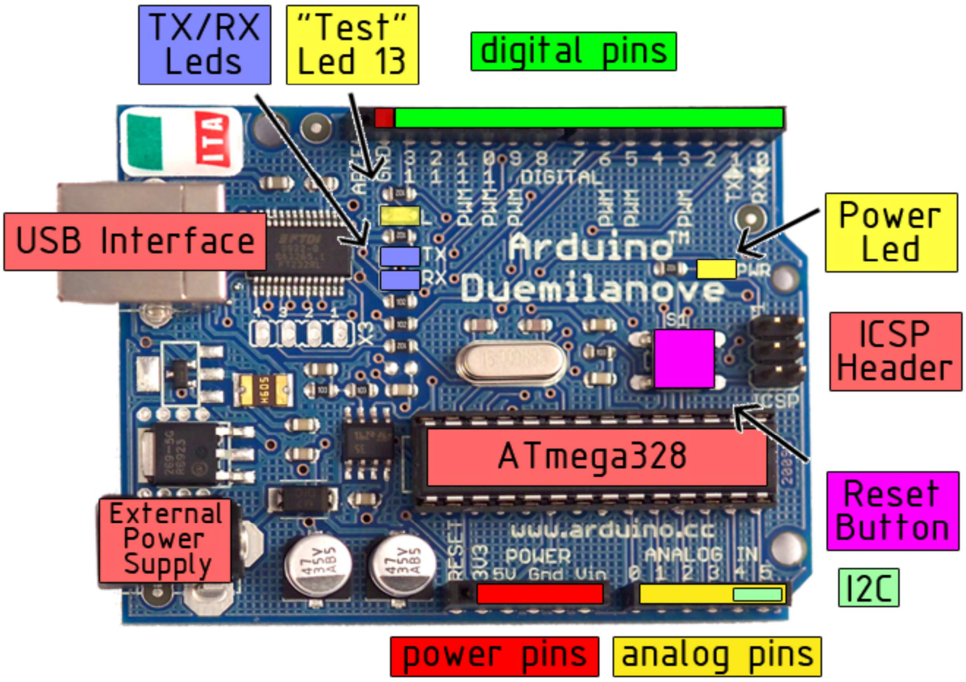


FIGURE 38 Arduino Duemilanove

4.4.2 Microcontroller

The microcontroller is the brain of the mobile robot as it controls the behavior and
actions taken by the robot. The control unit executing the control algorithm robot, the process commands for the actuators of the vehicle and signal acquisition
from the sensors is based on a single microcontroller trying to use its resources to the maximum to reduce the number of components external electronics as shown in Figure 39. The RobotDemos microcontroller is the Atmel ATMEGA 328p (Figure 40), an 8-bit AVR RISC-based microcontroller which combines 32 KB ISP flash memory with read-while-write capabilities, 1 KB EEPROM, 2 KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter capable of running up to 200

KHz, programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The ATMEGA 328p operates between 2.7-5.5 volts (ATmega328P. Date of retrieval 6.2.2013).

