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INFORMATION VIA AUGMENTED REALITY

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ABSTRACT

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The vast majority of mobile technology today has developed over the past decades. The thirst for information and communication has brought about high data transfer speed on modern mobile handset devices. This makes it possible for Augmented Reality to be used on mobile phones.

Vaasa University of Applied Science, Technobothnia science resource center and Lumivaara Museum saw the importance of information and decided to embark on a pilot project where Augmented Reality will not be only use as information sharing tool, but also to enhance user experience. The aims of this pilot project are: to improve product knowledge in Technobothnia mechanical engineering laboratory, to create pilot teaching material utilizing augmented reality and finally to improve user experience in Lumivaara Museum through Augmented Reality.

This was achieved by creating and editing of videos and audios as Aurasma overlays for the Augmented Reality. Since Augmented Reality is still a new technology, we saw the need to use QR code technology for windows phone users and via these codes they can access the same information which Apple and Android users can access via Aurasma.

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ABBREVIATIONS

1G, 4G:	First and fourth generation.
API:	Application Protocol Interface.
AR:	Augmented Reality.
FPS:	Frame per second.
GAI:	Graphic audio-visual and integration.
GPS:	Global Positioning System.
QR code:	Quick Response Code.
TB:	Technobothnia.
VAMK:	Vaasa University of Applied Science.
VEI:	Vaasa Energy Institute.

1 INTRODUCTION

Research shows that visual information has a tendency of 80% remembrance while reading and audio information has 20% and 10% respectively. /5/. Information has been very important in human life from generations to generations and is carried out in so many mediums and platforms. In recent generation, companies and institutions are thinking of the best way audience can receive information. Augmented Reality makes new possibilities to show visual information in a very interactive and interesting way.

This thesis explains how to work with Augmented Reality and how to use it to the advantage of the institution. Augmented Reality (AR) is a mobile platform application that visualizes digital view information to the physical world as though it is real from the user perspective.

1.1 Background of the Thesis

In the 1980s, cell phone which is known as mobile phone today was commercialized. The early mobile phones were classified as 1G which is an acronym for 1st Generation mobile phones. 1G mobile phone runs on analog network with a low quality voice call which was mostly intercepted. These phones came in big sizes which had 12 keys with a long antenna and were comparatively heavier than any other phones made after them. /2/.

The 2G or 2nd Generation mobile phone appears to be the breakthrough of mobile technology and was developed over a period of 20 years. 2G mobile phones run on digital networks with more accurate voice quality and data transfers. Unlike 1G, 2G mobile phone has multipurpose functions such as text message, multimedia message, simple web browsing, caller ID, camera, video, audio, ring tones and graphics. Its maximum download speed was measured to 144KB/s. /2/.

3G mobile phone was announced in 2000 which included all the features of 2G and more features such as quality web browsing, E-Mails, location-based services

(GPS, maps), low display; music streaming, video streaming and video calls. Further improvements were made which came along with the introduction of smart phones in 2010. Today, it appears 4G Smart phones has the sensitivity focus and sophisticated camera which makes it possible to use augmented reality program applications on phones. /2/

1.2 Objectives to the Study

This thesis is focusing on the usage and the promotion of Augmented Reality in VAMK and two other organizations known as Technobothnia and Lumivaara Museum.

The main objective of this thesis is to pilot the use of Augmented Reality in Vaasa University of Applied Science, Technobothnia and Lumivaara Museum. Vital information such as news, machine and equipment knowledge, navigations, robotic demonstrations and simulations to be channel via Augmented Reality.

1.3 Structure of the Study

The rest of the thesis is structured as follow. Chapter two presents the participation institutions which are VAMK, Technobothnia and Lumivaara Museum. Chapter three is the literature review of information and its importance, QR code and Augmented Reality. Chapter four describes user experience and how Augmented Reality can contribute to the user experience.

How to create an Augmented Reality and the over view of Aurasma application are explained in Chapter five. What was done in the pilot project and the analysis from the questionnaire survey is discussed in Chapter six. Finally, chapter seven draws the conclusions and recommendations of this project.

2 PRESENTATIONS OF INSTITUTIONS

2.1 Vaasa University of Applied Science

VAMK is a modern and international University of Applied Sciences which provides high level theoretical and practical oriented education in Finnish and in English, both at Bachelor level in full-time and part-time education as well as professional Master's degree level.

The main areas of focus are high technology, international business, and health care and social services. VAMK takes a special interest in combining the traditional entrepreneurial spirit of the region with international awareness, languages and culture in the education. There is a strong emphasis on internationalization and the instructors maintain high educational standard.

VAMK has an extensive co-operation network with universities and other educational and research institutions abroad, as well as in Finland. The personnel, programs and services team up to provide an extensive range of learning alternatives, offering an unbeatable combination of quality education in the modern and student-friendly city of Vaasa.

Currently, VAMK has 3,300 students enrolled and a full-time staff of over 230 members, as well as 50 part-time or visiting teachers and professors. VAMK has two campuses, one in Palosaari – the sea side campus, and one on Raastuvankatu right in the heart of the city center. Both campuses are easily reached and only 1.5 kilometers from each other. /4/.

2.2 Technobothnia

Technobothnia Education and Research Centre was founded as an answer to increased cooperation between the education of engineers in Vaasa and the region's industry. In year 1996 a massive renovation of the former Vaasa Cotton factory empty weaving hall were carried out and the state-of-the-art technical center got new premises for the education of engineers and M.Sc. students as well as for advanced research.

Technobothnia is being jointly used by University of Vaasa, Vaasa University of Applied Sciences and Novia University of Applied Sciences.

The state-of-the-art technology that is needed in engineering education, research and product development has been concentrated inside about 8000 m² in area. There is equipment available in the areas of electrical, mechanical, construction engineering, and environmental and information technology and the Centre offers a unique atmosphere that promotes creativity and development. Research and development projects are coordinated both inside Technobothnia and through another co-owned organization VEI, Vaasa Energy Institute. Technobothnia also offers services in testing and measuring as well as education for Vaasa region's industry. /3/.

2.3 Lumivaara Museum

Lumivaara municipality is located in the north-west corner of Lake Ladoga between Jaakkima and Kurkijoki officers. Its areas belonged to Finland until the end of 1922. Lumivaara belonged to the Vyborg province, Kurkijoki judgment municipality and Kurkijoki district. In 1940, its inhabitants earned a living from agriculture and forestry 93%, industry and manual labor by 2.6%, trade by 2.1%. /23/.

The municipality has a population peaked at approximately 6200 towards the end of 1920s (1928). Lumivaara municipality was spread towards southeast to northwest 34 kilometers long. Tervajärvi and Kumolan villages were about 15 kilometers wide. The municipality entire surface area was 292.4 square kilometers. In just over a third of Lumivaara area form the coasts and island villages, which are in addition to Kumolan village beach areas Kuhkaa, Harvio, Kalksalo and Kesvalahti. In addition to the above include the parish Huhtervun, Ihalan, Kostamo Lake, Oinaanvaaran and Tervajärvi kylät. Lumivaaraan had a total of 10 villages. /23/.

For hundreds of straits and bays separated by islands and peninsulas are that famous and wonderful nature of Ladoga archipelago, which is imprinted indelibly snow danger kinds of minds. /23/.

2.3.1 Old settlements

Lumivaara officer is assigned to the northwestern corner of Lake Ladoga areas, where the population is very old. This is evidenced by the many muinaislöydöt made areas. Term Stone Age artifacts have been found Lumivaara area by the year 1944, approximately 60 of these Kumolan village over a third. Artefacts is evidenced by the fact that the area has been inhabited for about two thousand years before Christ. When the millennium settlements characters is thought a number of stone castles that were the northwestern shores of Lake Ladoga, which has the remains of an even mm. Kumolan Lemettilä group. After the Winter War peace treaty enter into force on 03.13.1940 the snow the risk of people were forced to leave their homes and leave the snow Hazard Passover week, by Wednesday 03.20.1940. /23/.

2.3.2 The museum

Lumivaara museum is located in Seinäjoki Keskustie 28 which is under the management of Lumivaara-Perinneyhdistys ry and is headed by Mr. Kari M Rapo. The museum showcases several artifacts belongings form the 1920s to 1930s. The first item to be donated to the museum is the manually-operated sewing from the 1930's. The farming section of the museum exhibits the farming equipment used in that era and these are; separator, cow bell, grain spade and scales.

Building and woodwork section also showcases the wooden container holds planes, a clamp, measuring device and rulers. Forestry and Communal Forest items are located in a glass cabinet and these includes; typewriter, calculator, Duplex stapler, stamps, ink bottles, paper knife and telephone cable. Other items from different sections includes; log scribe, log holder, log drill, line mangle, line scotching device, spinning wheel, wooden swift for skeins, irons, linen brush, shears, wool card, shoemaker's tools, reeds, reed hook, shuttle, wool winding frame, embroidering patterns and many items which were used in the 1920s.

3 INFORMATION SHARING

3.1 What is information management?

Information could be defined as knowledge acquired from another or knowledge you can convey to others. /33/. Information is also referred as the meaning or semantic content of a message./37/. Information can be any differences you perceive in your environment or within yourself. It is any aspect that you notice in a pattern reality. /24/.

Information Management (IM) is the collection and management of information from one or more sources and the distribution of that information to one or more audiences. This may involve stakeholders, or a right to that information./32/. IM is also defined as the structure and processing of information in organization with the goal of improving the premises of organizational performance. Information management is a practical perspective which focuses on analyzing existing information resources, methods, strategies and processes./19/.

Management means the organization and control over the structure, processing and delivery of information. Information management involves all the aspects of management, including: planning, organization, structuring, processing, controlling, evaluation and reporting./32/.

3.2 Information Life-cycle

The life-cycle of information may be considered to be an extension of a process thinking. Eaton and Bowden (1991) stated in their perusal of the nature of information as a resource that information has a life-cycle beginning from the definition of needs and proceeding to the collection, transmission, processing, storage, dissemination, use, and finally disposal. /19/.

Figure 1 below shows the UCLA information life-cycle model.

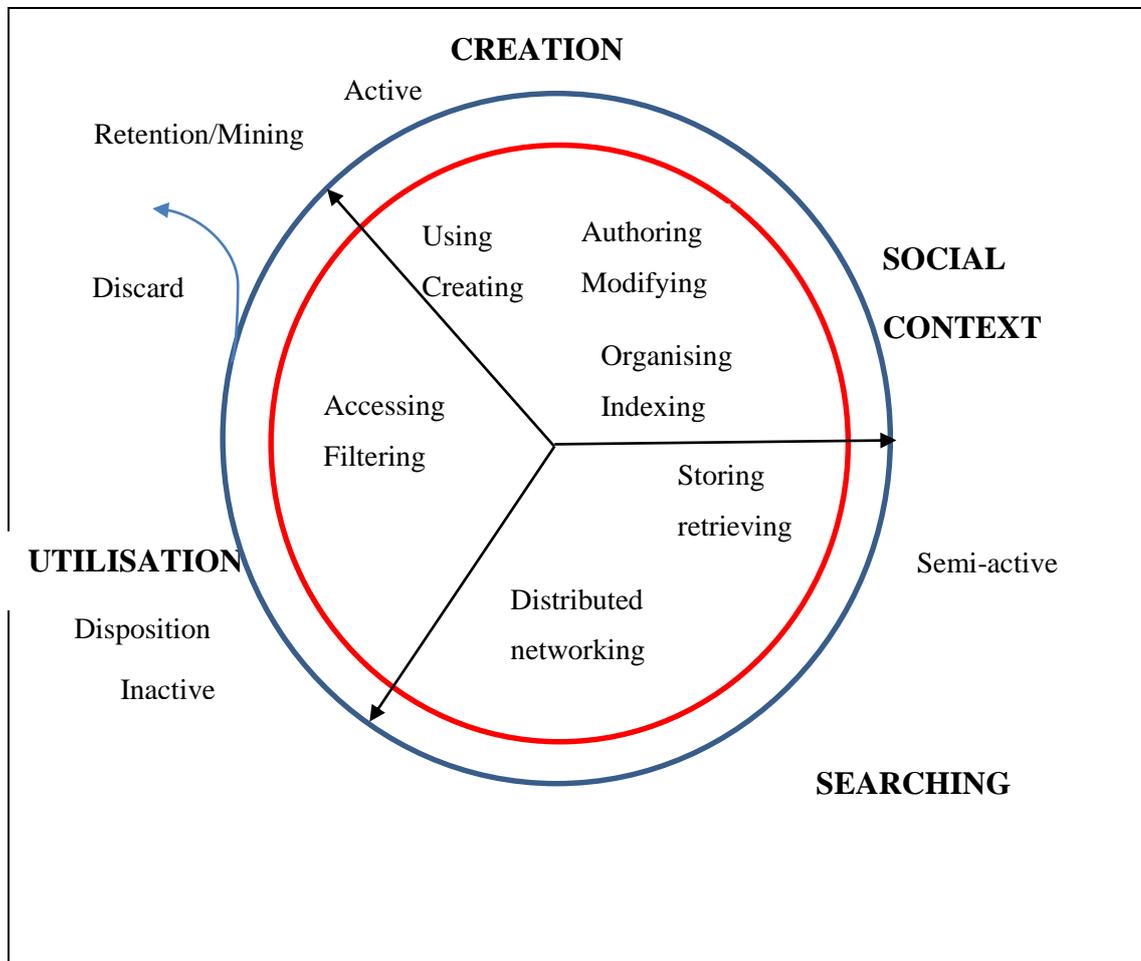


Figure 1. The information life-cycle /19/.

