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The improvements of NAO Robots in Education

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Abstract

This thesis presents the improvements of NAO Robots in education system. The idea is inspired by a robot program Alpha Go that can win chees champion with real human beings. The goal of the thesis is to investigate and develop the applications of NAO robot used in education by now and to find the possible improvements for the future. The initial response of behavior in Human-Robot Interaction between Humanoid Robot NAO and children with Autism Spectrum Disorder(ASD) is simulated in software choregraphe. The experimental shows the possibility that the autism behavior of the children with ASD in the Human-Robot Interaction based on the robot NAO is greatly reduced than the normal class session. Hence, it can be concluded that the humanoid robot NAO has potential to serve as a platform to support and initiate interaction for both students and teachers in education.

Keywords	humanoid robot; NAO; education; autism spectrum disorders

Contents

1 Introduction

In this thesis, the humanoid robot NAO by Aldebaran is analysed because of the vast application of the motion control in Education System. As figure 1 shows the outline of NAO robot. Further, the related improvements are also discussed, which can strengthen the application ability of the students and teachers. The software used is CHOREGRAPHE that can simulate the motion of robot. NAO robot is introduced into the experiments to improve the experimental performance. Robotics is a research field that has experimented several changes in the last years. Nowadays, robot application is the robot of free open platform, flexible configuration, and can be used on the sound identification, motion planning, image processing, etc. The objective of the thesis is to find and improve applications of the NAO robot that can not only help students learn the course knowledge better, but also cultivate the ability of independent thinking and practice, which can improve the teaching effects finally.

Figure1 Humanoid robot NAO. Reprinted from URL: http://www.brainaryinteractive.com

2 Background

2.1 NAO Humanoid Robot

Humanoid Robot NAO is a unique product which combines software and hardware together and consist of many sensors, motors and microcontrollers. All of software are based and controlled by a made-to-measure operating system: NAOqi OS.

Although NAO has not been used as a daily tool in family, he has been a super star in the field of education. NAO comes into the IT and professional technology colleges in over 70 countries. With the help of NAO, many undergraduate students will apply their knowledge of programming in a happy atmosphere.

NAO also conquered a large number of application developers. In their eyes, NAO is not only a powerful, amazingly expressive application creation platform that makes a lot of vision come true, opens up a new world of application development, but also paves the way for the future to create robots for the general public.

2.1.1 Platform

NAO is a programmable humanoid robot, as figure 2 indicates the following components:

- 25 degrees of freedom and a humanoid shape that enable him to move and adapt to the world around him. His inertial unit enables him to maintain his balance and to know whether he is standing up or lying down.
- Sensors: 2 cameras, 4 microphones, sonar rangefinder, 2 IR receivers and transmitters, board inertial device, 9 touch sensors, 8 pressure sensors.
- A variety of interacting devices including speech synthesizer, LED, 2 high-fidelity speaker
- INTEL ATOM 1.6GHz CPU (in head), RAM Linux, support the coding platform NAOqi created by Aldebaren
- The second CPU is inside the body

- 27.6Wh battery, it could support NAO working over 1.5 hours

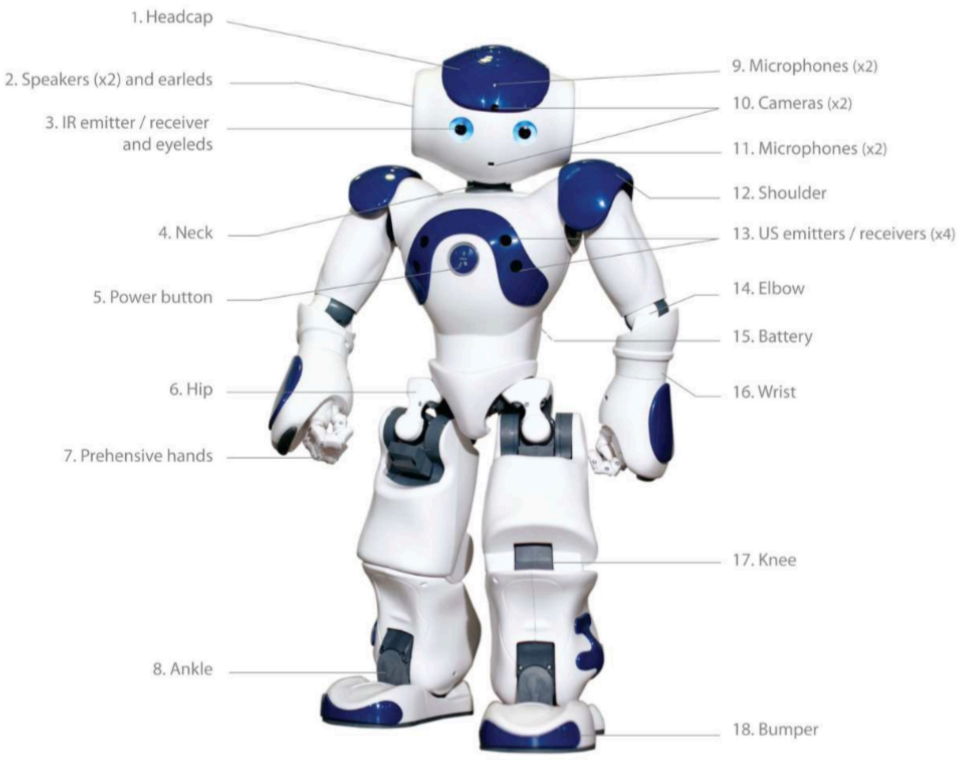

Figure 2. NAO Components. Modified from URL: http://disneyandmore.blogspot.fi/2009/09/introducing-nao-nice-little-robot.html

2.1.2 Motion

Walking

Nao uses a simple dynamic model and quadratic programming helping himself walk, through joint sensor feedback information to maintain stability, and ensure the robustness of walking, from small disturbances, and to absorb torso rotation in the forward and lateral planes. Nao is able to walk on a variety of grounds, such as carpets, wood floors, and walk smoothly from one floor to another floor with different surface.

The motion module of NAO is based on generalized inverse kinematics which can handle Cartesian coordinates, joint control, balance, redundancy, and task priorities. In other words, if the user requires NAO to show his arm, since taking into account their arms and legs into the joint, NAO will lean forward in the implementation of this action.

As figure3 indicated the X-ray file of NAO robot. To maintain balance, NAO will automatically stop moving.

Fall manager

Fall Manager may play a protective role when NAO falls, its main function is to detect whether the center of mass of NAO exceeds the support polygon. The latter point of contact with the ground is determined by the foot of the robot. Upon the fall of robot is detected, all motion tasks will be terminated. His arms will take the protective position according to the direction of fall, the robot's center of mass will reduce the stiffness will be reduced to zero.

Vision

Nao has two cameras which can track and memorize different images and faces. He has two 920p cameras that can shoot 30 images at most per second. One of cameras locates at forehead for horizontal vision and the other one locates at mouth for surroundings. NAO has a series of algorithms that can help robot itself search and understand faces and shapes it found. Therefore, NAO could recognize people who talks to them and find the ball or more complicate things. These algorithms are invented for decreasing the usage of CPU.

Voice

NAO has 4 microphones to detect voice and communicate with people using 8 languages by the function of recognizing and synthesizing voices.

Sound source localization is able to help robots distinguish the voice. When there is a sound source near NAO and make some voice, the receiving time of 4 microphones will be slightly different. Algorithm of embedded system is not very effective on robots so that it is possible to take some remote calculation on computers or servers. This is very important when dealing with signal processing.