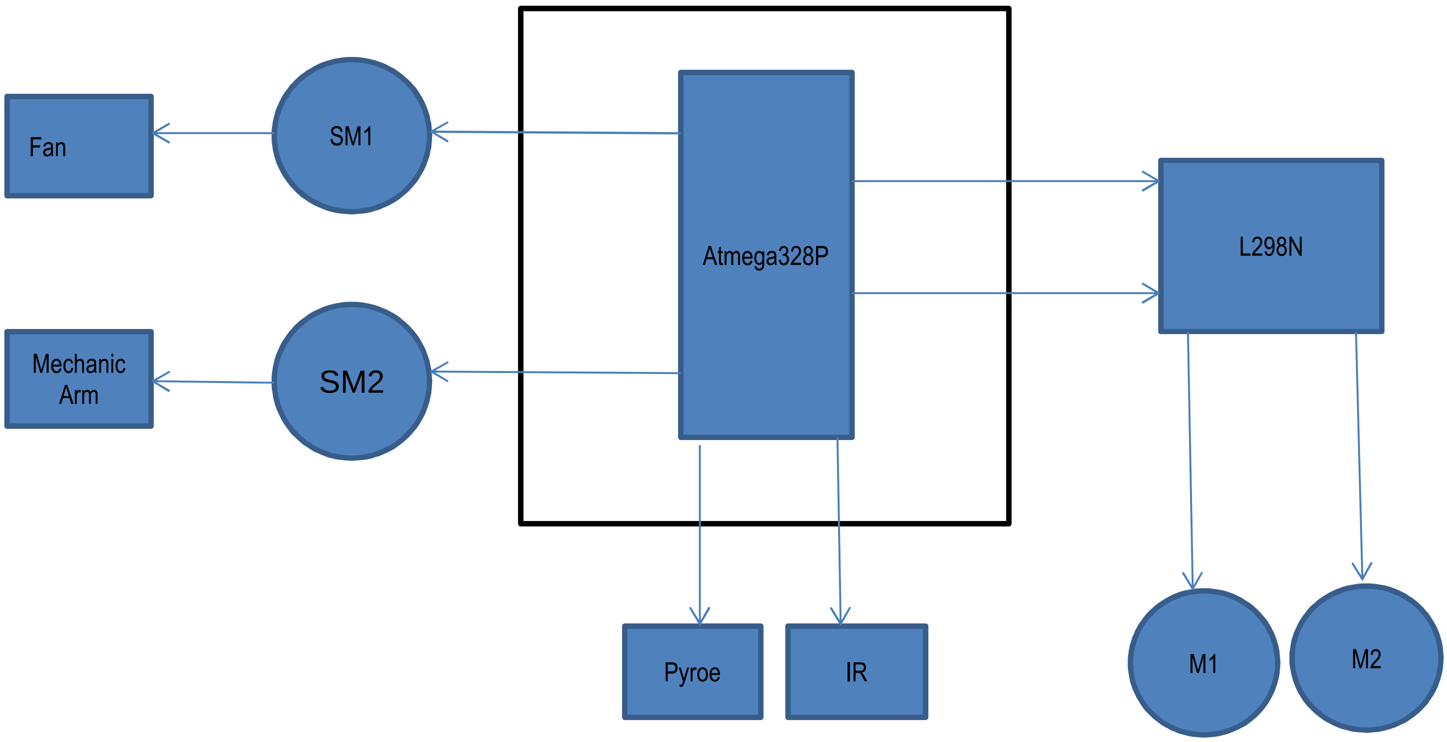


FIGURE 39 Connection diagram of the major components of RobotDemo

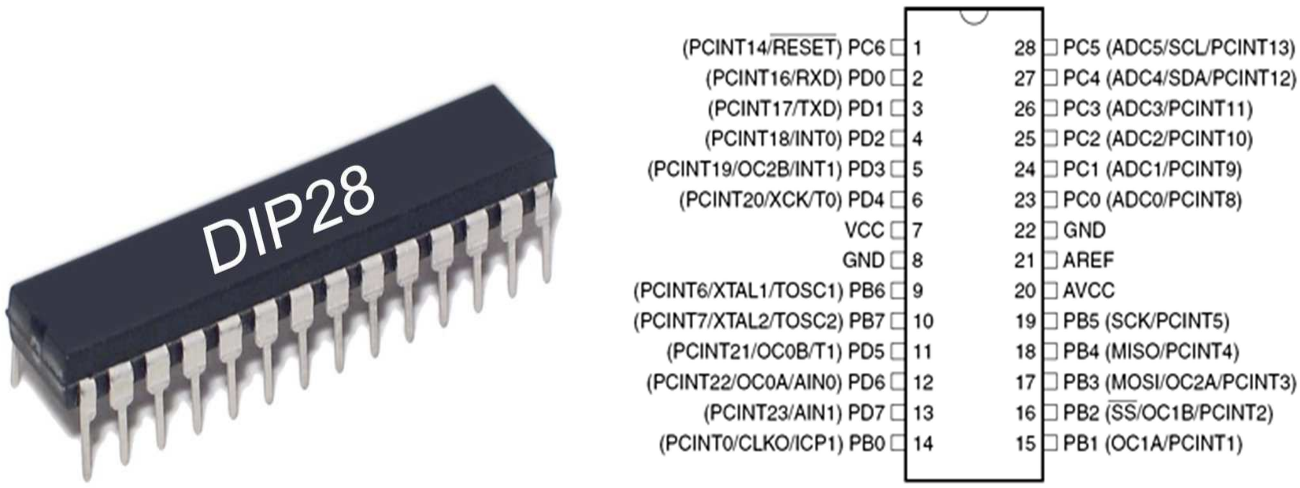
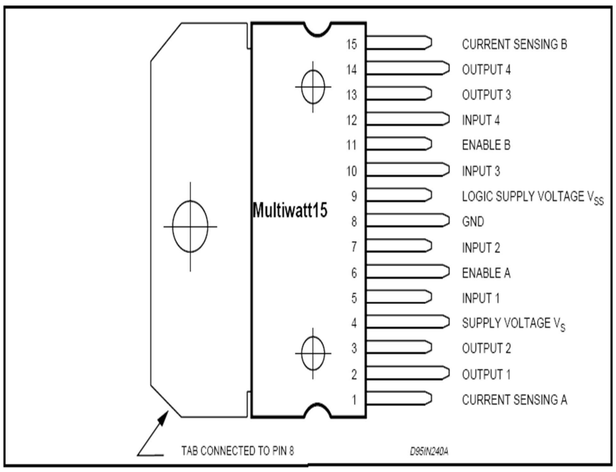


FIGURE 40 Atmega 328 P

4.4.3. L 298 N

L298N is a dual H Bridge motor driver (Figure 41), so with one IC we can interface two DCmotors which can be controlled in both clockwise and counter clockwise direction and if you have motor with fix direction of motion. It can make use of all the four I/O to connect to DC motors.
The L298 is an integrated monolithic circuit in a 15 lead Multiwatt. It is a high voltage, high current dual full bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors. Two enable inputs are provided to enable or disable the device independently of the input signals.The emitters of the lower transistors of each bridge are connected together and thecorresponding external terminal can be used for the connection of an external sensing resistor. An additional supply input is provided so that the logic works at a lower voltage (L298N. Date of retrieval 6.2.2013).

PIN CONNECTIONS (top view)



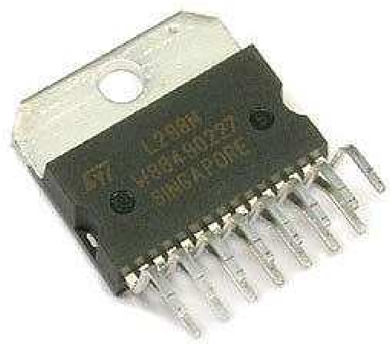


FIGURE 41 L298 N

The H Bridge generally has four switching (see Figure 42) 2 High (left and right), 2 Low (left and right). The motor changes its direction accordingly to how the switches are turned on. For example if switch on High side left and Low side right then the motor rotates in forward direction, as current flows from power supply through the motor coil goes to ground (Table 1).

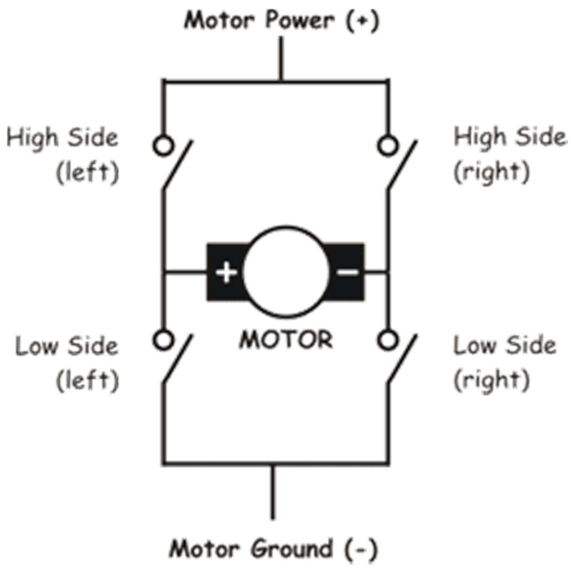


FIGURE 42 H Bridget

SWITCH			MOTOR
HIGH LEFT	**HIGH RIGHT**	**LOW LEFT**	**LOW RIGHT**
on	off	off	on
off	on	on	off
on	on	off	off
off	off	on	on

TABLE 1

4.4.4 Battery

The RobotDemo uses one rechargeable battery (figure 43). The battery is 6V, 2500mAh. The battery has the following characteristics (Battery 6V, 2500mAh. Date of retrieval 6.2.2013):
-It has a Hitec standard connector,Compatible For Hitec, Futaba, and JR models (TM)
- 5 AA 2500 mAh Ni-MH matched cells.
-measures are 71 x 51 x 14 mm. Weight: 5 oz. per pack
-High temperature PVC wrapper
‘Environmental friendly, Ni-MH contains no toxic waste
-High loyal capacity, long running time
-Meeting Stringent quality standard
-No memory effect

FIGURE 43 Rechargeable battery

4.4.5 Sensor

The sensors are transducers that convert a physical phenomenon into electrical signals, which can then be interpreted by the microprocessor implemented in robots. This can be done using an analog-digital (A / D), carrying a value from an input-output port (I / O) or using an external interrupt. Normally using an electronic interface between the sensor and the microprocessor for conditioning or amplifying the sensor signal (Jones, Flynn, Seiger. 1999). A determining factor for selection of the sensors that uses the mobile robot, is the cost of the sensors.

The RobotDemo uses the QTR-8A (IR sensor) to follow the black line in the labyrinth. There are basically two ways of building a line following robot. First, using a light dependent resistor(LDR) and second, using Infrared(IR) LED. A dark object reflects less light than a bright object or we can say a dark object absorbs more light than a bright object. So, sensor detects the difference between bright object and a dark object for example distinguishes a black line from a white surface.
A temperature sensor is used for detecting the candell (fire). It was bought from ebay (sensor doesn't have a part number or model).