The outer ring indicates the life-cycle stages (active, semi-active, and inactive) for a given type artifact such as business records, artworks, documents, or scientific data. The stages are superimposed on six types of information uses or processes (inner circle). The cycle has three major phases: information creation, searching, and utilization. The alignment of the cycle stages with the steps of information handling process phases may vary according to the particular social or institutional context. /19/.

3.3 Forms of information

There are three forms in which information presents themselves and they are constructional information, operational information and communication information.

3.3.1 Constructional information

Constructional information includes all information that is used for the purpose of producing something. Before anything can be made, the originator mobilizes intelligence, ideas, know-how and inventiveness to encode concept in a presentable way. Some examples of encoded blueprints are; technical drawing for the construction of a machine, a cake recipe, details of the chemical processes for synthesizing polyvinyl chloride, an electrical circuit diagram and many others. /18/.

3.3.2 Operational information

All concepts having the purpose maintaining some industry in the widest sense of the word are included under operational information. Many systems require operational information in the form of programs for proper functioning. These programs are indispensable and ensure that the preconceived processes run as expected. A barrel-organ cannot function without the required cylinder, and the human body is viable only when the conceptual information is provided with all the interactions carried by nervous system to and from the brain and all the body organs. /18/.

3.3.3 Communication information

Communication information consist of all other kind of information such as letters, books, phone calls, radio transmissions, bird songs and so on. The aspect of such information does not include the construction of a product, neither is it involved in maintaining some process. The goals are transmission of a message, spreading joy, amusement, instruction and personal confidences. /12/

3.4 Importance of information

3.4.1 Decision-Making Value

Information has a decision making value for the purpose of helping us to make the right decisions. These are some of the reasons information is valuable to us: a Satellite Navigation system in a car helps us to decide when to turn left and right on the road, phone book makes it easier for us to decide which number to press on the phone to call a friend, the message boards at the airport helps us to decide which gate we need to go for our flight and the car's speedometer informs us how fast we are driving. All of these examples show how this information is really about helping us to make better decisions. /35/.

3.4.2 Entertainment Value

We pay for films, music and video games. While some movies and song lyrics do help us think about issues in our lives, we generally use them for short-term entertainment. We value them because they give us pleasure. Generally, the more pleasure they give the more we are likely to value them. /35/.

4 USER EXPERIENCE

User experience is a new research field that received a lot of attention in the last decade. /27/. In general user experience describes all factors, which affect the user's experience of a technology, system, or product. /27/. The understanding of how an individual user is interacting with technology is crucial for the implementation of a new technology or device. Recent research is mostly focused on low perceptual issues. However, there is a need to identify obstacles that users face, an identification of the information that needs to be provided and an appropriate way of data presentation /17/, user experience tries to answer these questions. User experience could be referred as the practical, experimental, affective, meaningful and valuable aspects of human-computer interaction and product ownership. In addition, it includes a person's perception of system aspects such as utility, ease of use and efficiency. User experience is dynamic as it is constantly modified over time due to changing usage circumstances and changes to individual systems as well as the wider usage context in which they can be found. /31/.

User interface could mostly be mistaken as user experience but from the definition, user experience is a quality attribute of the user interface, covering whether the system is easy to learn, efficient to use, pleasant, and so on. Hence, user experience is a brother concept and very important. /34/. Hassenzahl, Partala & Saari describe four distinctive features of user experiences: subjective, holistic, situated, and dynamic. Below, there will be a brief overview of the most recent concepts in the user experience discourse.

4.1 Emotions and Psychological Needs

Emotions are seen as one of the most important concepts studying user experiences as they play a central role in human experiences. Partala & Saari who studied "the most influential single user experience related to successful adoptions over a range of different products" found that the user experiences were highly emotional. Their results imply that designers of technology have to focus on the user's emotional responses towards a device, besides focusing on the traditional attributes (e.g. usefulness, ease of use, output quality) /27/.

Additional to the emotional well-being of a user also the psychological needs of a person are intertwined with their use of technology or adapting to a new device/product. /15/. Hassenzahl, Diefenbach, and Göritz found that there is a clear relationship between the fulfillment of individual needs and the positive perception of a technology. According to them there is a clear relationship between individual psychological needs such as stimulation, relatedness, competence, and popularity in order to create a positive experience. /19/.

4.2 Values and Social Acceptance

Whether or not a new technology gains social acceptance is a challenge that AR has to face. User values and even culture can impede or favor the implementation of a certain technology. /30/. Currently, there is a research gap in this field even though social acceptance is essential for any new technology to become widely accepted. /35/. But from the reviewed literature it can be clearly stated that whether or not a system is in line with the individual's values, strongly influences the user's attitude towards a technology or system. /27/. Many factors play a role when social acceptance and values are considered such as: appearance ("unobtrusive fashionable appearances") to privacy concerns. Kaze & Taylor list a set of values that are mentioned in design of systems such as "privacy, trust, universal usability, autonomy, informed consent, courtesy, calmness and environmental sustainability" /20/.

4.3 Task Load

The concept of task load gives valuable insights when studying user experiences, because the difficulties that a user faces could inhibit a successful implementation of the new system. Task load is measured with the associated effort to do a certain task, including mental, physical and temporal effort that the user needed. /27/. An underlying assumption of this thesis is that any interaction with an interactive product with mobile AR demands that the design minimizes task load to achieve better usability. That is important to not overload the user interface with information, as well as in the case of AR systems to not let the user over-rely on the

technology. An over-reliance could lead to the fact that important cues from the environment are missed out. /21/.

4.4 Importance of User Experience

In the websites scenario, huge successful companies like Google, Twitter, Facebook, eBay and Amazon have recognized that user experience has a direct impact on their bottom line. These companies did not succeed by chance, because they continuously put to test, every aspect of their business with real users to ensure high level of customer satisfaction /36/. Previous research shows that understanding the needs and expectations of potential customers or users of devices or products is crucial in order to ensure acceptance and success of the technology. Therefore, it is critical to comprehensively study user experiences in advance. /34/. Similarly, Roto have found that the foundation of any user experience is defined on the conceptual level of any new application or product, meaning before a user – application interaction has taken place. Correspondingly, Heikkinen suggest that the knowledge of user expectations and research on user experiences could help in the approximation of user experiences before the product is on the market. /36/.

Consultancy identifies that a good user experience:

- Increases sales and customer conversations
- Improves brand perception
- Improves google search rankings
- Reduce customer dissatisfaction and chum
- Reduces the cost of development and support
- It also gives the customer a chance to participate in a program, product or services. /36/.

Hartmann & Sutcliffe proposed a framework for users' judgment of quality of interactive systems. Their framework differentiates between inherent characteristics from outcomes who would be produced through interaction with a system or

product. As illustrated in Figure 2 their research verifies the underlining assumption that user experience is critical in judging a certain system. /32/.

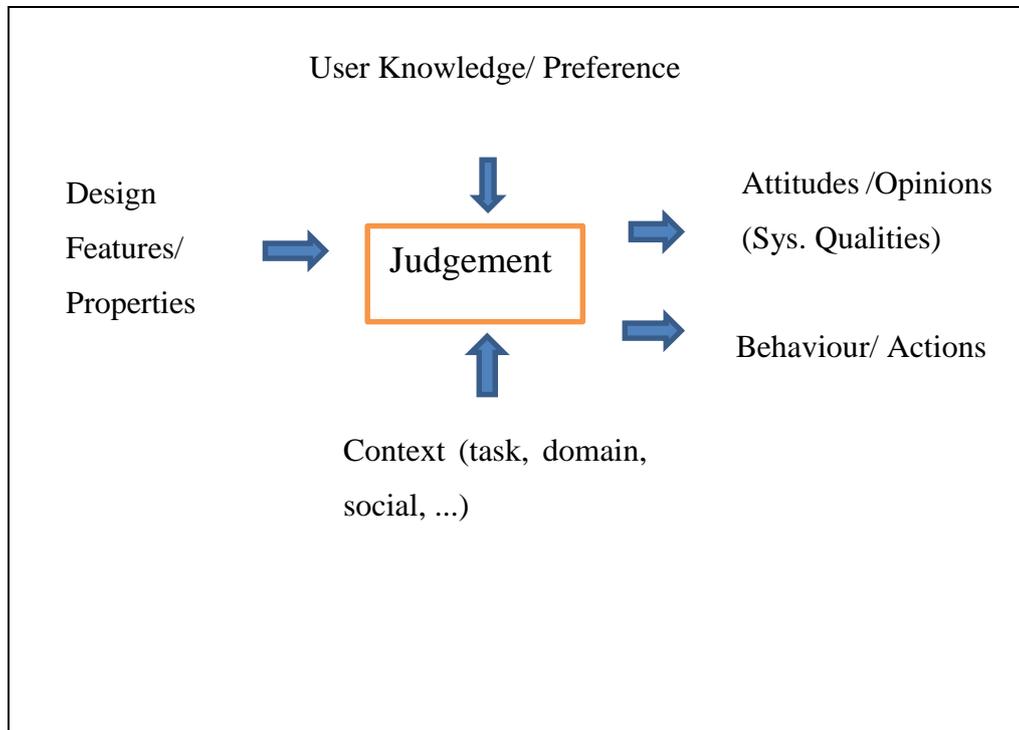


Figure 2. Overview of characteristics of a system leading to user's judgement./32/.

4.5 Improving User Experience through Augmented Reality

User experiences in AR is widely overlooked as previous research focused on the technical options with a limited perspective on understanding the human experiences. /37/. Augmented Reality offers a novel view to user experience as the experience of using technology in itself has changed. The technology is not passive anymore in the equation, but instead there is a synergy effect between the user and the technology in use that takes place through AR technology. /20/. “The technology can serve as a probe which by interaction with the user can uncover new knowledge about people and their associated networks” /20/. This feature of AR technology that goes beyond utility creates a new opportunities for an enhanced user experience through AR. Bergvik, Svendsen & Evjemo confirm that user acceptance goes beyond utility. In their research on the acceptance of mobile devices they found that

hedonistic and non-utilitarian factors are particularly strong predictors of user acceptance. /29/.

Additionally, Neal M found that many Augmentic Reality applications even though they vary in their utility and navigation have to considerate to create a flow experience for the user leading to an ongoing engagement between user and application. Because of the unique features of mobile AR technology it offers opportunities to enter into a flow state. A flow state is achieved when a person experiences a mental state of immersion and engagement, which would reflect positive on the application or product in use. Figure 3 shows the individual experience of a flow state that can be experiences while using mobile AR application according to Neal. /25/.