Communication

Except for cameras and microphones, NAO has also capacitive sensors which are located on head and hands. Users can transfer information to NAO by touching him just like press his head slightly to let him stop moving. These sensors are also able to trigger some related actions. NAO has two sonar channels, two transmitters and two receivers. Hence NAO is able to estimate the distance with surrounds. This distance of estimation is between 0 to 70 cm.

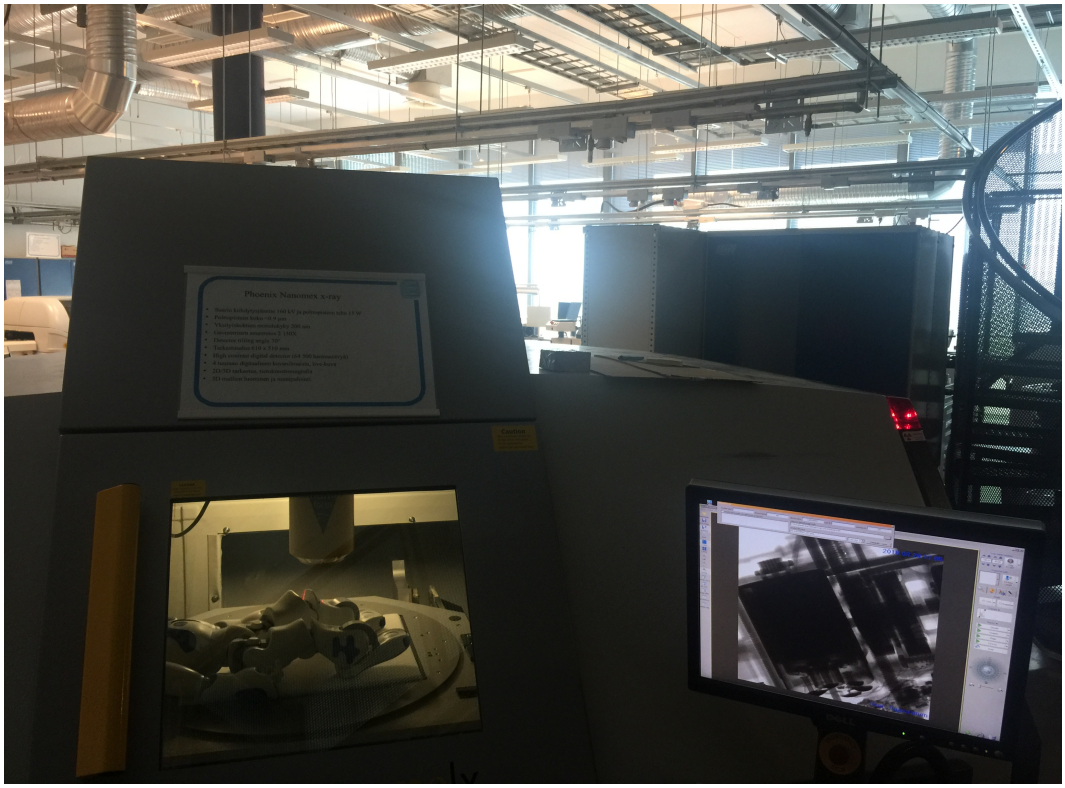

Figure 3. X-ray film of NAO taken by Technopolis Oy

2.1.3 motor

Motors

There are 3 types of motor in NAO - V. 4.0:

	Motor type 1	Motor type 2	Motor type 3
Model	22NT82213P	17N88208E	16GT83210E
No load speed	8 300 rpm ±10%	8 400 rpm ±12%	10 700 rpm ±10%
Stall torque	68 mNm ±8%	9,4 mNm ±8%	14,3 mNm ±8%
Nominal torque	16.1 mNm	4.9 mNm	6.2 mNm

Figure 4. Motors in NAO. Reprinted from URL: http://doc.aldebaran.com/1-14/family/nao_h25/motors_h25.html

As figure 4 shows that there are three types of coreless DC motors in NAO which are mostly used. Coreless DC Motors are constructed with a rotor attached to a commutator plate. Brushes providing commutation, these lightweight motors have a low starting inertia for maximum acceleration & minimal power consumption.

We can find DC motors in many portable home appliances, automobiles and types of industrial equipment. The stator provides a constant magnetic field, and the armature, which is the rotating part is a simple coil. The armature is connected to a DC power source through a pair of commutator rings. When the current flows through the coil, an electromagnetic force is induced on it according to the Lorentz law. Then the coil starts to rotate. As the coil rotates, the commutator rings connected with the power source of opposite polarity. Hence on the left side of the coil the electricity will always flow away. On the right side electricity will always flow towards. This ensures that the torque action is also in the same direction throughout the motion so that coil will continue rotating. But if we observe the torque action on the coil closely, we will notice that when the coil is nearly perpendicular to the magnetic flux, the torque action nears zero.

As a result, there will be irregular motion of the rotor if we run such a DC motor. Here is the trick to overcome this problem: add one more loop to the rotor, with a separate commutator pair of it. In this arrangement when the first loop is in the vertical position, the second loop will be connected to the power source, so the motor force is always present in the system. Moreover, the more such loops, the smoother will be the motor rotation. In a practical motor the armature loops are fitted inside slots with highly permeable steel layers. This will enhance magnetic flux interaction. Spring loaded commutator brushes help to maintain contact with the power source. A permanent magnetic stator pole is used only for very small DC motors. Most often, an electromagnetic is used. The field coil of the electromagnetic is powered from the separate magnetizing source makes up a so called “foreign magnetized DC-motor”. The filed coils can be connected to the rotor windings in two different ways, parallel or series. The result is two different kinds of DC motor constructions. A shunt and a series motor. The series wound motor has good starting torque, but speed drops drastically with the load. The shunt motor has a low starting torque but it is able to run almost at a constant speed, irrespective of the load acting on the motor.

Unlikely the other electrical machines, DC motors exhibits a unique characteristic: the production of BACK EMF. A rotating loop in a magnetic field will produce an EMF according to the principle of the electromagnetic induction. The case of the rotating armature loops is also the same. An internal EMF will be induced that opposes to the applied input voltage. The BACK EMF reduces armature current by a large amount. BACK EMF is proportional to the speed of the rotor. At the starting of the motor BACK EMF is too low, thus the armature current becomes too high, leading to the burnout of the rotor. Therefore a proper starting mechanism that controls the applied input voltage is necessary in large DC motors. One of the interesting variation of the DC motor is a universal motor which is capable to run under both AC and DC power sources.

2.2 Various Humanoid Robots

- ASIMO

ASIMO humanoid robot was born in October 31,2000, developed by the Honda Motor Company of Japan. Figure 5 shows that the robot is 130 cm tall and weights 54 kg.

ASIMO can move freely, dance, and climb stairs. Everything can be controlled by a mobile phone. ASIMO looks friendly and moderate, often called as" children wearing space suits".

ASIMO humanoid robot has the strongest mobility, the ability to coordinate with people by tools, as well as the ability to exchange information. In terms of move, ASIMO can walk freely even go up and downstairs. In addition, he is not only able to run at 6 km / h, but also change the direction by himself during the running.

Each part of his body has ability with balance and coordination. The trolley forward, carrying the tray is "ASIMO" in coordination with people with tools to make other robots unmatched forte.

Moreover, ASIMO has many functions like voice recognition, gesture and action recognition, face recognition and other powerful features that make it possible to interact with human being. ASIMO's favorite hobby is dancing, he can even dance better than professional human beings. ASIMO is able to put the drink on the table accurately and smoothly at the speed of 6 km / h. ASIMO can also use the PC to access the Internet connection to retrieve information such as weather forecast for you.