4.4.5.1 QTR-8A

Sensor module has 8 IR LED/phototransistor pairs mounted on a 0.375" pitch, making it a great detector for a line-following robot. Pairs of LEDs are arranged in series to halve current consumption, and a MOSFET allows the LEDs to be turned off for additional sensing or power-savings options. Each sensor provides a separate analog voltage output. The QTR-8A can be broken in two

separate modules as shown in Figure 44, each of the two resulting pieces will function as an independent line sensor (QTR-8A. Date of retrieval 4.2.2013). The RobotDemo use one module the bigger with 6 sensors, 3 for follow the black line and at the ends for find extra black marks which inform to the Robot where is the objects that has to take.
Specifications (QTR-8A. Date of retrieval 4.2.2013):

-Dimensions: 2.95" x 0.5" x 0.125" (without header pins installed)
-Operating voltage: 3.3-5.0 V
-Supply current: 100 mA
-Output format: 8 analog voltages
-Output voltage range: 0 V to supplied voltage
-Optimal sensing distance: 0.125" (3 mm)
-Maximum recommended sensing distance: 0.25" (6 mm)
-Weight without header pins: 0.11 oz (3.09 g)

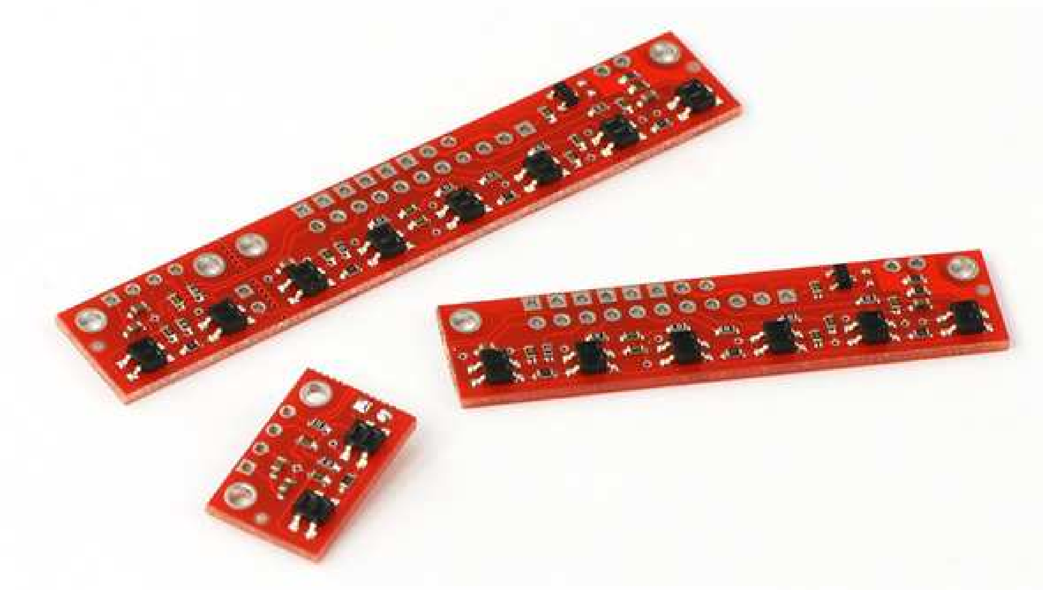


FIGURE 44 QTR-8A

4.4.5.2 Thermistor Temperature sensor

TheRobotDemo Temperature sensor uses a thermistor (Figure 45) which is suitable for detecting the ambient temperature. Thermistor is a temperature-sensing element composed of sintered semiconductor material which exhibits a large change in resistance proportional to a small change in temperature. Thermistors usually have negative temperature coefficients which means the resistance of the thermistor decreases as the temperature increases.
The thermistor on the ambient temperature is very sensitive, generally used to detect the temperature of the surrounding environment, can be changed to the temperature detection threshold through the adjustment of the potentiometer. The temperature detection range is of 20-80 degrees Celsius.
Specifications (Thermistor sensor. Date of retrieval 4.2.2013):

-It can detect the ambient temperature output analog and set the digital output of a temperature value.
-The Sensitivity is adjustable, stable performance.
-Operating voltage 3.3V-5V.
-The output in the form: Digital switching outputs (0 and 1).
-Small board PCB size: 3.2cm x 1.4cm

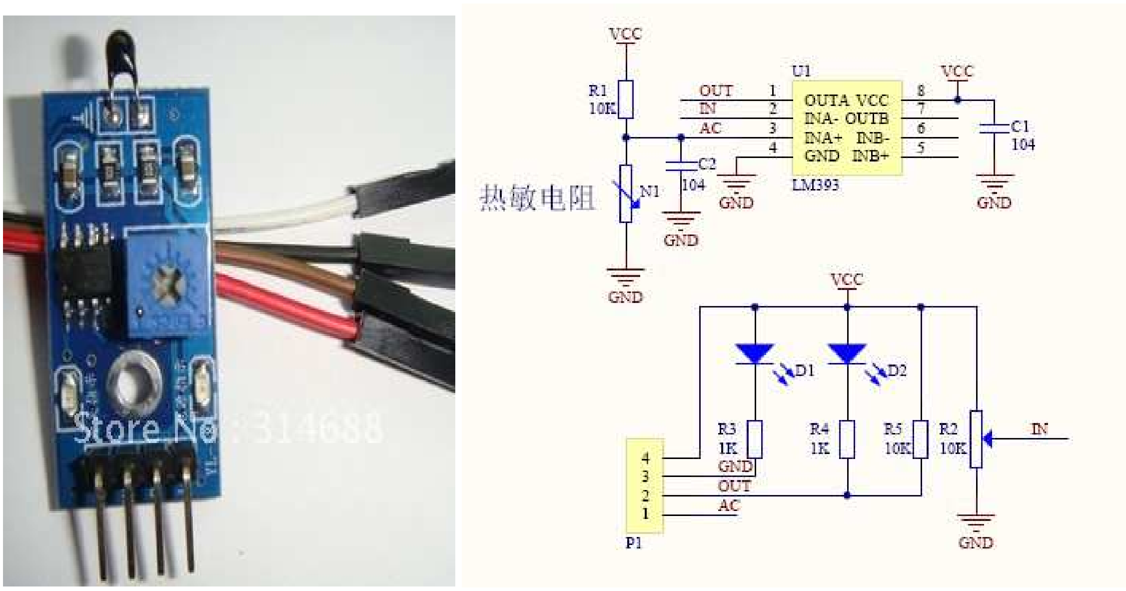


FIGURE 45 Thermistor Temperature sensor

A software is required for the control of the hardware and its funtions. The RobotDemo uses the Arduino IDE (integrated development environment). It is a cross platform developer tool written in Java that contains an editor which we can use to write sketches (which is the name of Arduino programs).
Using the IDE, the program has written, it is converted to a C program and then compiled using avr-gcc, a free and open source compiler is based on the Gnu C Compiler (gcc). This process produces binary code which the microcontroller will be able to understand and execute.
Arduino allows users a simple pathway to create interactive objects that can take input from switches and sensors, and control physical outputs like lights, motors or actuators. Because the language is based on well-used frameworks, Arduino can interact with other software on the computer such as Flash. Arduino has been developed for the very popular Atmel AVR microcontroller. The content written by the program can be uploaded using the Arduino Duemilanove board and an USB cable.