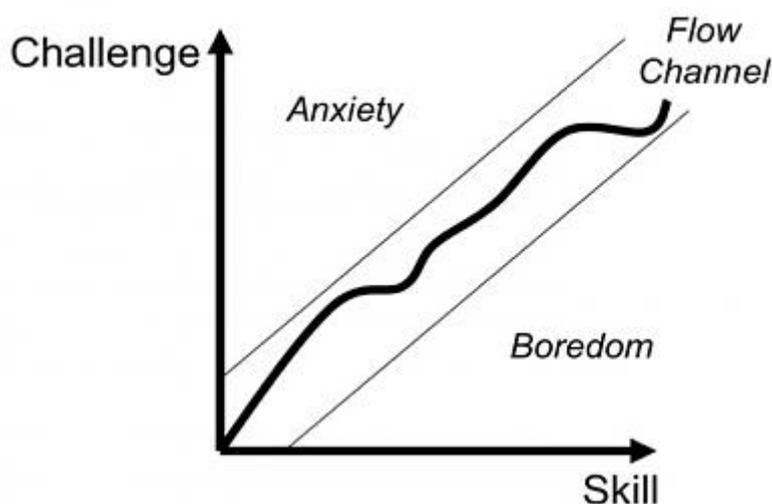


Figure 3. User experience flow concept /25/.

Augmented Reality maintains the user's knowledge of the “real environment by compositing the real world and the virtual contents in a mixed (blended) 3D space”. In this mixed 3D space there is an illusion between the virtual and real objects surrounding the individual, so they coexists in the augmented space. /26/. Many research articles on AR focusing on the use of 3D graphics and the enhanced users

view on the world, only analyzing the visual aspect of AR even though from a user's point of view any media could enhance the reality in a specific context. User experience and augmented reality are intertwined and cannot simply be separated as AR is foremost a technology that should widen the reality of the user that is involved. /29/.

5 MODERN TECHNOLOGIES USED IN INFORMATION UTILIZATION

5.1 Description to QR code technology

5.1.1 QR code as a means to easily access information

Quick Response Code (QR Code) is a machine-readable code consisting of an array of black and white squares, typically used for storing URLs and other information that can be read by the camera of a smartphone. QR Code was first designed for automotive industry in Japan by Denso Wave. The QR code system became popular outside the automotive industry due to its fast readability and greater storage capacity compared to standard barcodes. /29/.

A QR code consists of a black module arranged in a square grid on a white background, which can be read by an imaging device such as smartphones and processed using Reed-Solomon error correction until the image can be appropriately interpreted. The required information or data is then extracted from patterns that are present in both vertical and horizontal components of the image. /29/. QR codes can be generated to provide a precise and accurate way to disseminate the information to users via embedding URLs/URIs/GPS coordinates into QR codes. /31/.

5.1.2 QR code structure and the software tool for processing QR codes

The figure 4 below is a description of the structure of QR codes.

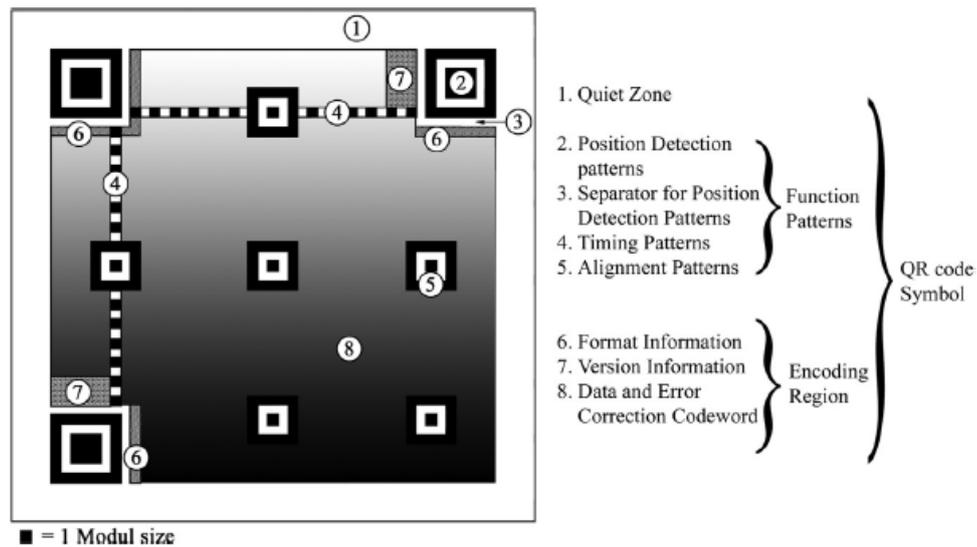


Figure 4. Structure of QR code /33/.

QR code is a two-dimensional barcode defined by the industrial standard ISO/IEC18004:2006, developed and protected by the Japanese company Denso Wave Incorporated, which is a member of Toyota group. Each QR code is structured by dark (logical “1”) and light (logical “0”) modules. The modules are evenly distributed in a square net of fields, where the size of a field is the size of a single module. By the standard ISO/IEC18004 one module should be sized 4 x 4 px (pixels) with the print resolution of 300 dpi (dots per inch). This size ensures readability by the majority of optical devices. The research results in Section 4 show that the module size of 3 x 3 satisfies the readability conditions, if a higher resolution camera is used. Each QR code symbol consists of Function Patterns and Encoding Regions. Function patterns do not contain the encoded data. /22/.

5.1.3 How to create a QR code.

QR codes are simple and easy to use and the following are three steps to create a QR code.

Step 1 Select a QR code generator

There are lots of QR code generators available but these are the most popular ones; Kaywa, GOQR.me, Visualead and QR Stuff. /17/. On the simpler note, QR codes

can be generated online for free. Simply by going to google and typing “QR code online generator”. This gives you several websites that you can generate your code for free.

Step 2 Link and generate

Copy a URL which you want to generate into QR code and paste it in the text box provided in the software or website. And click on “create” or “generate” as stated. See figure 5 below.

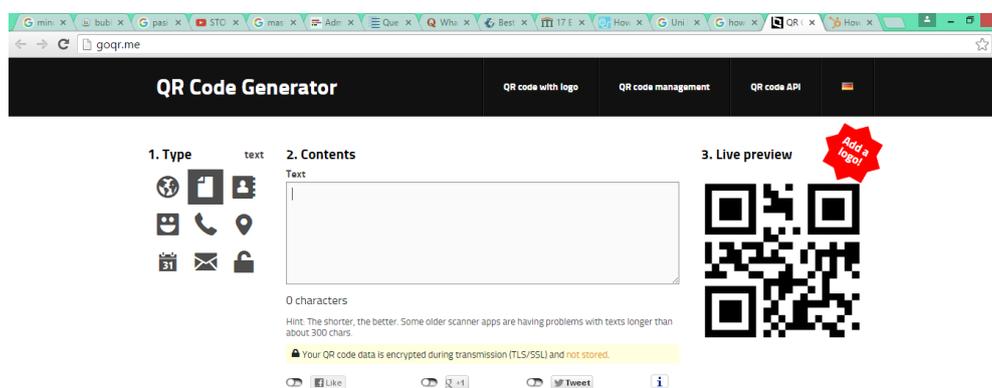


Figure 5. QR code generator /36/.

Step 3 Preview and download

After your code has been generated, click preview and see how it looks. You can now download or copy your QR code for use.

5.1.4 The importance of QR code

The benefits of using QR codes are as follows;

- They serve as a shortcut of URL links to web pages,
- They are also used in storing product information such as prizes, item number, item location, item date and description.
- They are also used in product tracking and identification, most especially at sales terminals.

5.2 Description of AR

Augmented reality could also be defined as a live, direct or indirect view of a physical, real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data. It is related to more general concept called mediated reality, in which a view of a reality is modified by a computer. /1/

As a result the technology functions by enhancing one's current perception of reality. By contrast, virtual reality replaces the real world with a simulated one. Augmentation is conventionally in real-time and in semantic context with environmental elements, such as sports scores on TV during a live match. /1/

Figure 6 Describes Milgram's Reality-Virtuality continuum and corresponding interaction styles.

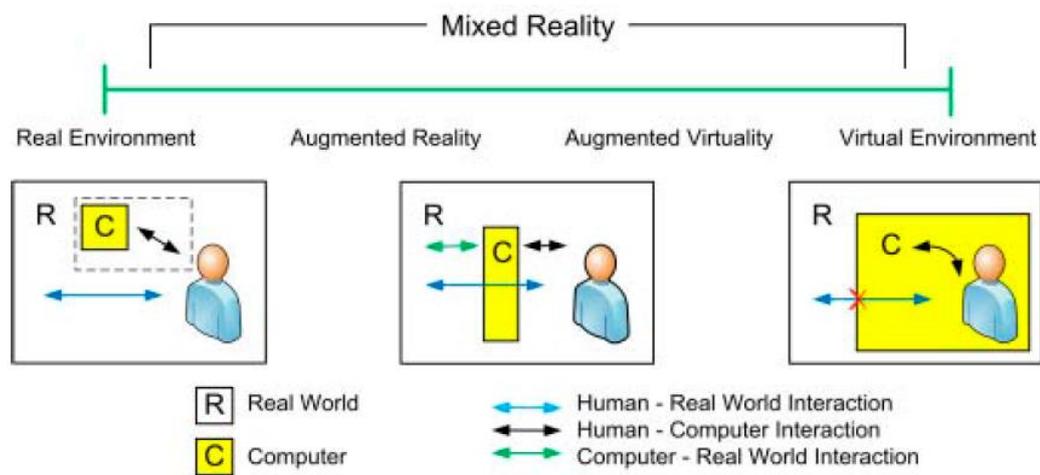


Figure 6. Miligram's Reality description of AR /1/.

The upper part describes Milgram's continuum, which range from the real or physical environment to immersive virtual environments. The lower part illustrates the corresponding interaction styles. Interaction in a real environment requires a user to switch focus between computer and physical environment, where Mixed Reality interaction superimpose these domains. A Virtual Environment permits no real world interaction. /5/.

5.2.1 GAI based AR System for Handheld Devices

Graphics, audio-visual and Interaction (GAI) based mobile AR system is an Augmented Reality application system for Symbian and Android Smartphone where the general AR users can develop their own multimedia based mobile AR applications by using this AR system. An interaction system has integrated into mobile AR system which allows users to interact with the virtual objects in augmented environment. This section presents the core components of mobile AR system and an interaction method which has been implemented in the mobile AR system./15/

5.2.2 Video Capture

Video capturing is the first step of this Augmented Reality system. Symbian, Android and Apple smartphone's built-in camera is used as a video capturing device. Camera API (Application Protocol Interface) is a part of Symbian and Android SDK. The entire camera related operations such that video capture, image capture can be done by using camera API. Hence, Symbian and Android camera API is integrated in mobile AR system to perform video capturing operation. The maker tracker library "ARToolkitplus" defines resolution 256X192 [Width X Height] is used for video capturing in all smartphones./18/.

5.2.3 Tracking

Open source ARToolkitPlus is used in AR system as a tracking library. ARToolkitPlus is a well known tracking library for mobile Augmented Reality. ARToolkitPlus library has no longer update since June,2006. Due to absence of continuing development, ARToolkitPlus is lacking some features and has compatible issue with latest Symbian^3. According to systems requirements, ARToolkitPlus source code was modified and rewritten the function for loading multiple marker, detect multiple marker, detect pattern image and increased frame per second (FPS) rate for better video rendering. Hence modified ARToolkitPlus library is built-in into the AR system and offered better tracking performance./18/.