Figure 5. ASIMO Humanoid Robot.
Reprinted from URL: https://www.youtube.com/watch?v=R8UeT9r4cmg

- ATLAS

Atlas is a humanoid robot for disaster rescue tasks and was unveiled to the public in 2013. As figure 6 indicates that ATLAS is 1.9 meters tall, weighs 150 kilograms. He is able to walk upright on two legs just like human beings. He is designed not only to walk, extract, but also pass through the harsh terrain outdoors, use hands to climb.

ATLAS is almost a future warrior. He can take a big step forward on the conveyor belt, escape from the sudden appearance of wood on the conveyor belt. In addition, he is able to land firmly from high buildings. It is so easy for him to run up the stairs, stand on just one leg, keep balance when he was hit by a ball by accident.

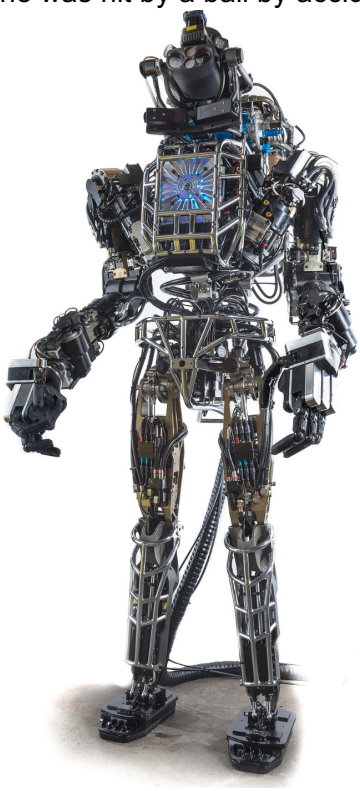

Figure 6. ATLAS Humanoid Robot. Reprinted from URL: https://en.wikipedia.org/wiki/Atlas_(robot)

ATLAS has 28 joints, two hands, tow legs, two feet and a body. His head includes a stereo camera and a laser rangefinder. His power is from a power supply which set off outside. There are seven working groups that are developing their own robots ATLAS

In short, Atlas gives the impression that except for their awkward action, they look a little like people. He is also so friendly that will not get angry when being kicked many times. It will not be like this forever; otherwise human beings will be in trouble.

- ICUB

ICUB Humanoid robot was created by Italian scientists and he can learn how to use a bow and arrow to shoot their own goal. As figure 7 demonstrates that he has a bow, an arrow and his head was still wrapped around by the Indiana headdress. Through a complex computer algorithm, ICUB learned lessons and experience from shooting failure and got continuous improvement, until the arrow hits consecutively. The researchers said the archery is a natural consequence of the integrated motor control and image processing technology, it is unnecessary to accuse those robots who tried their best to achieve their goals. ICUB use of a name learning algorithm for the system of ARCHER. The system uses a camera to capture and process the image of target, analyzes the previous failed attempts, and to find the best shooting angle, strength, flight path, then shoot it finally.

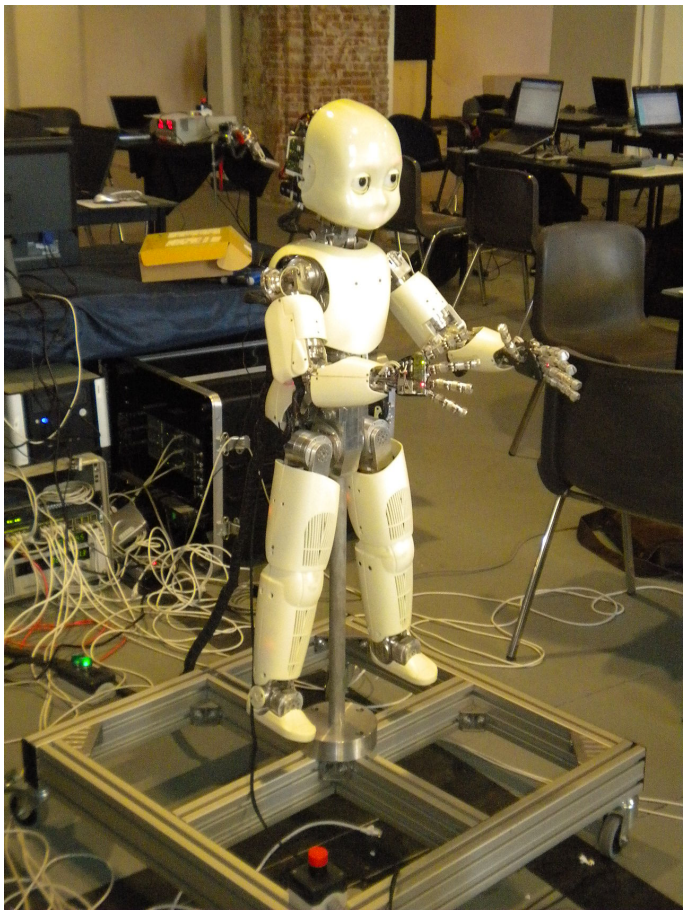

Figure7. ICUB Humanoid Robot. Reprinted from URL: http://imechanica.org/node/15120

2.3 Robocup

The RoboCup competition was initially inspired by Hiroaki Kitano in 1993 and his idea eventually led to the establishment of the RoboCup Federation. The RoboCup competition has a bold vision: “By the year 2050, to develop a team of fully autonomous humanoid robots that can win against the human world soccer champions [1,723-727]”. All the teams participating in RoboCup have to find real-time solutions to some of the most difficult problems in robotics (perception, cognition, action, coordination). All the divisions in RoboCup (soccer, RoboCup@Home, RoboRescue, etc.) are designed so as to test the proposed solutions by the various teams to the problems mentioned above. So far, the researchers participating in RoboCup have made a lot of progress in solving real-world problems that show up in the various RoboCup leagues within each division.

The Standard Platform League (SPL) is one of the many leagues in the soccer division of RoboCup. As figure 8 shows, in this league all the teams use the same robot, the Aldebaran NAO humanoid robot, and they focus only on algorithm design and software development for this robot. For this reason, the teams are prohibited to make any changes to the hardware of the robot. The robots are completely autonomous and no human intervention from team members is allowed during the games. The only interaction of the robots with the “outer world” is the reception of data from the Game Controller, a computer that broadcasts information about the state of the game (score, time, penalties, etc.).

Currently, the SPL games are conducted on a field with dimensions 4m→6m. The field consists of a green carpet marked with white lines and two yellow goals. The appearance of the field is similar to a real soccer field, but it is scaled to the size of the robots. The ball is an orange street hockey ball. Each team consists of four robots and each robot carries a colored waist band (blue or pink) that distinguishes the teams. The total game time is 20 minutes and is broken in two halves; each half lasts 10 minutes.

Figure 8. NAO Humanoid Robot. Reprinted from URL: http://www.robocup2013.org/robocup-soccer/

3 Application in Education System

- Software

Choregraphe is the software used to be the platform for programming. This software is widely applied to create very complex behaviors without writing lines of codes, test them on a real robot or even on a simulated robot and control NAO. Moreover, it allows you to add your own Python code to a Choregraphe behavior.

1. For teachers

NAO is a fascinating teaching tool thanks to its interactive applications and intuitive interface. It captures the attention of children and promotes individual and group work. Children discover technology and enjoy learning. You can also talk about geography, mathematics, basic concepts, and much more with NAO.

Teacher NAO robot is not only able to use different languages and make PowerPoint, but also interact with the students, to answer some of their questions. This new method of teaching has become possible to traditional classroom. By this new method, the atmosphere in classroom will be more active and it can improve the enthusiasm of the students in the classroom greatly. Students who participated in the class with NAO robot would find that NAO robot looks cute and their lectures are really impressive. The atmosphere of class is also very good, including content, gestures, movements and convergence with PowerPoint. His language skill is also very good. Although some minor issues can not be performed well in process, it is also believed that as technology advances, these problems will not be a problem.