5 CONCLUSION

Throughout the development of this project the biggest drawbacks were the time. The topic suggested by the tutor: robot competition with its labyrinth design and building a robot for this competition, resulted in my view to be very broad.

5.1 Collection of information

Data collection took a long time as it required collecting information about labyrinths, their design, types, history (since when) and how all these could be applied to a robot competition labyrinth. Data about robot competition that are organized primarily by universities from different countries, in order to formulate regulations for our own competition. Finally information to build the robot, even though in educational training is not imparted robotics concepts, but the knowledge of Electricity, Electronics, Digital Technology and Programming taught in our educational center helped in understanding and developing the robot.

5.2 The design of the labyrinth

Many of the competitions are speed robots as the followers of lines, or the sumo fights, which in our opinion make these simple competitions almost boring especially for a non-professional audience. So it was decided a competition with a theme, labyrinths based on ancient cities, which were real labyrinths. They were built considering access control and how hard it would be able get out of these cities. And to give more entertainment it was chosen the theme of a burial of a character of these ancient cities giving us the opportunity to provide the robot specific tasks.

5.3 Implementation and social order of the DemoRobot

The robot was endowed with systems composed of a mechanical arm and a fan for the execution of tasks. These systems with their elements (sensors, mechanical arm, fan) can find their application in real-life tasks, like in fire rescue, environmental disasters such as earthquakes, explorations, high-risk situations for humans where a robot could carry out efficiently.

5.4 DemoRobot components

The location of these elements in the robot has been changing, as we have proved it. In the case of mechanical arm perhaps it might have been better to place it at the top and lower it through a mechanism to the center front of the robot, allowing the robot to move in a more efficient way and also it would have left a free space for the heat sensor location in the front of the robot, but this would have needed another servo motor.

The fan should also have a mechanism that allows to adjust it giving the proper inclination for turing off the flame. Though, it proved that a small amount of air was enough to blow out the candle it was necessary to give sufficient adjustments having prior knowledge of the height of the candle location.

Wheels of a larger diameter would have allowed us to locate the battery below the chassis. This would have been a better choice in the case that the mechanical arm and the fan were located at the top with its moveable clamp-mechanism, so the height of the robot would be lower.

5.5 The software of the DemoRobot

To develop the software for the microcontroller Atmega 328 (designed for Arduino boards) it has been used Arduino IDE program (programs written for Arduino are called sketches). The Arduino software is free with many examples easy to apply with own libraries and thousands of professionals developing and implementing the program components of Arduino (Brian. Date of retrieval 6.2.2013). Another point in its favor is its low cost. Finally, there is much information about Arduino, which makes these products easy to use.

5.6 Suggestions for the future

At the start of the project I had the idea to build the DemoRobot with recycling parts. Unfortunately due to limited time I discarded this idea and aimed to encourage utilizing used parts in the development of the robot.
I will mention some of the devices that can be reused in building robots.
From CD Players it can be used the spindle motors, sled motors, drawer motors, micro switches and all kinds of gear.
From VCR Small it can be found solenoids, reel motors, IR sensors, micro switches and all kinds of gear.
The Cassette can offer small solenoids, reel motors, capstan motors, Hall Effect sensors, micro switches and all kinds of gear.
From the Fax machines we can get small solenoids, stepper motors, micro switches and all kinds of gear.
Only 2 kinds of robots have been included but it is possible to add many others such as removing the black line and robots using methodologies to avoid obstacles.
IF this type of competition is organized, it should include other types of tasks, such as the classic sumo or soccer.
A kit for the competition can be made, which would be purchased by the participating teams. This would have the basic components such as a microcontroller, sensors and an actuator.

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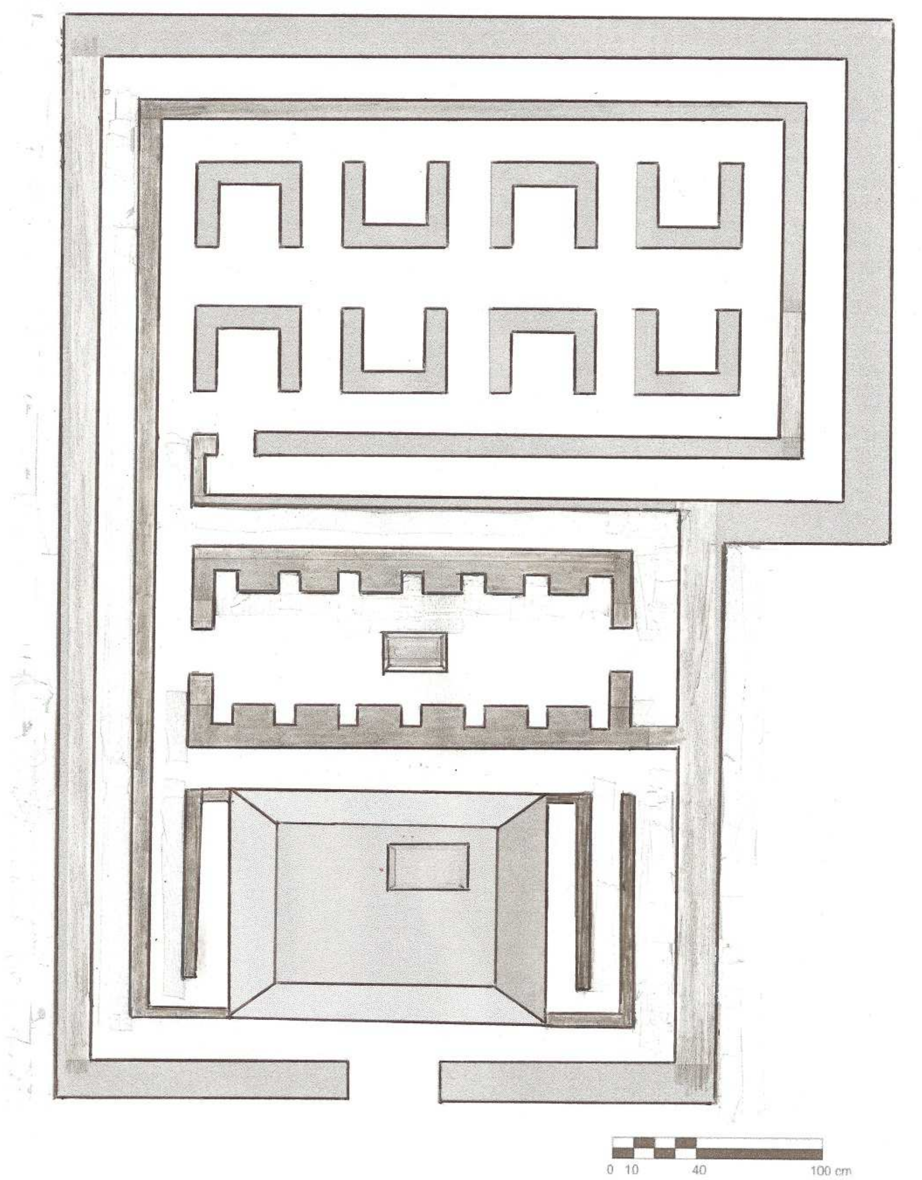
APPENDICES