5.2.4 Audio-visual based Virtual Object Generation

The main purpose of AR is to create the 3D virtual objects which are realistic so that the augmented objects will integrate into the visual perception of the perceiver. The open source graphic library "OpenGL ES" is the core of any mobile AR rendering system. In order to achieve the purpose, several OpenGL ES features play an important role in mobile AR graphics. OpenGL ES features like texturing, shading, lighting makes the virtual object true realistic. Texturing is a very important component for mobile graphics which will improve the visual perception in mobile AR rendering. Texture mapping is a technique that maps a 2D image on a 3D objects so that the 3D objects will be displayed with specific texture. As a result, the surface of the 3D objects will be perceived as rough instead of completely smooth. In addition, lighting condition and surface reflection needs to be calculated in real-time during the AR rendering. Therefore, the performance of AR rendering depends on lighting affect. /15/

Furthermore, a mirror can be used in order to calculate the light source correctly. Hence, computer generated lighting can be reflected properly and produce the shading which is compatible in the real environment. As a result, the virtual objects become truly realistic .All these OpenGL ES features are included into mobile AR rendering engine. So users can easily use these OpenGL ES features according to their application and games developing requirements. /15/

3D virtual object is very important aspect in mobile AR. Now a days, modern smartphone is developing with 3D graphics accelerator. Therefore, 3D object rendering in mobile AR become easier and smoother. 3D virtual object can be generated by using OpenGL ES and 3D studio max. Basically 3D object generated from 3D studio max looks more eye-candy and smoother. 3D object can be generated in 3D studio max including animations. According to the mobile AR rendering engine, the entire graphics model data has to convert into OpenGL ES format. It is always been difficult to find better solution to export 3D model data into OpenGL ES format from 3D Studio Max. The open source graphics library PowerVR is one of the easiest solutions to export 3D data. Therefore, PowerVR

graphics library was chosen as 3D model exporter and integrated it into mobile AR system. This solution also allows users to draw 3D model with key frame animation in 3D Studio Max and export the 3D data with animations in their rendering engine. /15/

GAI mobile AR system has included 3D Graphical User Interface (GUI) feature in its rendering engine. 3D user interfaces seem to be the most natural User Interface (UI) method for AR applications. Some application which uses 3D user interface has also been developed and embeded with AR. The User Interface of these applications and games look very pleasing to watch in AR view. The mobile AR system has included some 3D GUI patterns for users to use their applications and games. /15/

In addition, animations of the computer generated objects are also important in Augmented Reality. Animation is what ultimately breathes life into 3D graphics. Animations play as a very significant role in games and graphical related AR program. Furthermore in some applications and games 2D/3D objects should be displayed with movements, especially the animals, human beings, game characters, etc. GAI based mobile AR system supports all type of animation in AR environment for OpenGL ES 2D/3D object and 3D studio max 3D object. There are some animated 3D games and applications that have been developed by using multimedia based mobile AR and evaluated by users successfully. /15/

Text is another useful feature of mobile Augmented Reality. Any information can overlay by using text on real world image. Normally text acts as very important role in tourism, games, advertisement related AR applications. A 2D text engine has been developed by using OpenGL ES bitmap and included this text engine into mobile AR system. Therefore, user can develop any text base mobile AR apps using text engine. /18/.

In multimedia based mobile Augmented Reality, audio and video visual is mandatory component. In game related AR applications, audio can play very important role. Audio visuals can provide the real gaming performance for AR user. Audio can also implement in various types of AR applications such that education,

tourism, navigations and guided museum based AR applications. An audio module has been implemented in mobile AR engine using Symbian and Android audio API. User can choose variety of sound format like .mp3, .wav, .amr from this mobile AR system to develop their own multimedia based AR apps./15/

Video is another important feature of mobile AR. It is very useful feature for advertisement, educational, museum guide based AR applications. The predefined video clips can overlay on real time image once application detect the marker. The video clips can contain useful information. Video clips can be included in the installable (.sisx for Symbian, .apk for Android) file or Video clips can be stored in Smartphone memory drive for larger size video. A video module has also been implemented in mobile AR engine using Symbian and Android video API. User can choose variety of video formats like .mp4, .3gp from this mobile AR system to develop their own multimedia based AR apps. /15/.

5.2.5 Interactions

Interactions with mobile AR applications are supplemented by simpler techniques, like displaying classical 3D interfaces on the Smartphone. This allows integrating classical e-learning methods such as multiple choice questions, which are more rapidly produced. An own interactions system is implemented based on color picking algorithm for Symbian and Android Smartphone which is integrated with mobile AR system. User can use this interaction feature of mobile AR system to develop their own interaction based mobile AR applications and games. This interaction feature is very easy to use. Users just need to define the RGBA (Red, Green, Blue, and Alpha) color value of every object vertex using OpenGL color functions. Multimedia base mobile AR system supports two type of interaction. Button based interaction and finger touch based interaction. /15/.

5.2.6 System Design

Figure 7 shows the total flow of AR system.

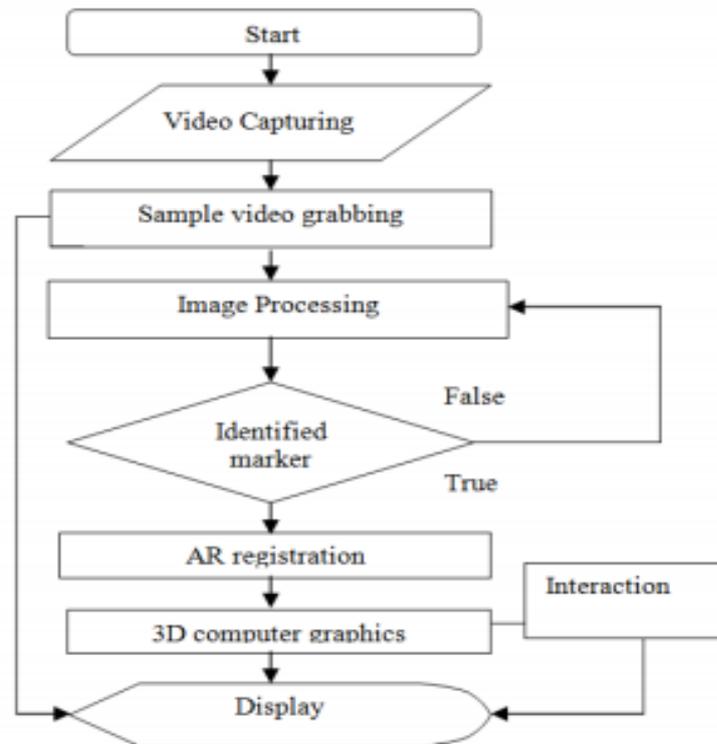


Figure 7. The flow chat of AR /15/.

At first video capturing is started and sample video is grabbed by using Smartphone camera. At this time user is able to see the real time video in screen. Then this sample video is further processed by image processing task to detect the predefined marker. If marker is detected, the AR registration is done between real world and 3D world. AR registration is a method to enable the virtual objects aligns properly in the real environment so that the users can perceive the virtual objects in the correct position and orientation. After that 3D computer graphics are generated on top of real world video. Now user is able to see the complete AR environment of mixture of real world and virtual world in Smartphone display. At the same time user can interact the virtual 2D/3D/GUI object by hand figure touch and menu button in AR environment. This whole procedure is continued until specific markers are detected./15/

5.3 Integration of QR Code and AR

It is mostly recommended to integrate AR with QR Code due to the fact that some people do not use smartphones. There are three key technologies upon which augmented reality system is built: tracking, registration and display hence modern smartphones makes it possible for AR applications to operate successfully. On the contrary, 2G and 3G phones do not have some of these enabled technologies but can only read QR Codes. In this case, the QR Code users will only have access to the information but will not have the virtual reality experience.

5.4 Application of AR

The following are where augmented reality is mostly applied:

- Advertising and Promotion
- Entertainment
- Education
- Museum
- Zoo
- Medical
- Military
- Navigation etc.

The next subheading talks about Aurasma which is a mobile application used in Augmented Reality and how to create an Augmented Reality.

5.5 Aurasma Technology

Aurasma is a program associated with Augmented Reality which is downloadable from either Google Play Store or Apple App Store for smart phones. The QR codes below are links to install Aurasma mobile application from Android and Apple stores respectively.



Figure 8. QR Codes of Aurasma for Android and Apple devices.

Aurasma is HP Autonomy's augmented reality platform. It is available as an SDK or as a free app for iOS and Android mobile devices. Aurasma's image recognition technology uses a smartphone's or tablet's camera to recognize real world images and then overlay media on top of them in the form of animations, videos, 3D models and web pages. /33/.

5.6 History

Aurasma's augmented reality technology was created in Cambridge by software company Autonomy, and first demonstrated publicly in early 2011 at MipTV in Cannes by Matt Mills. On May 5, 2011 Aurasma Lite was launched as an application for iPhone, and a version for Android followed on June 10, 2011. In addition to Aurasma's own mobile app, this augmented reality technology has also been integrated into thousands of other smartphone and tablet applications, the first being created for the 2011 J. J. Abrams film Super 8. /33/.

In December 2012, the Aurasma mobile app was updated and 'Lite' was dropped from its name. The update included new features and an improved user interface. Users now 'follow' content created by others, much like how Twitter works. Since its launch, Aurasma has powered more than 2,000 apps and worked with 20,000 partners operating in over 100 countries. Among the many recognizable publishers and brands using Aurasma are Conde Nast, Universal Pictures, Marvel Entertainment, Elizabeth Arden, Telefonica, Tesco, Maybelline, News

International, Forever 21, Kentucky Fried Chicken, GQ, NBCUniversal, the Toronto Raptors, and Tottenham Hotspur F.C. /33/.

5.7 User Interface of Aurasma Application

5.7.1 Aurasma Technology

The following terms are used in Aurasma application:

- **Aura:** is also known as **Trigger image:** it is the picture or object that when it is scanned by a smartphone camera, the AR will be played.
- **Channel:** it is the account that allows its **Aura** to be played when a user is following that account.
- **Overlay:** it is the information in the form of Video, Audio, 3D image or picture that is played when its aura is scanned.

Figure 9 below gives a brief summary of how to use Aurasma application in a general view. Detailed description of the Aurasma application is given in this chapter.

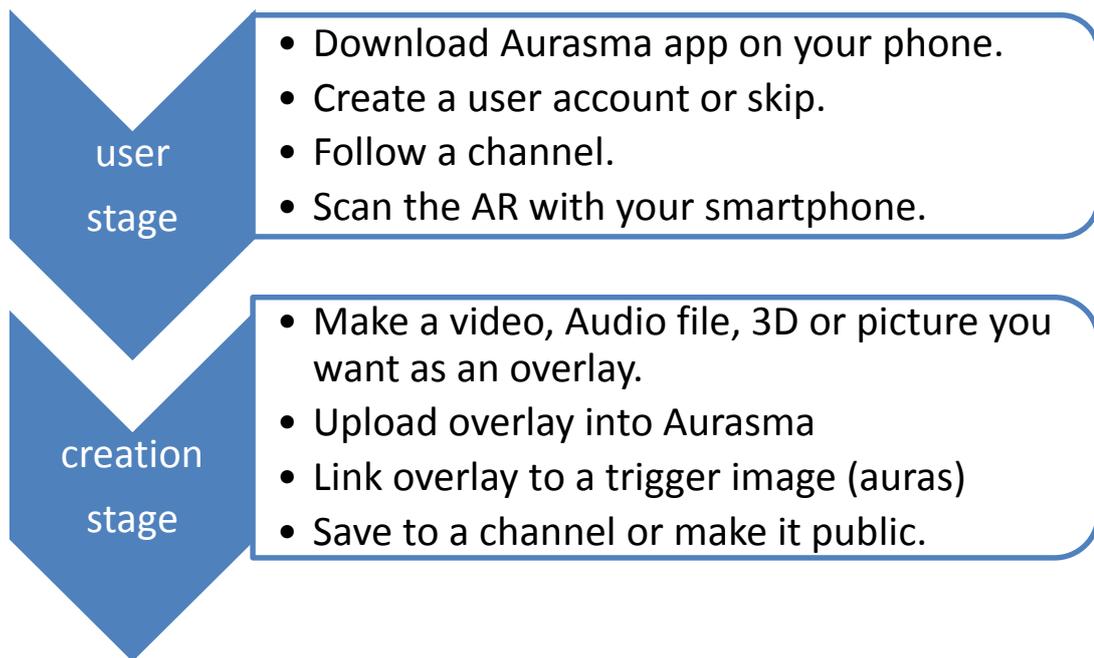


Figure 9. Overview of AR using Aurasma app.

Aurasma makes it easy to create an augmented reality on smartphones and makes it possible to scan existing triggers which also permits a user to share on social media. The QR code in figure 10 below is a YouTube video that gives detailed description of Aurasma application.

(<https://www.youtube.com/watch?v=2yIRCVQtyWA>)



Figure 10. A YouTube video describing Aurasma app.

5.7.2 Simplified steps to create an Augmented Reality with Aurasma Application

The following are the steps in creating AR and also an overview of Aurasma software.

STEP 1.

Make sure you have good internet connectivity and open the Aurasma application on your smart phone or tablet. See figure 11 for the Aurasma icon.



Figure 11. Aurasma icon at the lower right corner of the menu page.

By default, the app opens to the scanning option. To access the menu select the “A” icon at the bottom of the screen. See figure 12 below.

STEP 2.

The scanning view opens but we are not going to scan for any AR this time. Go ahead and click on the menu icon. See figure 12 (This could be seen on Android devices).