When students hear that they will study with NAO robot in class, all of them get excited. They would show great interest about NAO robot. They are very active and enthusiastic to ask questions in class which is particularly serious. The use of new teaching tools like NAO improved their students' enthusiasm for this novel way, a lot of students fell very fascinated during lectures.

Moreover, NAO makes it easy for students to learn new knowledge confidently. Here is one application called you are so smart with cheering. As figure 9 shows, the flow diagram created in Choregraphe describes the motion step by step. In the classroom NAO is very popular with students. This application is designed to encourage students to work hard in the classroom to learn more. In other words, NAO will replace teachers to praise students once students answer questions correctly NAO will say yes you are right and simply dance up and applaud to encourage students.

Application 1 You are so smart with cheering

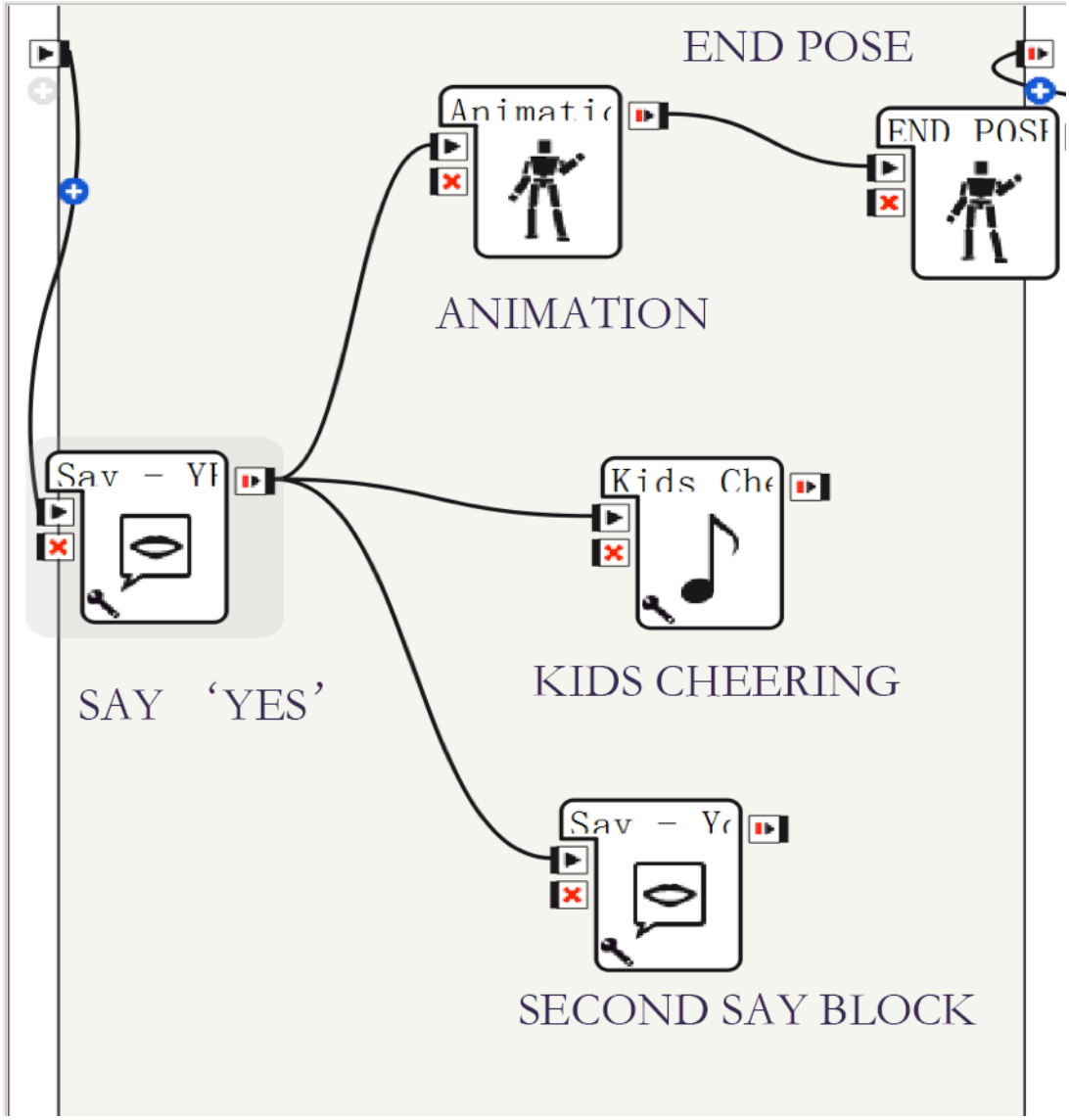

Figure 9. Flow diagram of application 1

Definitions of blocks:

1> First SAY block: NAO will say YES

2> Animation block: NAO will applaud to encourage students

3> Kids cheering: NAO will play a sound file. Select the file in parameters. The format of the file can be wav, mp3, or ogg. Note: There can be some delay to play mp3 files. It is advised to use wav if you want a fast play of the file.

4> Second SAY blok: NAO will say YOU ARE SO SMART!

5> End pose: NAO will have a cool end pose.

Scripts:

```
class MyClass(GeneratedClass):                          <1>
    def __init__(self):
        try: # disable autoBind
            GeneratedClass.__init__(self, False)
        except TypeError: # if NAOqi < 1.14
            GeneratedClass.__init__( self )

        self.tts = ALProxy("ALTextToSpeech")
             <2>
        self.sentences = {
    <3>
            "German" : " Hallo ",
            "English" : " You are SO smart! ",
            "Spanish" : " Hola ",
            "Finnish" : " Moi! ",
            "French" : " Bonjour ",
            "Italian" : " Ciao ",
            "Japanese" : " こんにちは ",
            "Korean" : " 안녕하세요  ",
            "Portuguese" : " Olá ",
        }
```

```
def onInput_onStart(self):
<4>
    sDefaultLang = self.tts.getLanguage()
 self.onStopped(self.sentences[sDefaultLang])
```

Listing 1. Scripts for the second block of SAY

Line 1: In fact, MyClass is the class representing the box. GeneratedClass is a class which is automatically generated at the execution of the behavior. It includes all the needed information concerning the box (inputs, outputs, parameters). It also defines all the additional built-in functions of the box script which could be useful for you to use in the script. The fact that MyClass inherits from GeneratedClass makes possible for you to use all these built-in functions in the script. Moreover, as you can edit MyClass, you can add your own functions.

Line 2: This line creates an object, called tts.
self is there to make sure tts will be available not only locally, but in all the code blocks of the script.
tts is the name we gave to the object instance (could have been myspeechmodule or speakingmodule).
ALProxy() is a class of objects, allowing you to have acces to all the methods of a module.
ALTextToSpeech is the name of the module of NAOqi we want to use.[3, 10-12]

Line 3: This line uses the object tts to send an instruction to the NAOqi module.
self.tts is the object used.
say() is the method.
“You are so smart” is the parameter.

Line 4: This line activates output of the box from the language chosen. In application 1, English is selected that NAO will speak English.

This script uses the say method of the ALTextToSpeech module. ALTextToSpeech is the module of NAoqi dedicated to speech. The say method makes the robot pronounce the string given in parameter. The ALTextToSpeech module allows the robot

to speak. It sends commands to a text-to-speech engine, and authorizes also voice customization. The result of the synthesis is sent to NAO's loudspeakers.