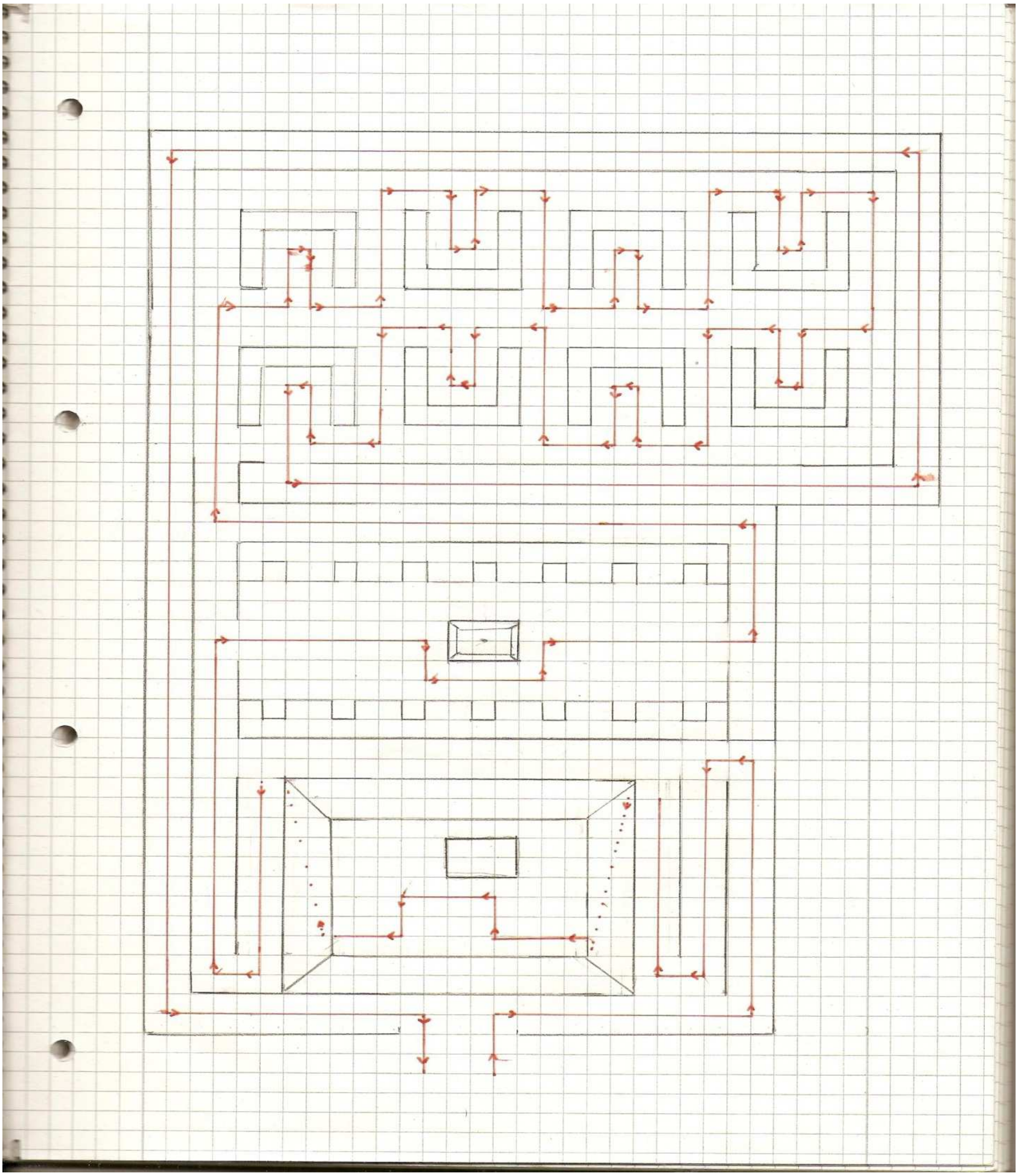
APPENDIX 1

Plane of labyrinth



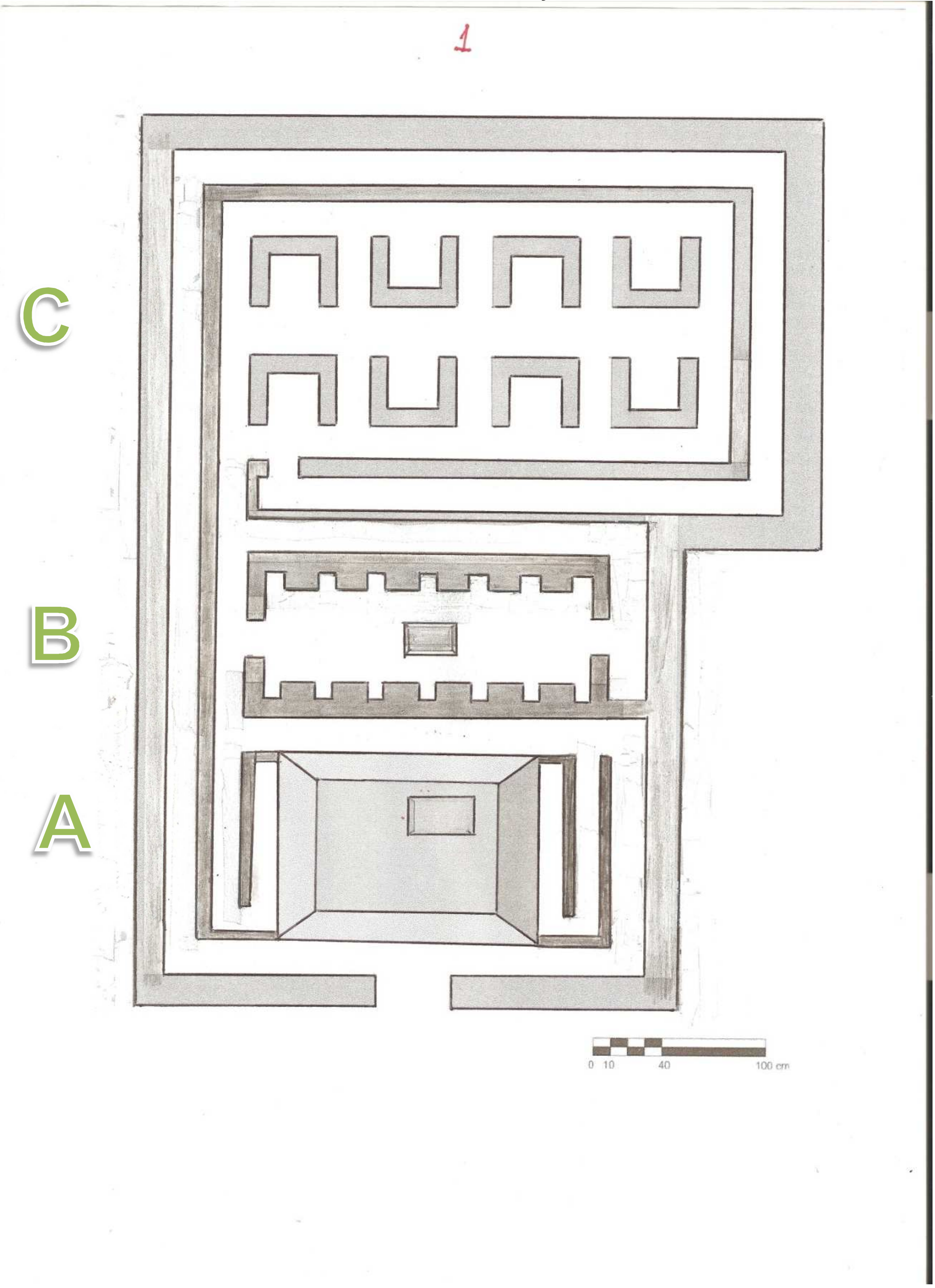
APPENDIX 2

Travel plane Labyrinth



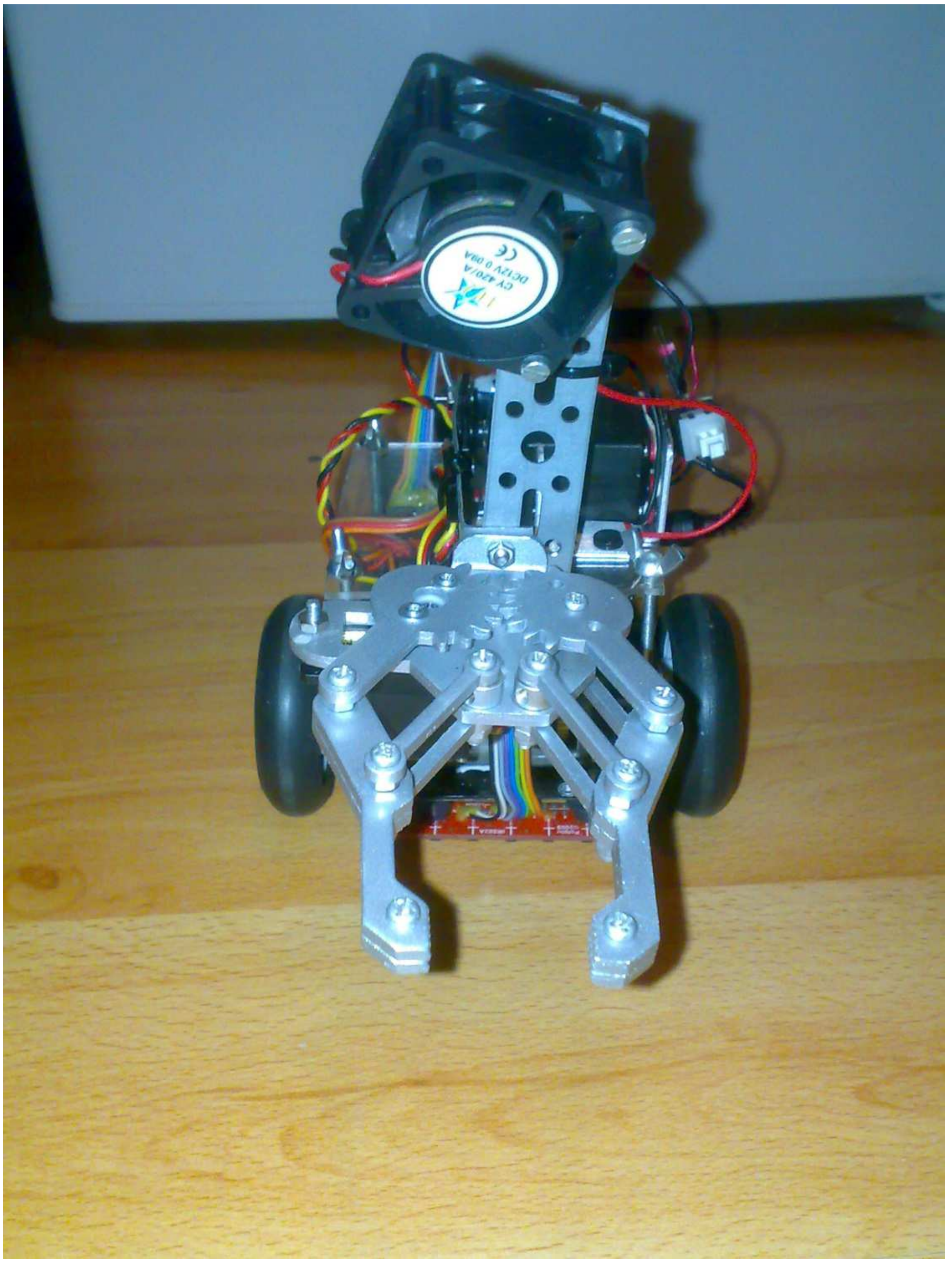
APPENDIX 3

Sectors of the Labyrinth



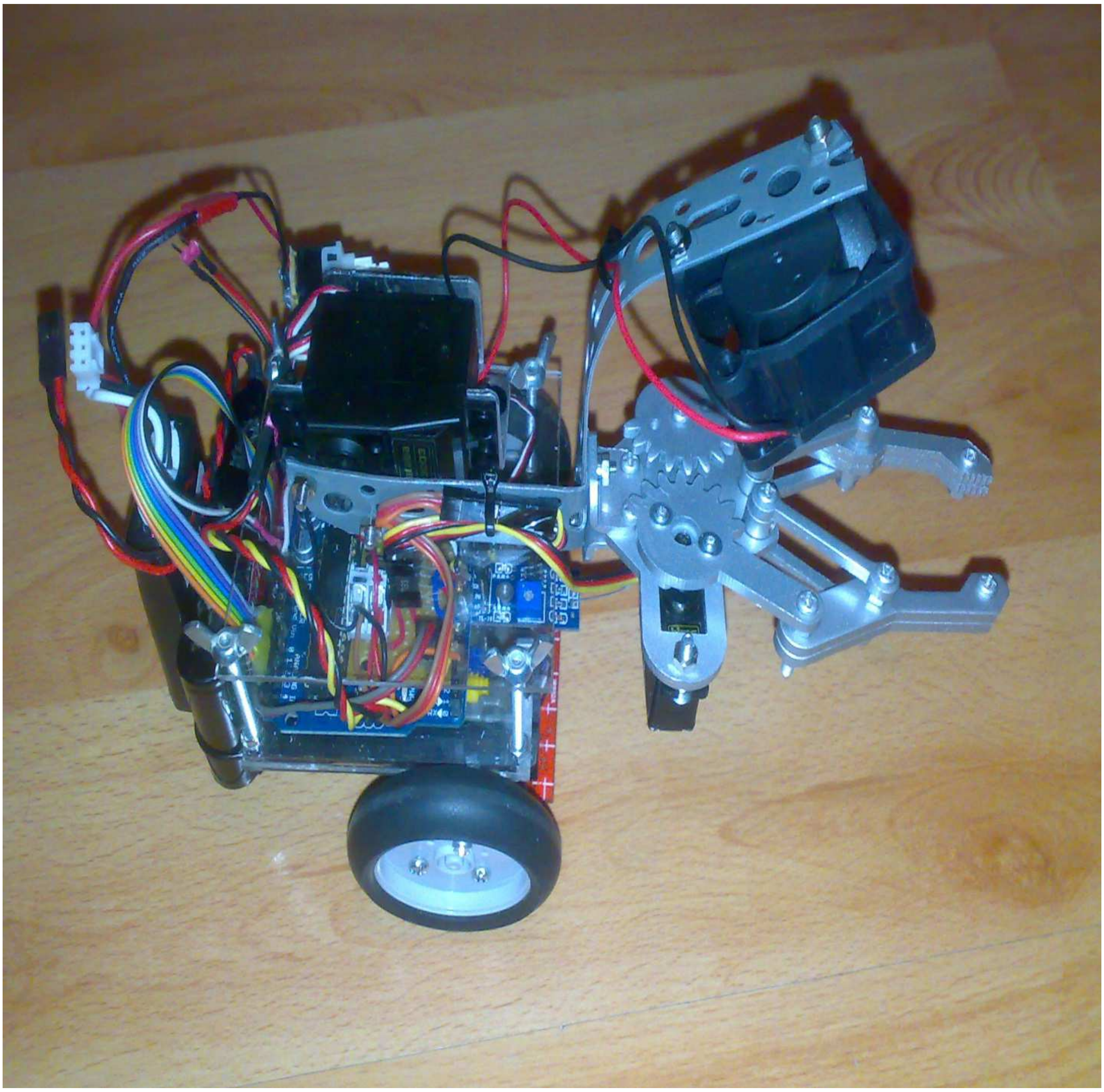
APPENDIX 4

The RobotDemo front view