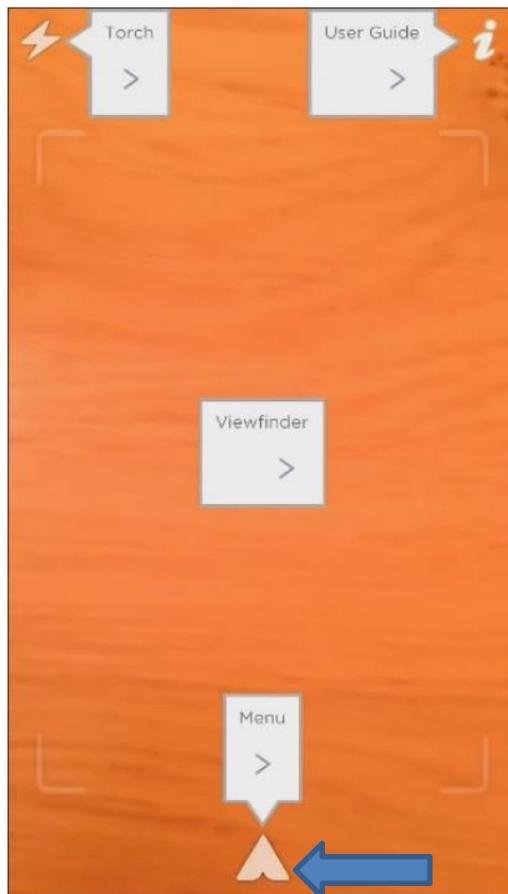


Figure 12. Scanning/Option Menu

- **Torch:** Pressing this batten will provide you with a beam of light to help the viewfinder see the trigger more clearly if you happen to not have enough light.
- **User Guide:** Pressing this batten will give you a quick breakdown of what all the other icons can do.
- **View finder:** Helps you to engage with the aurasma that has an aura attached to it.
- **Menu:** Pressing this icon allows you to the main content menu (Explore Tab)

The Explore view opens (figure 13).

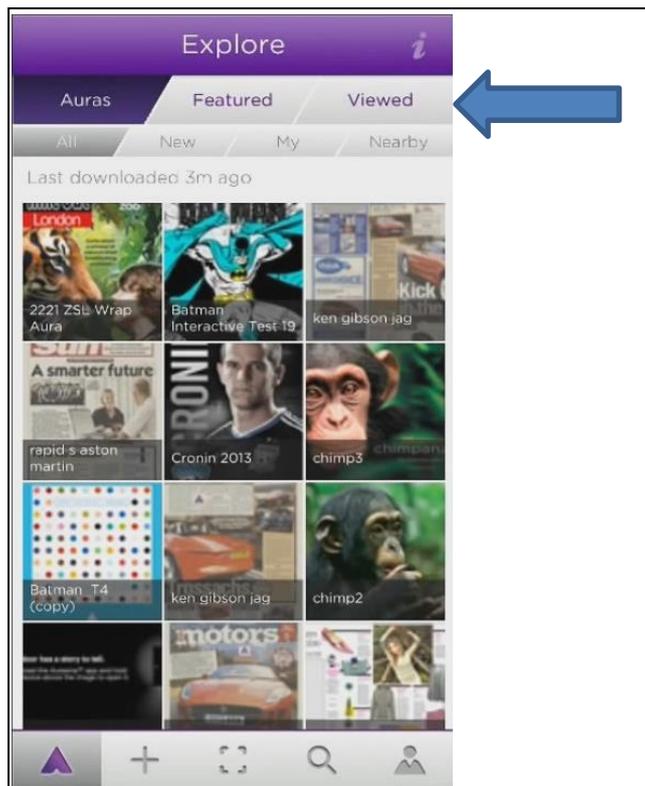


Figure 13. The Tabs of Explor View.

The Auras tab contains all the auras you have created on the device, all of the auras in the channel you have subscribed to and all of the super auras.

The Featured tab contains all of the contents that Aurasma has chosen to highlight for you. Click on any of the featured channels and follow the ones that you like best.

The Viewed tab shows you a blip history of what you have recently checked out.

STEP 3.

In the Explore View, click the plus or add sign (+) and it will open the create view.

See figure 14.

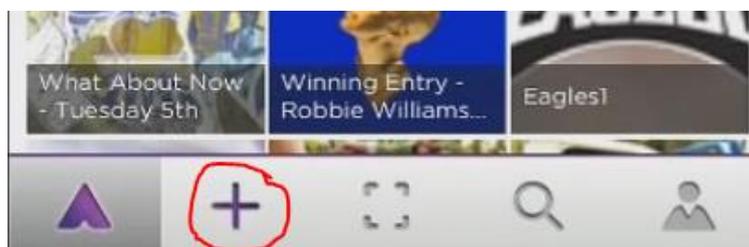


Figure 14 Create section

The plus sign (+) is where you create your own overlays, or auras, right from the app. Choose an overlay supplied by Aurasma, or you can choose a video or image

from your device. Lastly it will help you tie your overlay and your trigger together. Clicking the plus sign (+) will launch you into the create view as seen in figure 15 below.



Figure 15. Creating overlay.

This feature enables you to upload media into Aurasma or you can choose an existing media in the library as your overlay.

STEP 4.

Here, you have the opportunity to choose an overlay from the library or upload your customized overlay from the device. To upload your customized overlay, click the plus or add sign (+).

STEP 5.

An optional menu with the indications as “camera” or “library”. Choosing camera will launch your device camera to take a picture or record a video. Choosing library will prompt you to select photo or video which is already in your device storage.

STEP 6.

Create overlay view will open and type the name you want for your overlay then click finish.

STEP 7.

Create an Aura menu will open which will ask the question “Would you like to create an Aura with this Overlay?” select yes to continue. An Aura is the picture which triggers the overlay assigned to it.

STEP 8

Your device camera will open to take a picture as your Aura. Take your picture as soon as the indicator gets to the green bar. You have the option to well position your Aura and click proceed when done.

STEP 9

Finally, you are given the option to let it go public for other users to access or made private for your personal use. You are also given additional option to add to a channel, click yes and select the plus or add (+) sign. Type the name of your channel and my give it a description. Select finish when done. Test your Augmented Reality and see how it looks.

Figure 16 and 17 below are the Search and Account user interface respectively.



Figure 16. Search Section.

The search section allows you the opportunity to search auras, channels, or other Aurasma users. Following other channels or users gives you the opportunity to use their auras.

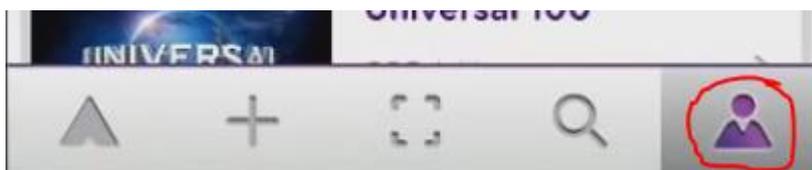


Figure 17 Profile Section

The Profile section gives you access to:

- View the channels and users you are following
- View all the auras that have been created under your account, both private and public
- Gives you access to edit your account information or log out of the app.

6 PILOT PROJECT

6.1 Pilot Project Overview

The pilot project is divided into three different section and under each section contains several project activities therefore making 30 project activities. The three different sections are Vaasa University of Applied Science, Technobothnia and Lumivaara Museum. A survey was done in order to capture information of students in VAMK on their knowledge of Augmented Reality. Figure 18 below is the illustration of the plan for the pilot project.

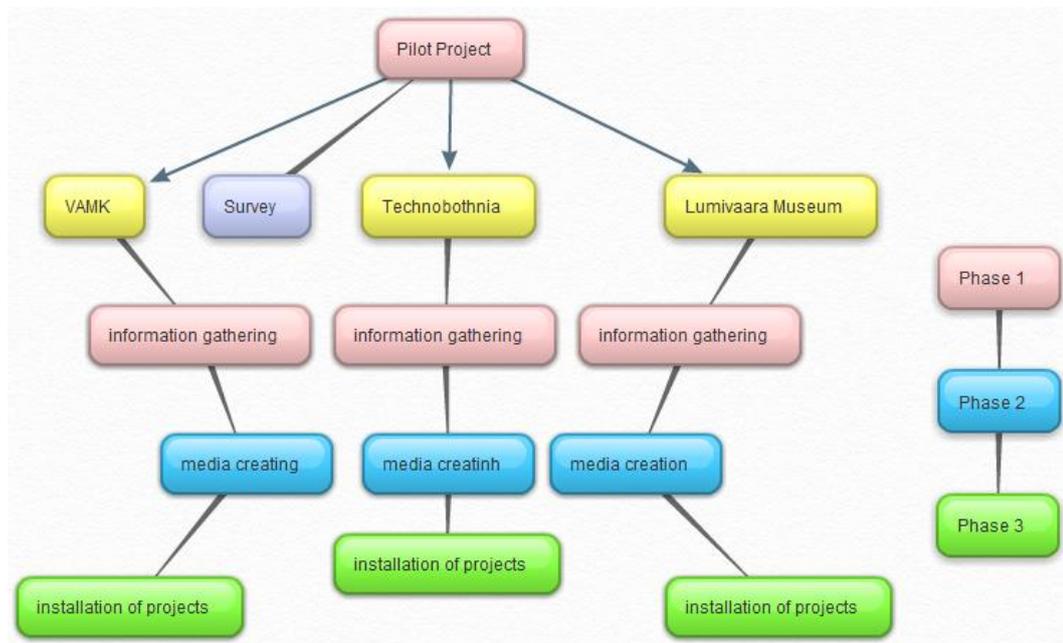


Figure 18. Mind map overview of the pilot project.

From figure 18 above, gathering of information from the three institutions is the first phase of this project. The second phase consist of creating and editing of videos and sound files, taking pictures, printing and making Augmented Reality. The final phase is the testing and installation of augmented reality created at vantage points of the three institutions.

6.2 Survey on AR

6.2.1 Questionnaire and Data Analysis

A survey was carried out through questionnaire which was developed and distributed to students of different departments in Vaasa University of Applied Science. The purpose of this survey was to see the familiarity of students with Augmented Reality. The first year students were the target group for this survey since it is a pilot project. 200 copies of questionnaire were printed out and 171 were answered.

The first question was about gender. It appears male students' turns out to be the majority with a percentage of 64 while female had 36 percent. See figure 19 below.

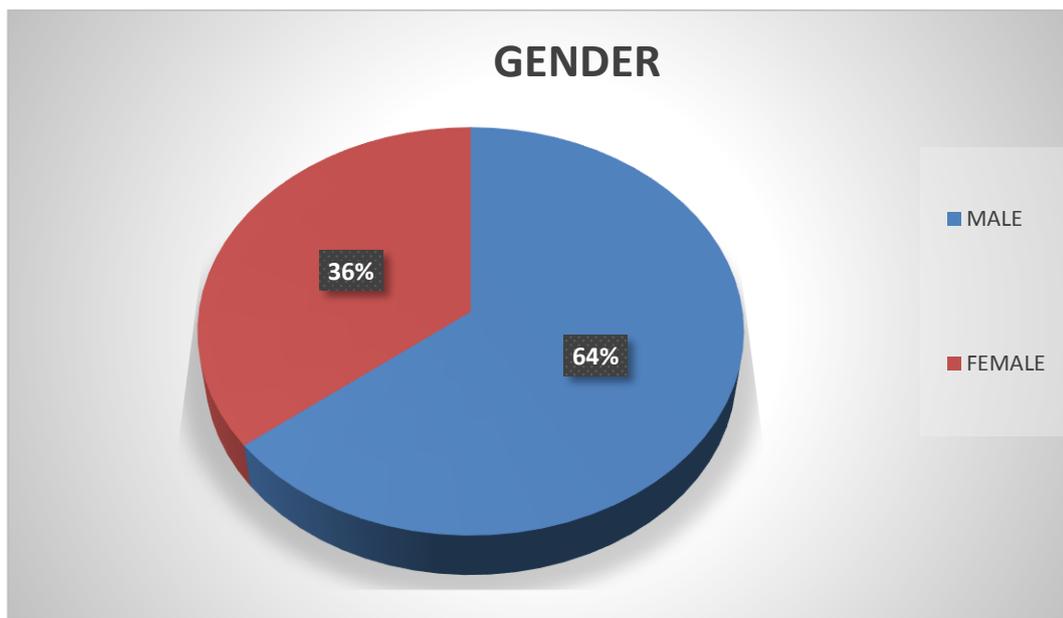


Figure 19. Gender of respondents.