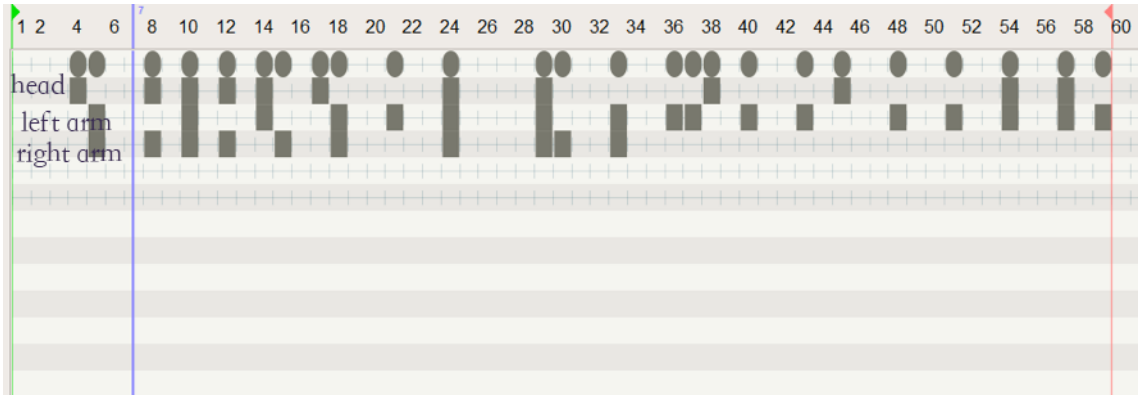

Figure 10. Timeline editor of Animation box of Application 1

Figure 10 illustrates the timeline editor of Animation box of application 1. Timeline shows the different period of NAO movements by head, arms and legs. As figure 9 shows the connection to every block, these movements will happen at the same time when NAO speaks YOU ARE SO SMART.

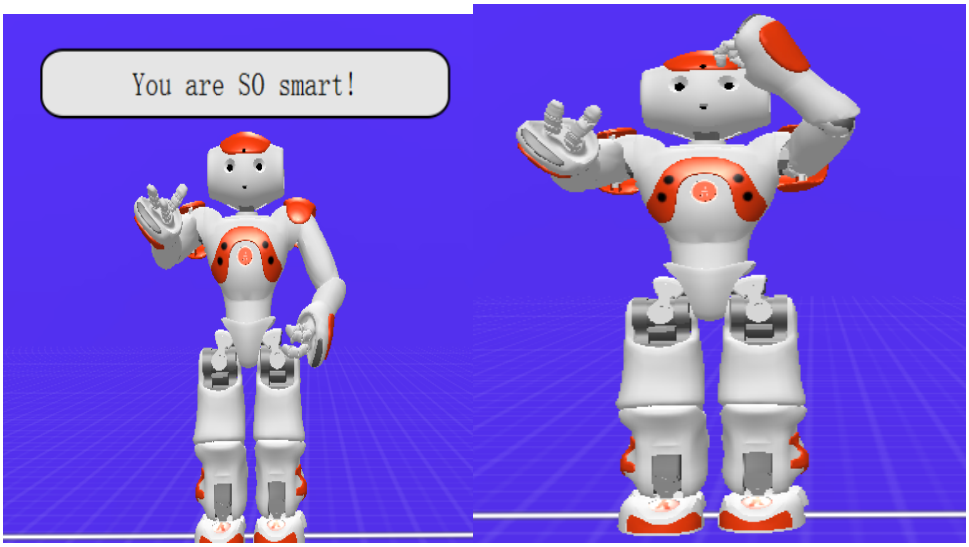

Figure 11. Simulated animation of application 1

Listing 1 illustrates the scripts for the second block of SAY. It is programmable to add more languages for NAO, like Finnish or Swedish. As figure 11 shows the simulated animation, NAO is able to follow the program doing actions like speak out and put his hands up. Choregraphe is really easy to set up blocks in the flow diagram to simulate how NAO will move, the window of simulated animation is on the lower right corner. In the timeline, you can gently slide the mouse wheel to change the time connection between actions.

NAO Robot teachers in the future will have more advantages, for example, can mimic senior teachers teaching under stress, allow more people to share equal and qualified education resources. For a small number of teachers in remote and backward areas, low education levels, the NAO robot teacher could imitate outstanding teachers giving lectures for those students in remote areas. Sometimes the NAO robot teacher is more attractive to students and improves student interest in learning, of course, the NAO robot teacher can also dance and do other programs for students to broaden their horizons.

2. For students

NAO is the most widely used humanoid robot for learning Science, Technology, Engineering and Mathematics (STEM). [2,12]

NAO is an interactive, fully programmable humanoid robot which is being continuously developed and which meets the requirements of educational methods that are based on experimentation and analysis. He can not only assist teacher giving lectures to students but also accompany with students studying together. The second application in education system is to be used in class as well but it focuses on the student behavior.

Application 2 You are right with clapping

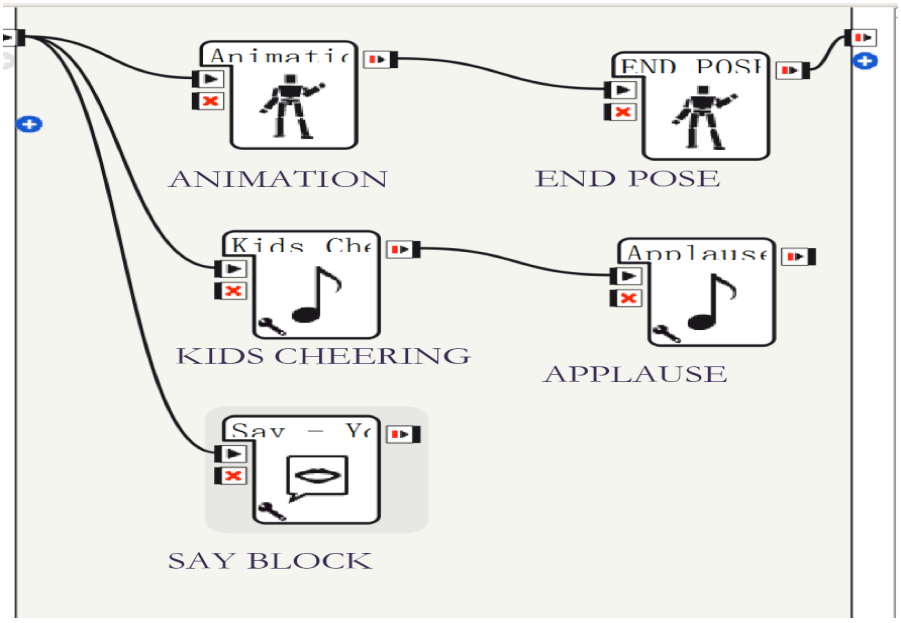

Figure 12. Flow diagram of application 2

Definitions of blocks:

a) SAY block: NAO will say YOU ARE RIGHT!
b) Animation block: NAO will clap hands to cheer students up.
c) Kids cheering: NAO will play a sound file for hands up. Select the file in parameters. The format of the file can be wav, mp3, or ogg. Note: There can be some delay to play mp3 files. It is advised to use wav if you want a fast play of the file.
d) Applause: NAO will play a sound file for clapping hands.
e) End pose: NAO will have a cool end pose.

As figure 12 shows the simulated animation, NAO is able to follow the program doing actions like speak out and clap hands. As the movements goes on, NAO will say you are right to prove your answers are right. Meanwhile he can also make some movements to cheer students up. To make students study hard and more confidently, NAO should be a good friend.