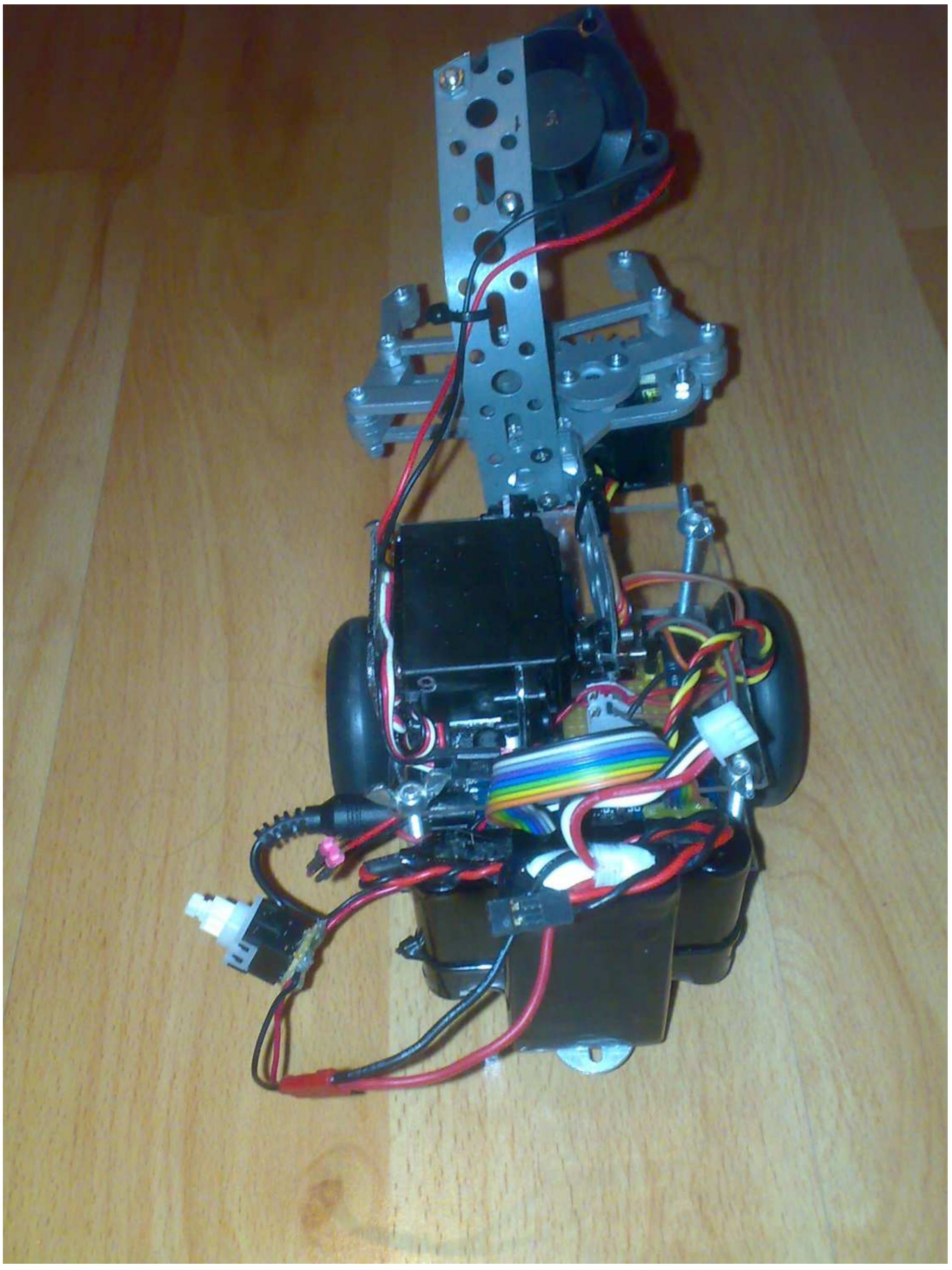
APPENDIX 5

The RobotDemo side view



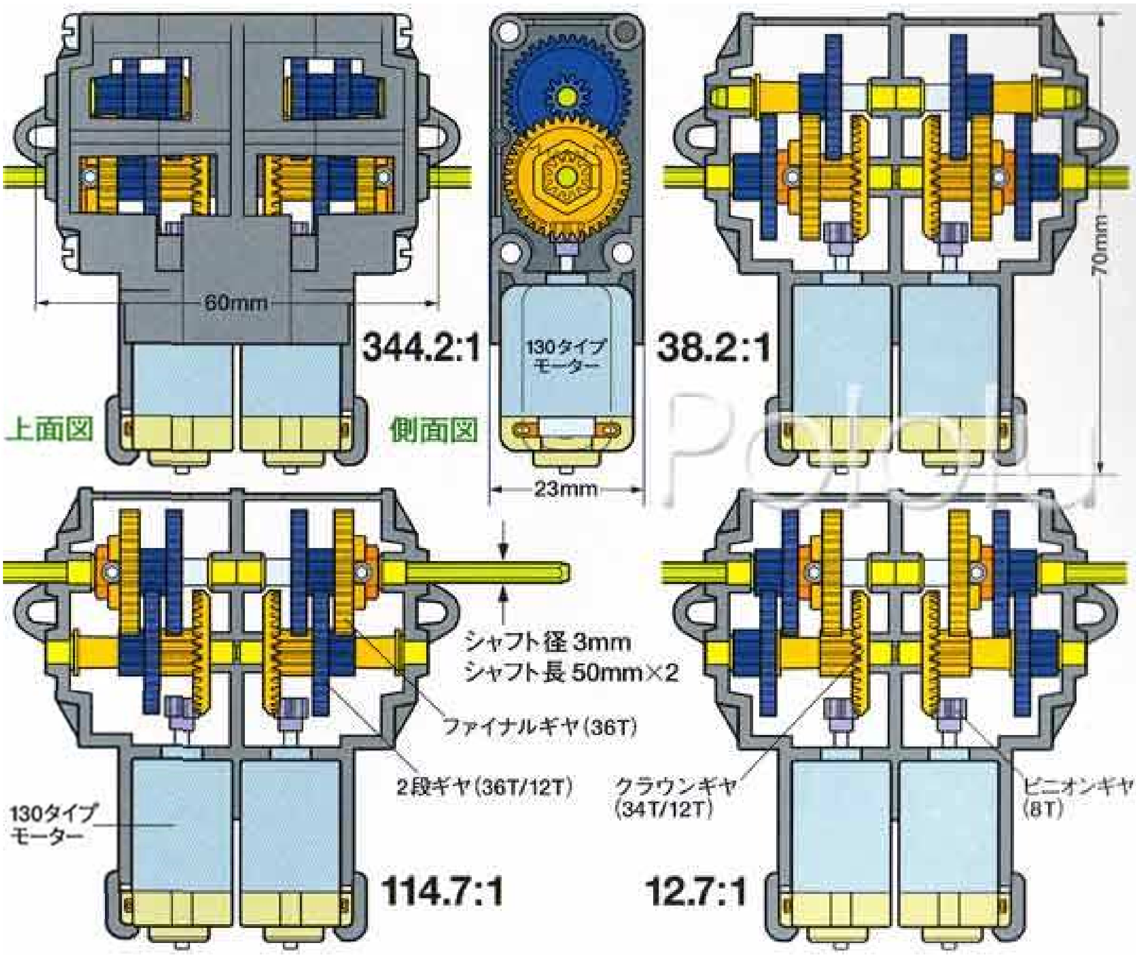
APPENDIX 6

The RobotDemo back view



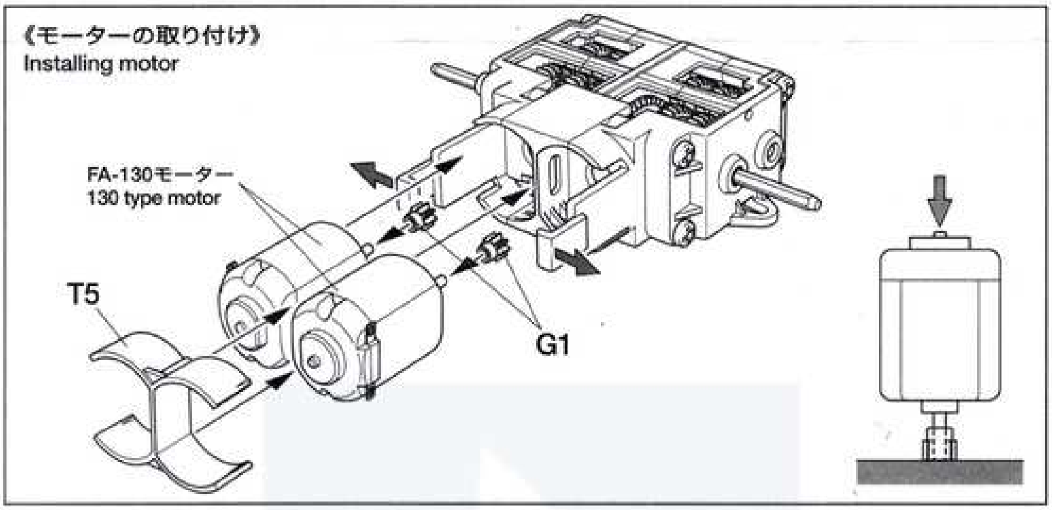
APPENDIX 7

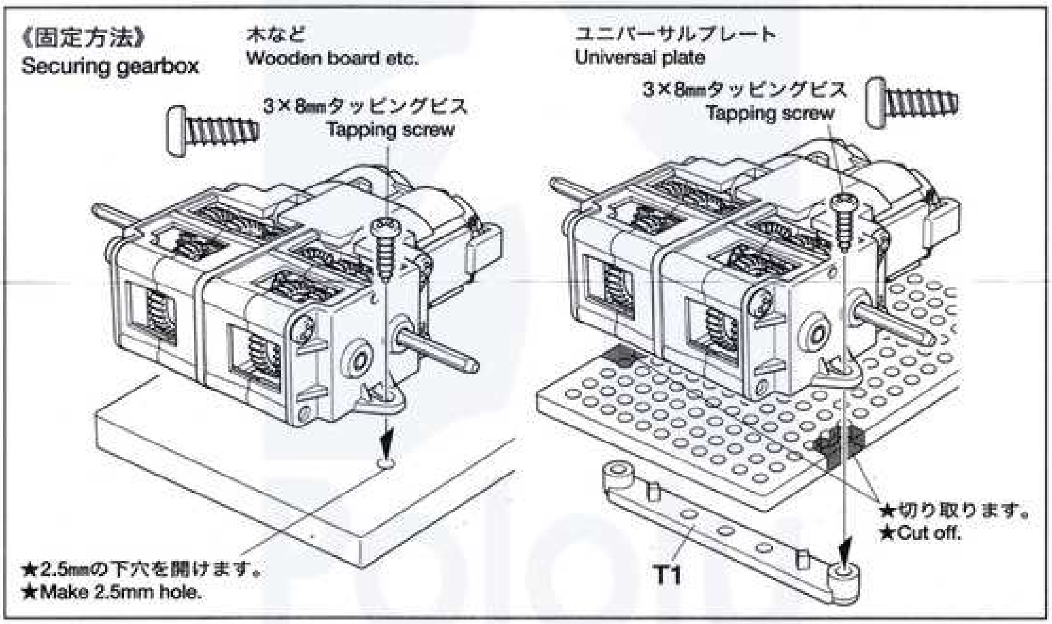
Mamiya gearbox



APPENDIX 8

Assemble the Mamiya gearbox





●電源は3Vでご使用ください。
●記載されている性能以上での使用はトラブルの原因になりますので避けてください。
●回転しているギヤやシャフトに手を触れないでください。指をはさんだりして危険です。
また、可動部を押さえつけたり、止めたりしないでください。モーターが発熱して危険です。

●Use 3V power source.
●Full-performance will not be guaranteed if used under conditions not outlined in instruction manual.
●Do not touch any moving parts, such as gear or shaft as this may cause injury. Do not hinder movement of gear or shaft by force, as this will result in motor heat build-up that can burn fingers.

万一、不良や不足部品などありました場合は、当社カスタマーサービスまでご連絡ください。

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東京 03-3899-3765（静岡へ自動転送）
営業時間/平日 8:00〜20:00 /土、日、祝日 8:00〜17:00

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