In the second question, students were asked about their department. See figure 20 below.

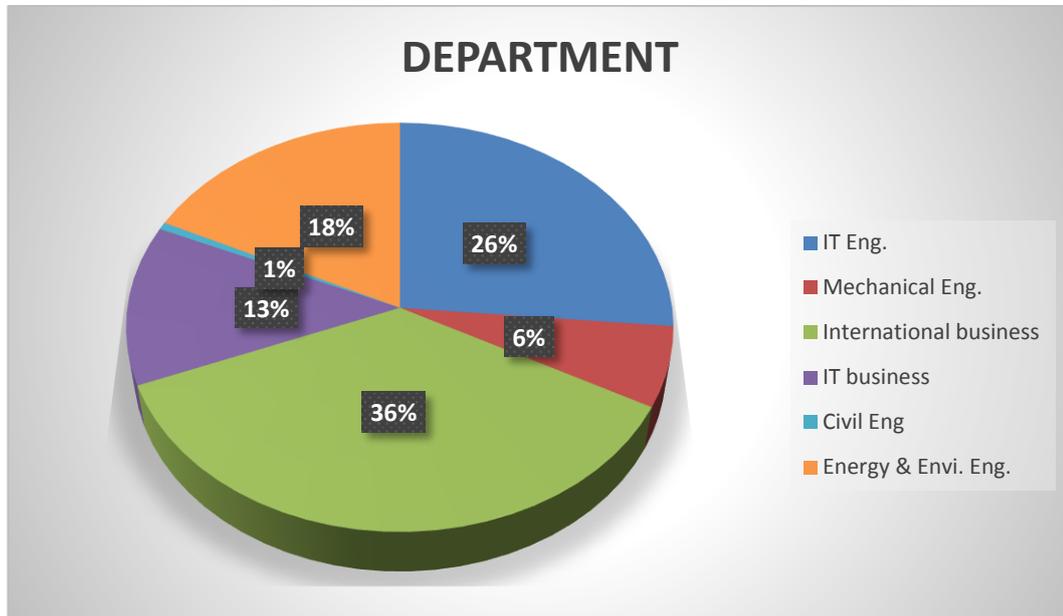


Figure 20. Department of respondents

From the data collected, International Business were the majority by 36 percent followed by IT Engineering 26 percent, Energy & Envi. Eng. 18 percent, IT business 13 percent, Mechanical Engineering six percent and Civil Engineering by one percent. The unlisted department means no questionnaire got to them since the time for the survey was very short.

Question 3 asked about the possession of smartphone as seen in figure 21 below.

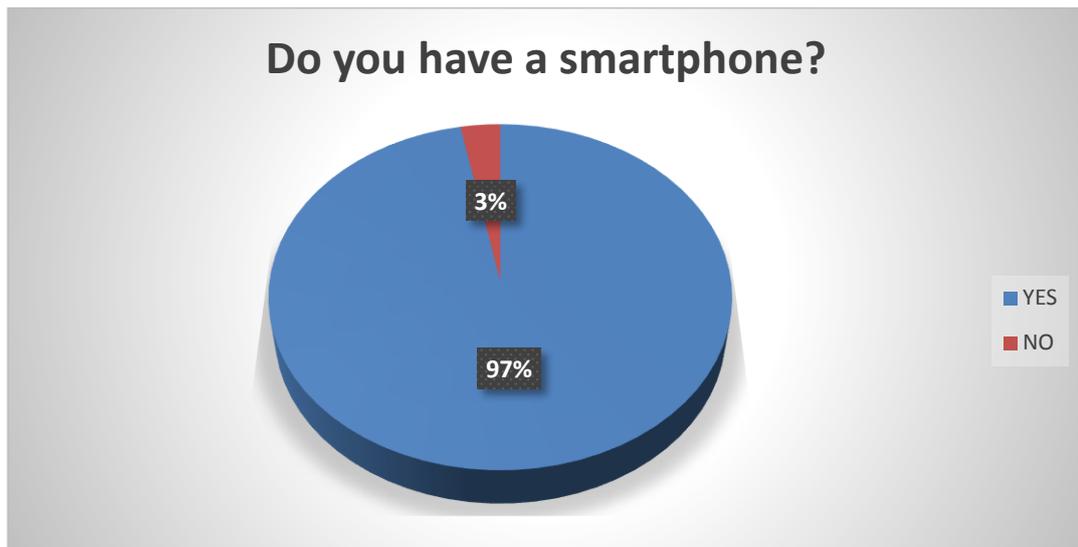


Figure 21. Possession of smartphone.

It turns out that 97 percent has smart phones while 3 percent said they do not have. This suggest that this pilot project has a great potential in the school.

The next question was asked about the knowledge on QR code as expressed in figure 22 below.

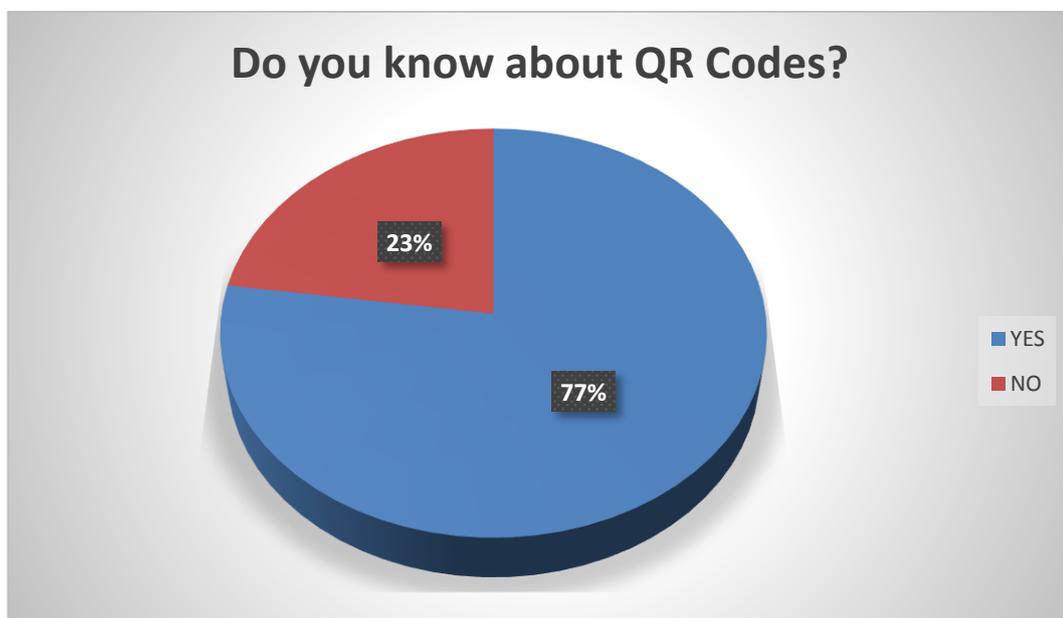


Figure 22. Knowledge related to QR codes.

Question 4 was asked, do you know about QR code? 77 percent of the students know what QR code is while 23 percent had no idea. This data also supports that the pilot project will be successful.

Question 5 is about the scanning intensity of QR codes and is seen in figure 23 below.

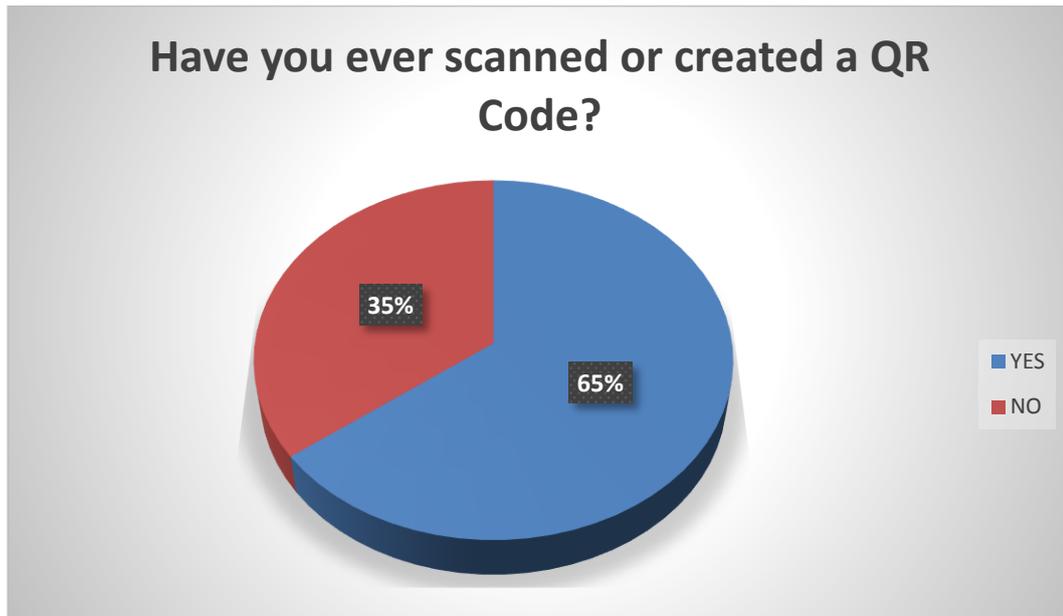


Figure 23. Scanning intensity of QR code.

Question 5, have you ever scanned or created a QR code? The response was that 65 percent has either scanned or created a QR code before. This also means 35 percent has an idea on QR code but has never used it.

Question 6 asked knowledge on AR and the result is seen in figure 24 below.

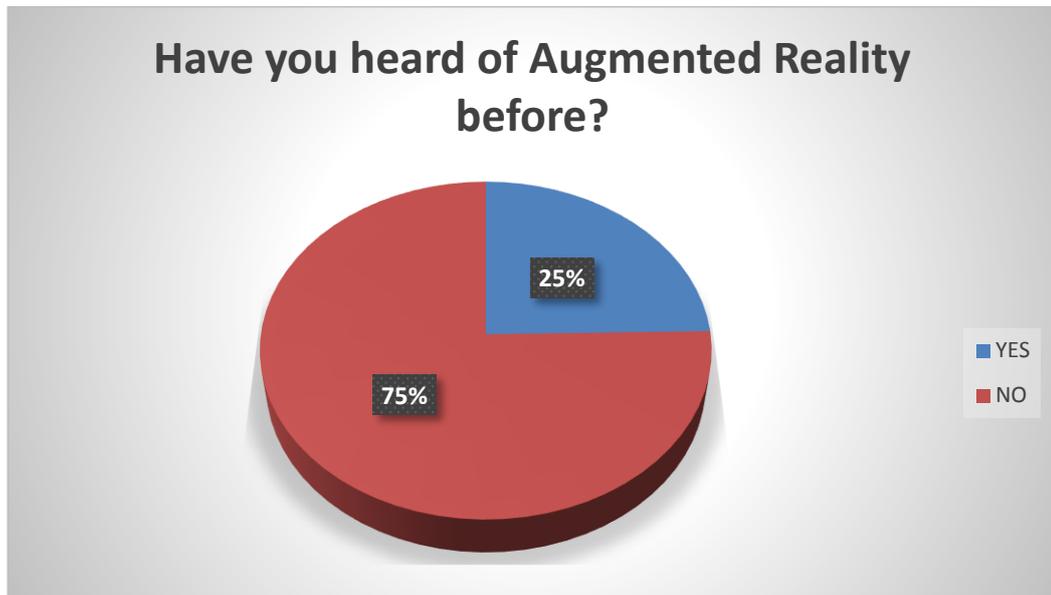


Figure 24. Knowledge level of AR.

The result indicates 75 percent do not know what Augmented Reality is about. This shows that this technology is still new and much publicity needs to be made to create awareness.

The next question was about scanning intensity and its response is shown in figure 25 below.