Scripts:

```
class MyClass(GeneratedClass):                    <1>
    def __init__(self):
```

```
            GeneratedClass.__init__(self)
            self.player = ALProxy('ALAudioPlayer')
                                                          <2>
            self.playerStop  =  ALProxy('ALAudioPlayer',  True)
#Create another proxy as wait is blocking if audioout is remote

        def onLoad(self):                                 <3>
            self.bIsRunning = False
            self.ids = []

        def onUnload(self):                               <4>
            for id in self.ids:
                try:
                    self.playerStop.stop(id)
                except:
                    pass
            while( self.bIsRunning ):
                time.sleep( 0.2 )

        def onInput_onStart(self, p):
                                                          <5>
            self.bIsRunning = True
            try:
                if (self.getParameter("Play in loop")) :
                   id                  = self.player.post.play-
FileInLoop(p,self.getParameter("Volume (%)")/100.,self.getPa-
rameter("Balance L/R"))
                else :
                   id      = self.player.post.playFileFromPosi-
tion(p,self.getParameter("Begin  position (s)"),self.getParam-
eter("Volume (%)")/100.,self.getParameter("Balance L/R"))
                self.ids.append(id)
                self.player.wait(id, 0)
            finally:
                try:
                    self.ids.remove(id)
                except:
```

```
                    pass
                if( self.ids == [] ):
                    self.onStopped() # activate output of the
box
                    self.bIsRunning = False

        def onInput_onStop(self):
                                                              <6>
         self.onUnload()
```

Listing 2 Scripts for the first sound

Line 1: In fact, MyClass is the class representing the box. GeneratedClass is a class which is automatically generated at the execution of the behavior. It includes all the needed information concerning the box (inputs, outputs, parameters). It also defines all the additional built-in functions of the box script which could be useful for you to use in the script. The fact that MyClass inherits from GeneratedClass makes possible for you to use all these built-in functions in the script. Moreover, as you can edit My-Class, you can add your own functions.

Line 2: ALAudioPlayer provides playback services for multiple audio file format and the associated common functionalities (play, pause, stop, loop). The resulting audio stream is in all cases sent to NAO's loudspeakers. It relies on several decoding Linux libraries (mainly Gstreamer and SNDFile) to efficiently decode and stream to audio outputs a good variety of audio file formats. [3]

Line 3: When a box is loaded, the onLoad function of its script is called. This is done when the box is loaded. Blsrunning gets new value [false]. Ids gets value list empty.

Line 4: When it is unloaded, the onUnload function of its script “for id in self.ids” is called. For every id in list[ids], the id is stopped. IF stopping did not succeed then wait until id stops running at 0.2 seconds.

Line 5: When it is started (with an onStart input), the onInput_<self> function of its script is called. Firstly, create id, remove id if it is now free. If list ids are empty, nothing is running and stop the box.

Line 6: When it is stopped with an onStop input, the onInput_<self> function of its script is called.

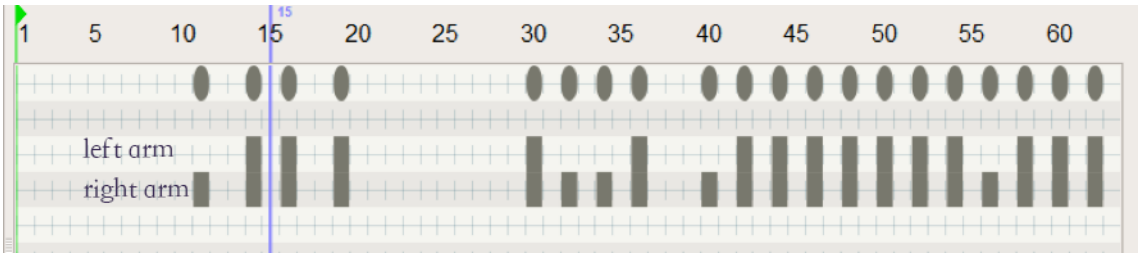

Figure 13. Timeline editor of Animation box of application 2

Figure 13 illustrates the timeline editor of Animation box of application 2. Timeline shows the different period of NAO movements by head, arms and legs. As figure 12 shows the connection to every block, these movements will happen at the same time when NAO speaks YOU ARE RIGHT as animation block and say block received signals simultaneously. For instance, NAO will put his left and right hands up together between 11 to 19 second.

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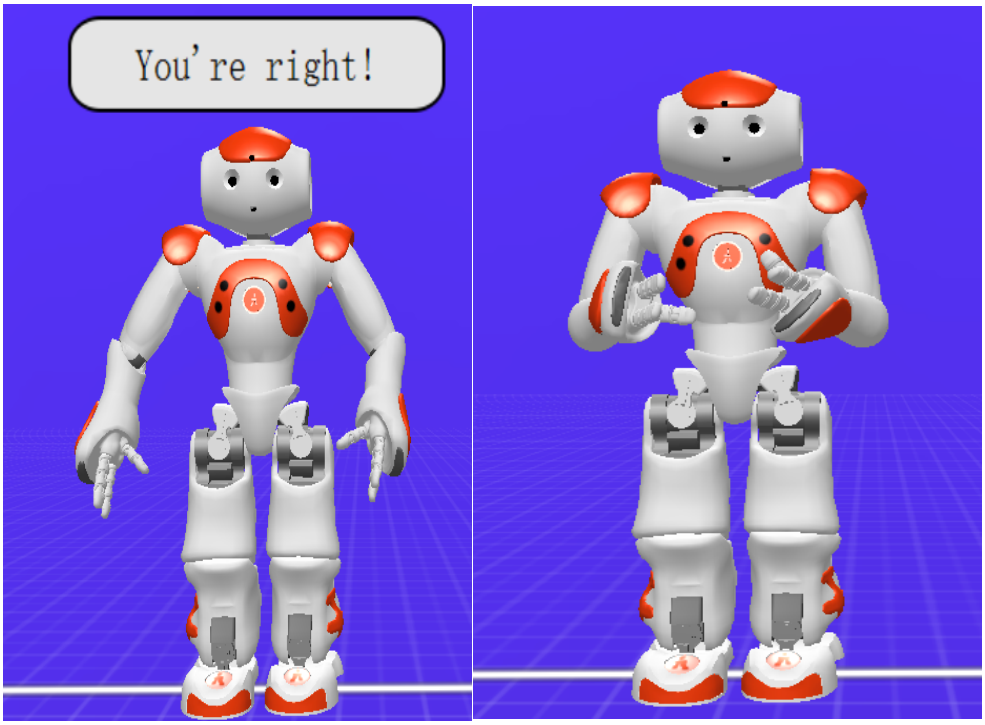

Figure 13. Simulated animation of application 2

Listing 2 indicates that when NAO makes some movements he can even sing a song to cheer students up at the same time. Initially choose a sound file like mp3 or wav, then set the file as the parameter of sound block in the timeline. Maybe there will be a delay when mp3 is choose, if you want to play a fast song, wav is recommended.

The figure 13 shows the animation of application 2. The robot will encourage students by clapping hands and use a lot of body movements to indicate students' affirmative answer. There is no doubt to increase the self-confidence and learning research better for students. At the same time NAO looks cute, it is possible to make students curious to focus more attention on learning.

4 Further Improvements

Autism

Autism (autism spectrum disorders, ASD) is a widely obstacle to development. The main clinical features are social interaction disorders, verbal or non-verbal communication defects, narrow interests and stereotyped behavior.

There are 35 million people who had autism around world, of whom 40% are children, as figure 14 shows. The number of Chinese children with autism is more than 100 million. [4, 60-68] In recent years, the number of children with autism is increasing, but experienced doctors are few. How to help these autistic children back to health? NAO will play a key role in the future by advanced improvements.