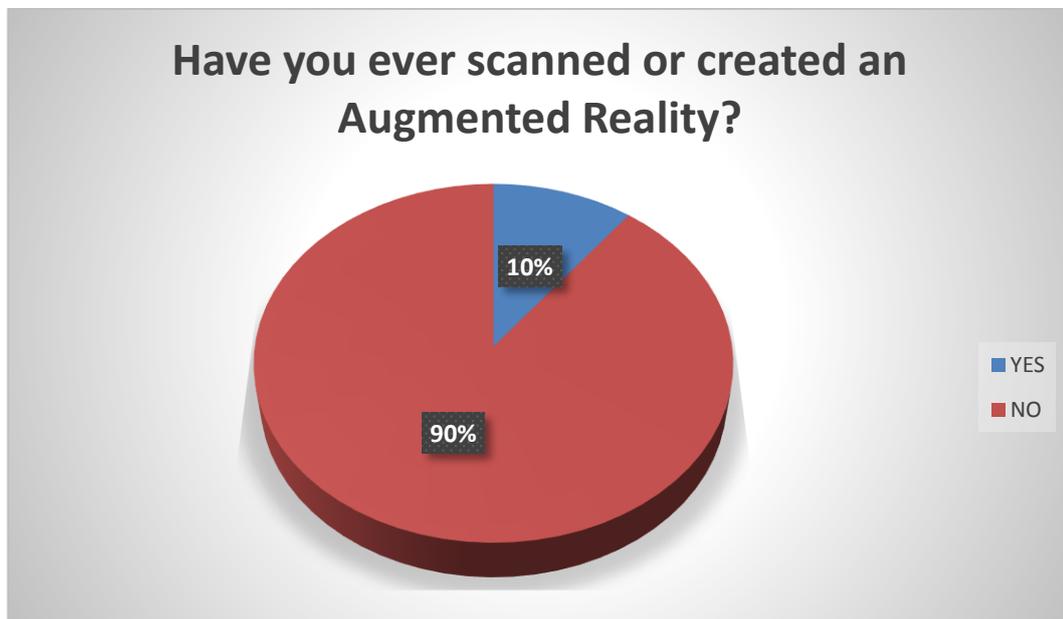


Figure 25. Scanning intensity of AR.

Question 7, have you ever scanned or created AR before? 10 percent of the students have scanned an AR before which is comparatively small compared to the total population. This means that lots of education needs to be done on Augmented Reality in the school.

Question 8 asked about their knowledge on how Augmented Reality works as seen in figure 26 below.

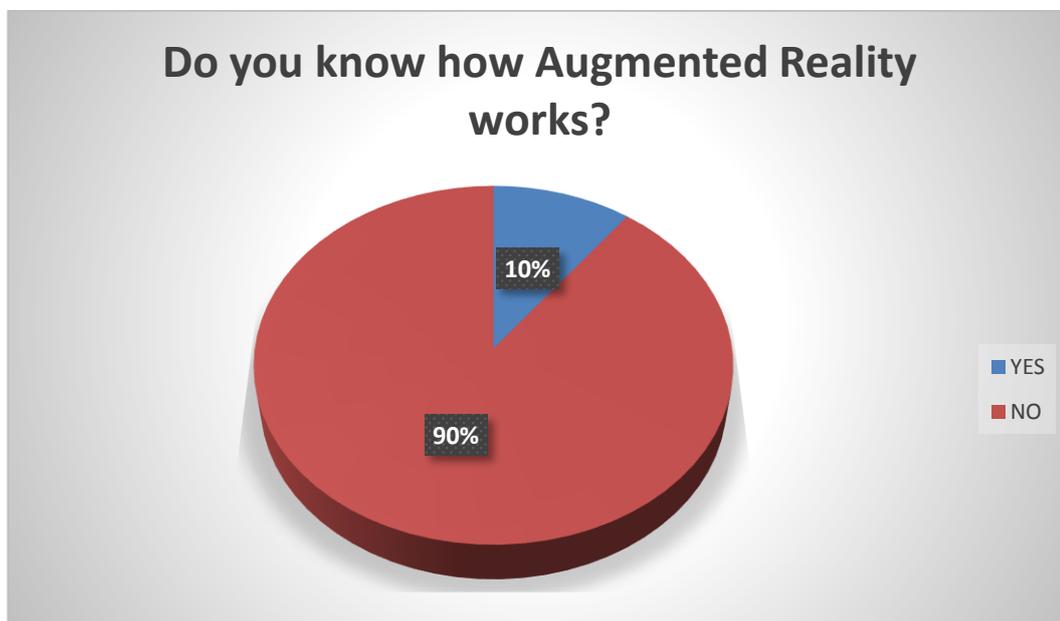


Figure 26. Knowledge about how AR works.

Question 8 asked about their knowledge on how Augmented Reality works. It appears that few students were able to access the YouTube link that explains how AR works and were able to answer this question which raised the yes to 10 percent.

6.2.2 Conclusion of Survey

The response data of the survey indicates that, QR code technology is well known and that is possible because almost every students possesses a smartphone. On the contrary, augmented reality is not well known as compared to QR code. This could be attributed to the fact that AR technology is still in its new face and under development.

6.3 Pilot Project on Augmented Reality

6.3.1 Information and material gathering

A visit was made to the Lumivaara Museum in May 2015. There, all information needed for the generation of media was acquired including taking of pictures and video. Figure 27 below is a sample of the pictures taken.



Figure 27. Picture taken from Lumivaara Museum.

In the school, information was gathered on various machines such as robots and CNC machines. Pictures were also taken as seen in the Figure 28 below.



Figure 28. Fanuc Robot in TB.

6.3.2 Media creation and software being used

Media in form of videos and audios were created and edited for both the museum and the institutions. Videos were downloaded from YouTube channels with the aid of a software known as YTD Downloader as seen in figure 29 below.

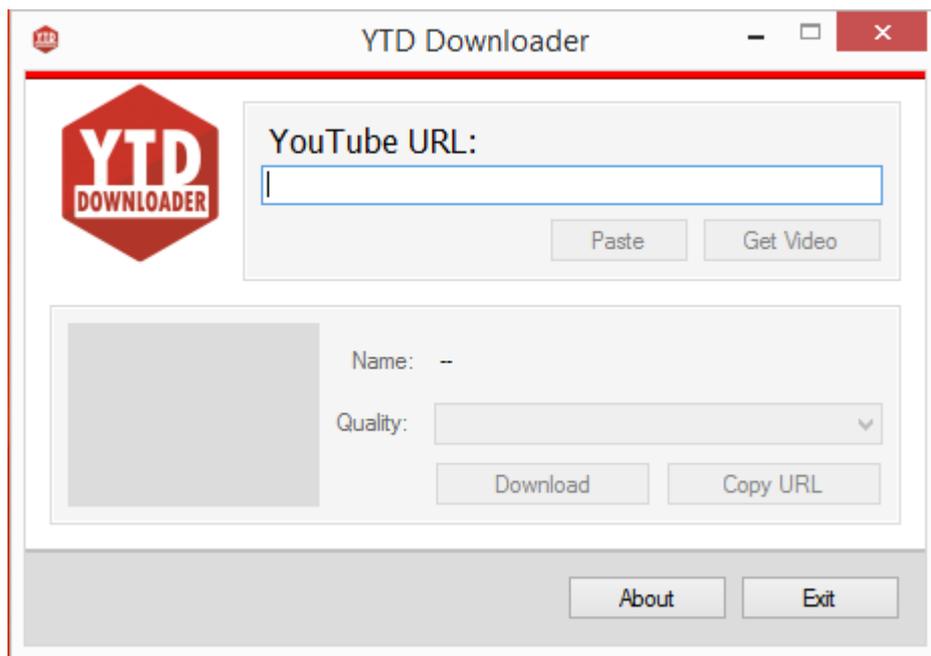


Figure 29. YTD software.

The videos were edited using Sony Vegas Professional 2013. This was quite simple and has a good user interface for beginners. The picture of this software is shown in the figure 30 below.

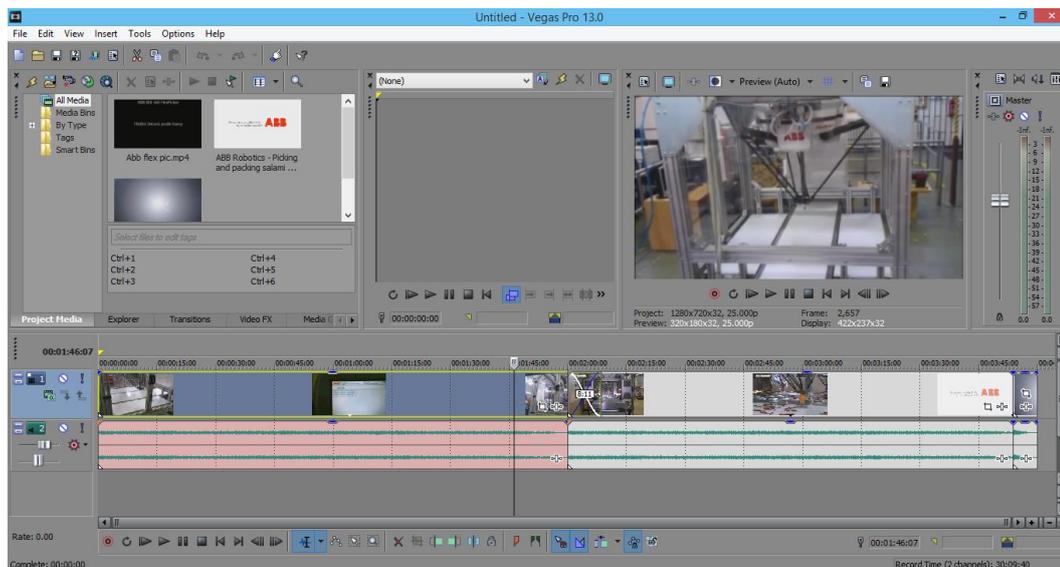


Figure 30. Sony Vegas software.

After creating the videos, it appears the file sizes were huge and Aurasma cannot accept files above 100 MB. Therefore, there was a need to reduce the file sizes without losing the video qualities. Handbrake which is another software was able to shrink the video size drastically while keeping the same video quality. The software was able to convert videos from different format into mp4 format which is the best video format accepted by Aurasma. Figure 31 bellows the picture of the software.

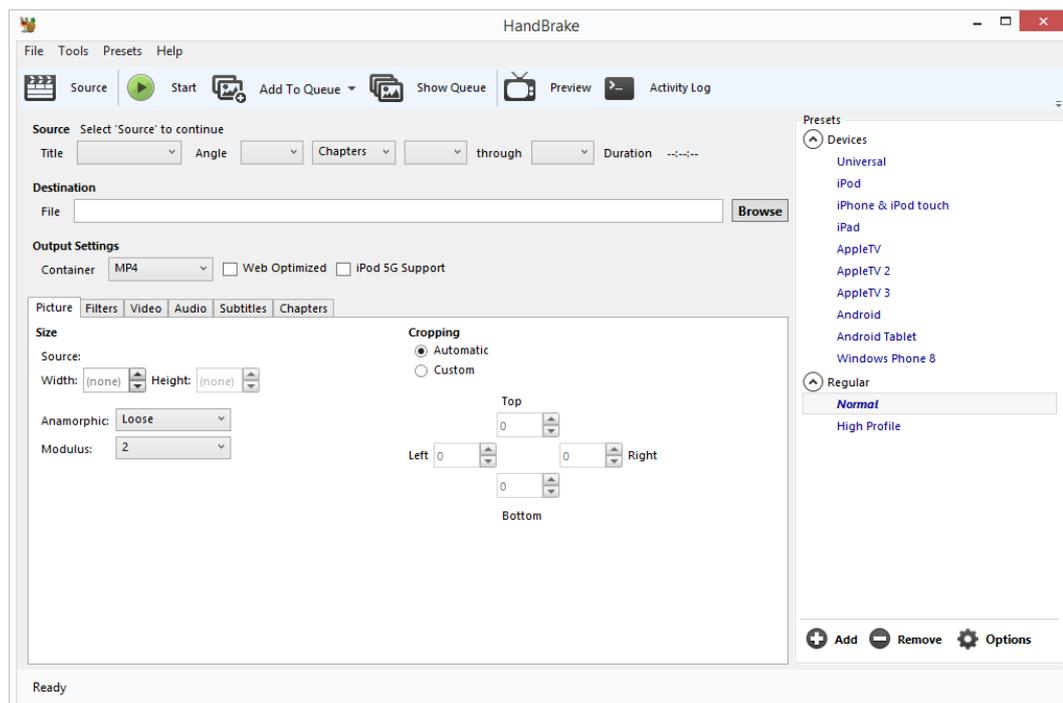


Figure 31. Handbrake software.