Figure 14. Autistic children. Reprinted from URL: https://amongsthumans.com/the-autistic-child

Autism is a medical term, also known as loneliness. It is classified as a developmental disease since the disorders of nervous system. It has symptoms including abnormal social skills, communication skills, interests and behavior. Autism is a pervasive developmental disorder which is unable to have normal skills of social interaction and communication. It always causes mental illness such as stereotyped patterns of behavior, interests and activities.

Parents can often detect children's autism when infants were only at the age of 2. Typically, autism is evolving gradually, but some children patient with early symptoms of autism will get worse rapidly. Early therapeutic intervention can help autistic children learn to survive and basic social skills. Although some news talking about that autistic children have been cured, but there is not a certain and correct treatment existing in the world so far. Therefore, finding a suitable method has positive effects for intervention on the rehabilitation of children and their families' happiness.

NAO has a pleasing shaped and the ability to interact with people affectionately. It can also learn body language and facial expressions to infer emotional changes of people. Autism Solution for Kids (ASK NAO) was created by Aldebaran Robotics to customize NAO robot to help children with autism reach new levels of greatness. [5]

It supports teachers with in-class tasks and assists children to learn and function. This initiative was developed after noticing that many children with Autism seem impulsively attracted to technology, therefore allowing NAO to become the perfect bridge between technology and our human social world.

ASK NAO clears the path for a revolution in thinking, driven by those who are most intimate with Autism and technology. With NAO, we can shape the special education world of tomorrow for the best of the children.[6, 84-86]

To accomplish this Aldebaran Robotics is creating a multi-sided community made up of developers, therapists, researchers, teachers, parents, enthusiasts, to help children surpass their limits.

Application 3 NAO the little joker

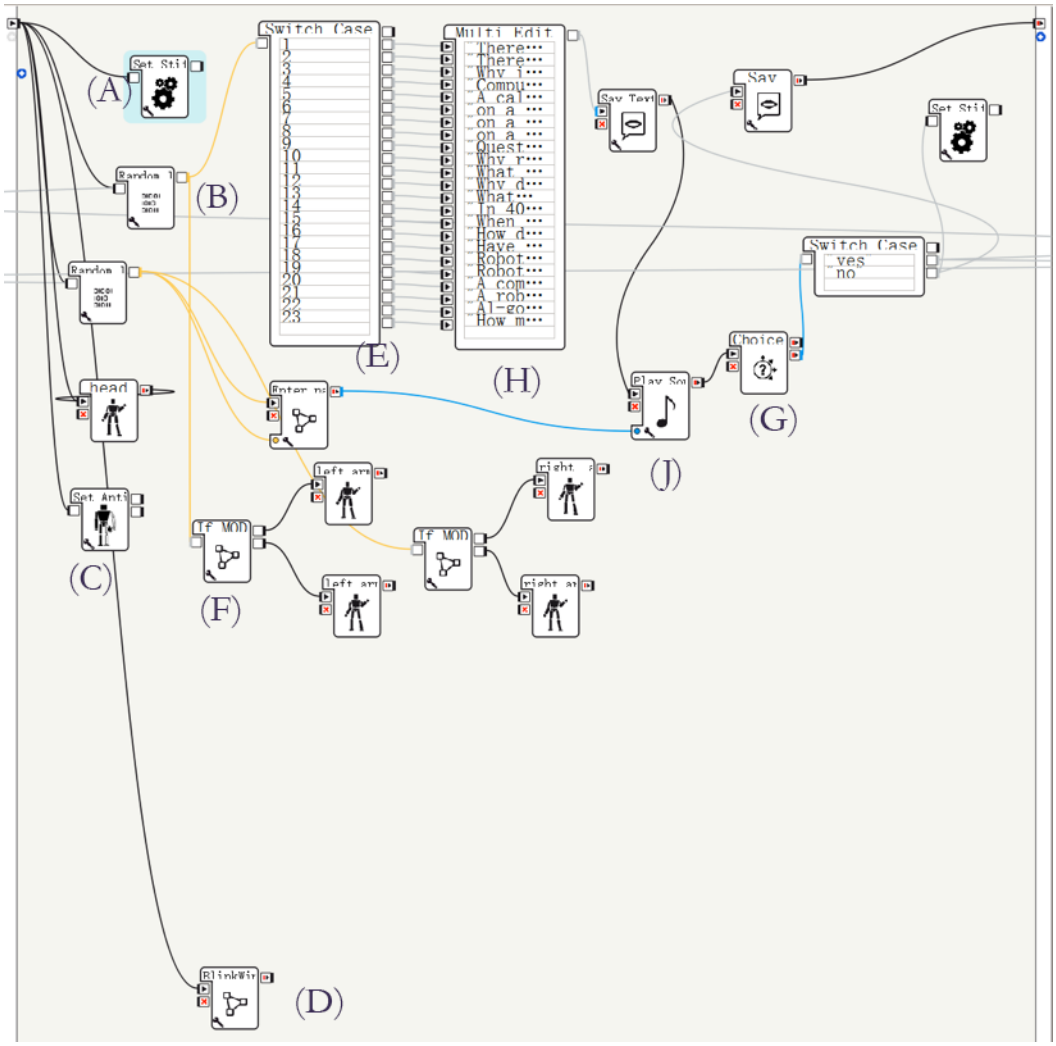

Figure 15. Flow diagram of application 3

Definitions of blocks:

a) Set Stiffness block: Stiffen the motors selected in parameters.

b) Random Int. block: Generate a random integer between a min number and a max number set as parameters. Note that the min and max numbers are included in the range of possible values.

c) Set Anti-Collision: Enable or disable the collision protection on some specific part of NAO's body. For example, if the protection is enabled on his left arm he will move his arm all the same than when it is not but avoiding his other body parts.

d) Blink Wink: NAO will Eyes keep blinking until box is stopped.

e) Switch Case: Test input value and stimulate the output matching to this value. If there is no matching output, the default output (on Default) is stimulated. You can edit a case by left double-clicking on the line.

f) If MOD: Test a condition and stimulate the then or else outputs depending on the Boolean value of the condition. The condition can be set in parameters.

g) Choice: Launch speech recognition, and wait for one of a defined number of expected answers (written in the table of the box). NAO will prompt the speaker if he cannot understand and give suggestions as to available answers and other ways of selecting your choice.

h) Multi Edit: Send the value in front of the input stimulated. There are many jokers set for NAO to speak out.

List of jokes:

1. There are 10 kinds of people in the world. Those who understand binary numbers and those who don't.

2. There are 2 kinds of people in the world. Those who understand hexadecimal and those who don't.

3. Why is it that programmers always confuse Halloween with Christmas?

4. Computers are like air conditioners \\Pau=600\\ they stop working properly when you open windows\n

5. A Californian man has invented a robotic parking attendant. He's calling it at the Silicon Valet.

6. on a MS DOS operated elevator \\Pau=700\\ you enter and push a button for the 8th floor, but it can't get past floor 6 point 4

7. on a Mac operated elevator \\ Pau=700\\ there is a single button for all floors. you push it, and it takes you to the floor it thinks is good for you.

8. on a windows 95 based elevator \\ Pau=700\\ when you push the button for the 32nd floor, it takes you to the 16th floor, \\ Pau=700\\ twice.

9. Question: Who was the first computer technician? \\Pau=700\\ Answer: \\Pau=440\\ Eve. \\Pau=440\\ She had an Apple in one hand and a Wang in the other.

10. Why robots are angry? \\Pau=700\\ Because people keep pushing their buttons!

11. What is a robot's favorite type of music? \\Pau=700\\ Heavy metal!

12. Why did the robot go back to robot school? \\Pau=700\\ Because his skills were getting a little rusty!

13. What's Silver and Lies in the Grass? R2 Doo Doo\n

14. In 40 years' robots will be doing most of the work Humans don't want to do; \\Pau=700\\ especially illegal robots from Mexico.

15. When I find my code in trouble, \\Pau=500\\ Friends and colleagues come to me, \\Pau=500\\ Speaking words of wisdom: \\Pau=500\\ Write in C.

16. How do you keep a robot in the shower all day? \\Pau=600\\ Give him a bottle of shampoo which says \\Pau=500\\ wash, rinse, repeat.

17. Have you heard about the object-oriented way to become wealthy? \\Pau=700\\ It is called \\Pau=400\\ Inheritance.

18. Robot Code number 17 \\Pau=700\\ When computing, \\Pau=600\\ what ever happens, \\Pau=500\\ behave as though you meant it to happen.

19. Robot Code number 24 \\Pau=700\\ When the going gets tough, \\Pau=600\\ upgrade.

20. A complex system that does not work \\Pau=600\\ most of the times \\Pau=400\\ have evolved from a simpler system that worked just fine.

21. A robot will always do what you tell him to do, but rarely what you want him to do.

22. Al-gor-ithm means \\Pau=500\\ The unscrupulous technique of continuing to count, and re-count \\Pau=600\\ until you get the result you want

23. How many software engineers does it take to change a light bulb? \\Pau=700\\ None.\\Pau=600\\ It's a hardware problem.

j) Play sound: NAO will play a sound file like laughing when he plays a joke to you.

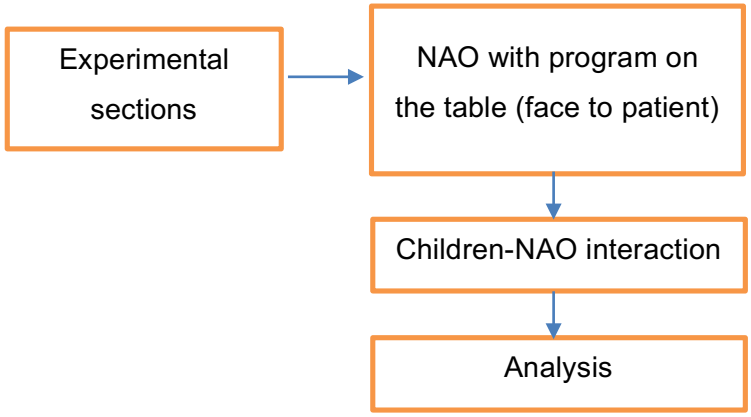

Figure 16. Experimental Flow diagram of application 3

As figure 16 shows the experimental flow diagram of application 3, this application is aimed to interact with autistic children. NAO will stand on the table facing to children patient and tell him some jokes. Figure 15 describes the flow diagram of the application.

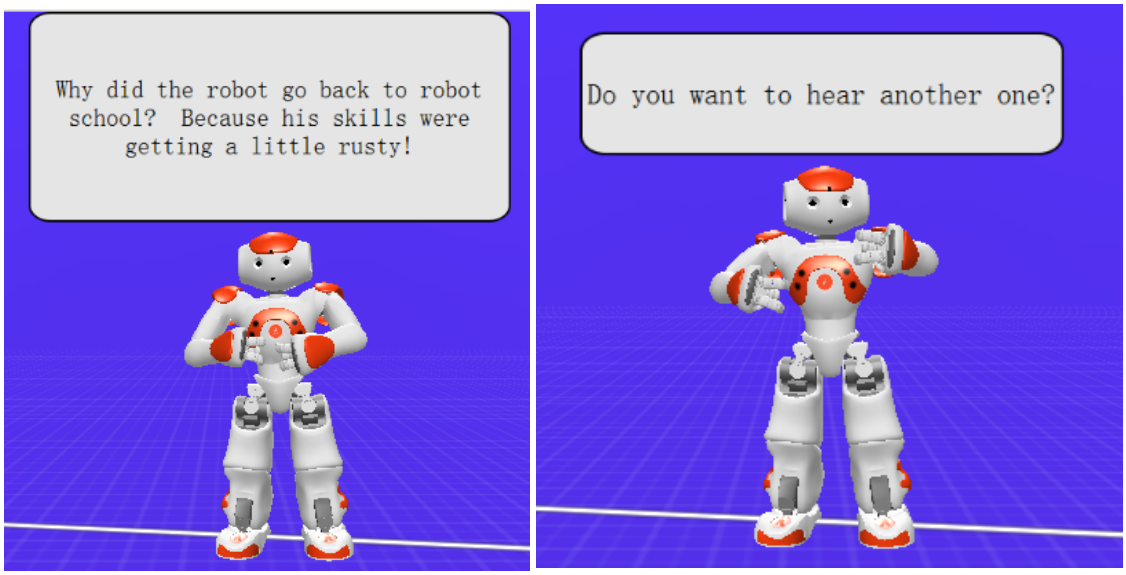

Figure 17. Simulated animation of application 3

Figure 17 shows the simulated animation of application 3. Initially, NAO looks at children and does some eye contacts. Then he will tell one of the jokes listed in block(h) multi edit to make children laugh. His eyes are also blinking to let you know he is looking to you. Meanwhile NAO plays a sound file including laughing to make children laugh out loudly.

Next step is to ask a choice question to children: Do you want to hear another one? NAO is lifting his left arms when he asks this question. If children reply YES, NAO will put his right arms up and tell another new joke to you. If children reply NO, NAO will say It was a pleasure entertaining you instead.

After this application was used for autistic children, they may feel better to communicate with other people, surroundings and even strangers.

Analysis:

The advantage of NAO

There is no difference between the autistic children and normal children when you look at them. However as long as talking a few words with autistic children, you will find that their problems are very serious: they are afraid of making eye contact with you, they will shake their bodies restlessly, even with the head. Although they have different sense of emotions, such as fear, anger and pleasure, but they are often indifferent to other other people.

What worried more is that an autistic child needs to be taken care of by two or three people, but the number of people who are able to take autism treatment and rehabilitation training is less than the number of patients with autism. With the increased level of intelligent robot, which is increasingly being seen as hope of autism researchers to save the autistic children. In addition to compensate for the lack of the number of therapists to carry out treatment whenever and wherever possible, the robot may also have more advantages than human therapists. [7, 26]

Most children with autism are lack of normal social skills, communication skills, and the variety of facial expressions and body movements may make them full of fear. On the contrary, although NAO humanoid robot is almost like a real human, they have similar appearance, but their facial expressions and body language are much simpler compared with real human beings. Moreover, NAO robot is equivalent to a height of 58cm, their shape makes them easier to get with children with autism.

By the application 3, NAO plays jokes with autistic children to make them happy. Hope the robot to establish contact with the children, because they are afraid to contact with people face to face, afraid to socialize, and to communicate with the machine is easier. Autistic children may be able to learn the basic surviving skills and social skills since this easier method contacting with NAO would make them receive information by simplified communication.

5 Conclusion

NAO is the most widely used humanoid robot in the academic world. Teaching robots like NAO are usually interesting, challenging and can inspire imagination of students. As a good assistant on teaching and learning, NAO is creating the new way in education system in the future

By the experiments and analysis in this thesis, NAO has a giant potential not only in education system, but also in health and care system. There are still some places needed to be improved. For example, nowadays many elderly people feel lonely because children are busy, often no one to chat. NAO can talk and accompany with the elderly, he can recognize your family to call their names, it can accompany you play chess, play ball. NAO can also be treated as a supervisor to supervise students studying hard. Hope NAO will play a more important role in the future in the education system.

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