6.3.3 Installation of finished projects.

The project installation happens to be the final phase of this pilot project. The trigger pictures and the description of how to use Aurasma were laminated and they can be seen in appendix 2. The installation aspect is pasting the laminated pictures at strategic locations that have good light intensity. Several trials were done with students and they appeared to be successful when they followed the user instruction. Figure 32 below is a sample of the installation in Technobothnia. The pictures for the finished projects can be found in the appendix 3.

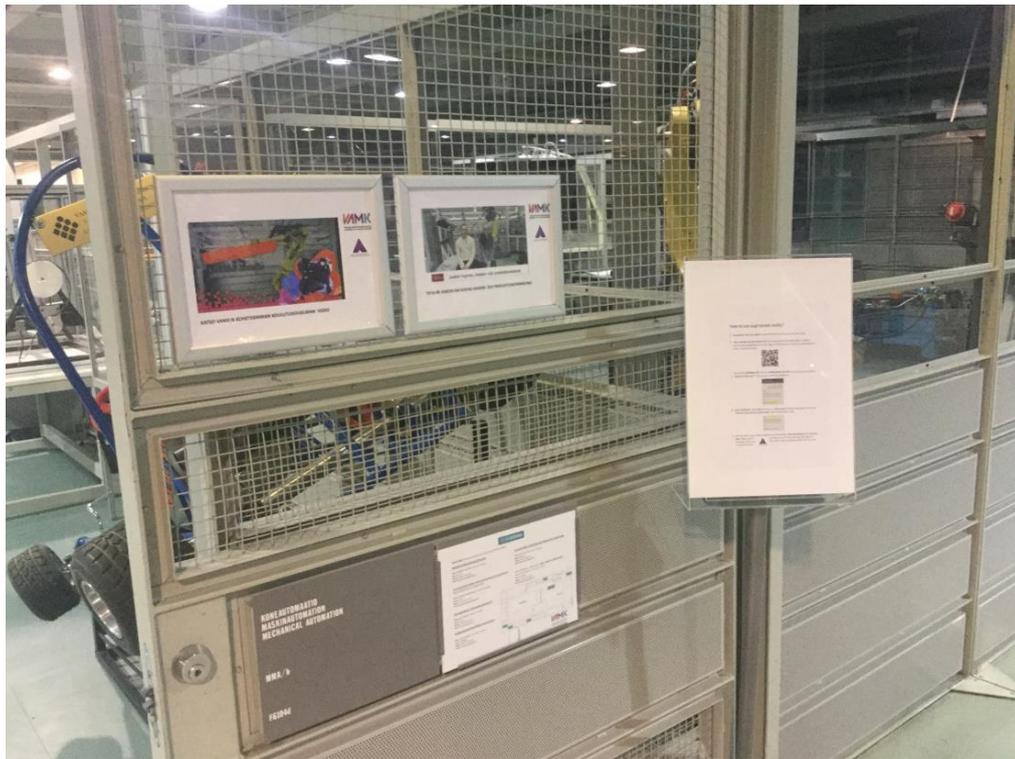


Figure 32. Installation of projects in TB.

Finally, a YouTube account for the Museum was created where all the project videos for Lumivaara museum were uploaded. To avoid copy right implications, permission for using one of the videos was obtain from its owner. QR codes for the projects were made out of the museum's YouTube videos so that Windows smartphone users can also gain access to these information. The figure 33 is a of Lumivaara Museum's YouTube page and figure 34 is a QR code (<https://www.youtube.com/channel/UCknx8qtRmPHODyVeC4JsBYg>) to that page.

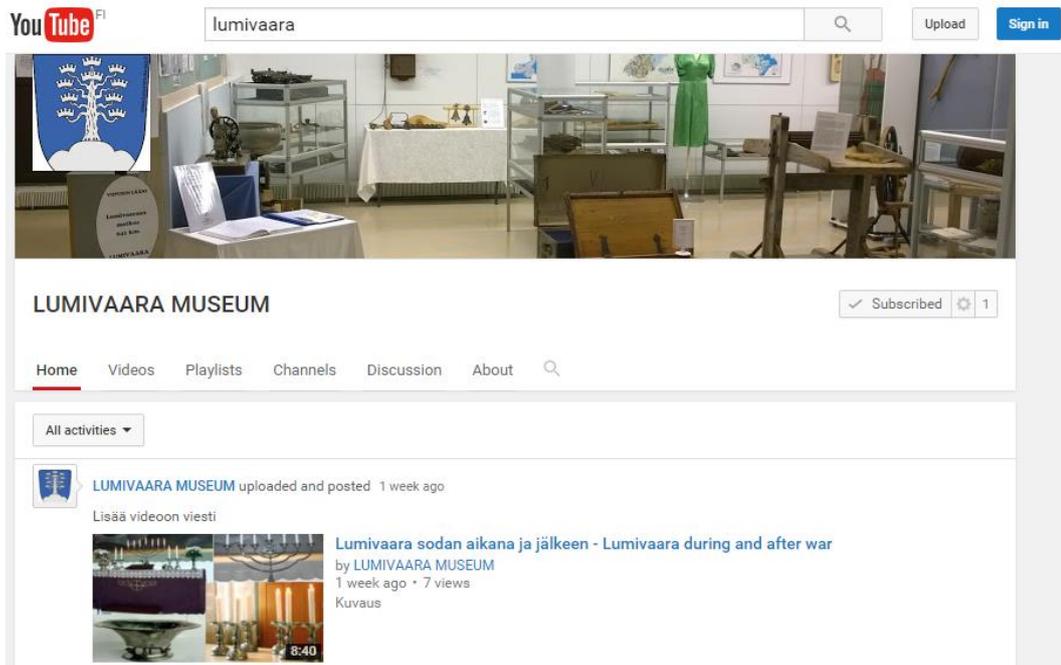


Figure 33. Lumivaara Museum Official YouTube page.



Figure 34. QR code to Lumivaara Museum YouTube page.

7 CONCLUSION AND RECOMMENDATION

The advancement of mobile phone technology have paved way for certain great applications such Augmented Reality. In short, Augmented Reality is one of the fastest way to receive visual information. Big companies like Jaguar and many advertising corporations has started using Augmented Reality in their magazines. Some museums, zoos, and game centers are using Augmented Reality to enhance user experience. Other educational and research institutions have taken the initiative to use augmented reality in their practical training programs such as welding.

In this thesis augmented reality projects were made for Lumivaara Museum and Technobothnia laboratory in order to improve user experience in these places and the final outcome was successful. The teaching materials developed were not so many as planned in the beginning of the project due to time constraints.

Augmented Reality is still a new technology and therefore requires more education and creation of awareness for students in other to take advantage of this technology. I will also recommend that research should be carried out on how to include indoor navigation system at VAMK in Augmented Reality which will support Aurasma application. This will easily help new students and exchange students to locate their lecture halls.

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[YES]

[NO]

*** A quick YouTube vide link about Augmented Reality ***

<https://www.youtube.com/watch?v=frrZbq2LpwI>



9. How would you like Augmented Reality to be used in the school?

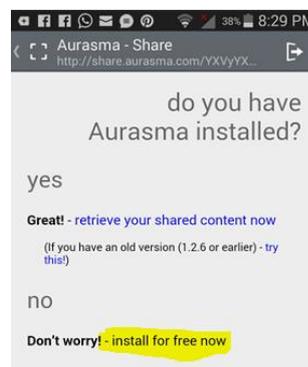
APPENDIX 2: Projects

How to use augmented reality in this museum?

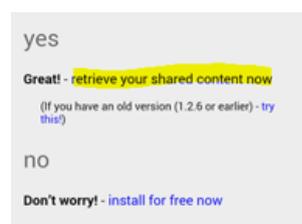
1. **Download a QR code reader** to your mobile phone (if you do not have it yet).
2. **Then scan this QR code below** with your mobile phone QR code reader in order to install Aurasma application on your Apple or Android device.



3. **“Install for free now”** – click on this. Install the application.



4. **After installation don't open** the app yet. **Come back** to the previous page and click on **“Retrieve your shared content now”**. Now everything is ready.



5. You can start using Aurasma application automatically : **Scan the pictures** with then you can start the sound files. When order to enter full **Aurasma logo** (=big purple A) and watching the videos or listening to video is playing double click it in screen.



Slide 1



Slide 2



The image shows an exhibition stand for Lumivaara. The stand is white and features a map of Finland with Lumivaara highlighted in yellow. To the left of the stand is a wooden bookshelf filled with books. To the right, there are blue display boards with various documents and photos. The background is a wall with orange square tiles.



The Aurasma logo consists of a blue shield with a white tree and a white cloud at the base. Below the shield is a purple triangle pointing upwards, with the word "AURASMA" written in black capital letters underneath. A QR code is located below the logo.

KUUNTELE TERVETULOTOIVOTUS – PLEASE LISTEN TO THE WELCOME ADDRESS

Slide 3



The image shows the exterior of a white stone church with a tall, conical steeple. The church is surrounded by green trees and a grassy area. The sky is overcast.



The Aurasma logo consists of a blue shield with a white tree and a white cloud at the base. Below the shield is a purple triangle pointing upwards, with the word "AURASMA" written in black capital letters underneath. A QR code is located below the logo.

KATSO MILTÄ KIRKON SISÄLLÄ NÄYTTÄÄ – VIEW THE CHURCH FROM INSIDE

Slide 4



TOINEN KIRKON SISÄNÄKYMÄ – ANOTHER VIEW INSIDE THE CHURCH

Slide 5



KUUNTELE LUMIVAARAN KIRKON RAKENTAMISESTA JA VIHKIMISESTÄ 1935

Slide 6



AURASMA



KUUNTELE JA KATSO MITÄ TAPAHTUI SODAN AIKANA JA SEN JÄLKEEN

Slide 7

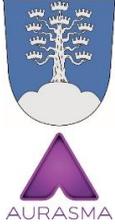


AURASMA



KUUNTELE JA KATSO VÄLÄHDYKSIÄ LUMIVAARAN KYMMENESTÄ KYLÄSTÄ

Slide 8



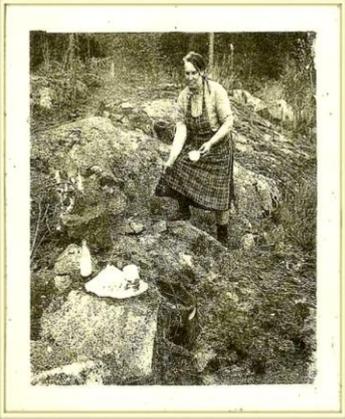
**KUUNTELE KERTOMUS ENSIMMÄISESTÄ LAHOITETUSTA ESINEESTÄ
– LISTEN TO THE STORY OF FIRST DONATED ITEM**

Slide 9



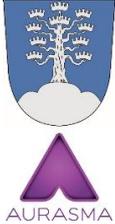
PUUSEPÄN TYÖVÄLINEITÄ - CARPENTER'S TOOLS

Slide 10



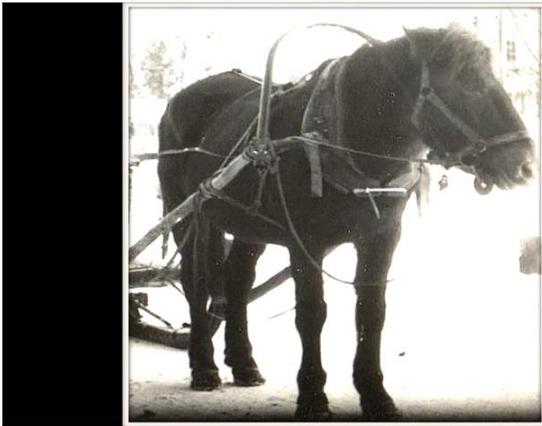
LISTEN TO THE STORY OF THE COFFEE POT

Slide 11



LISTEN TO THE STORY OF THE HORSE CALLED PERHO

Slide 12



LISTEN TO THE STORY OF THE HORSE CALLED SENNI

Slide 13



MAATALOUSTYÖKALUJA – FARMING EQUIPMENT

Slide 14



THE STORY OF THE FIRST TELEPHONE



Slide 15



OFFICE EQUIPMENT

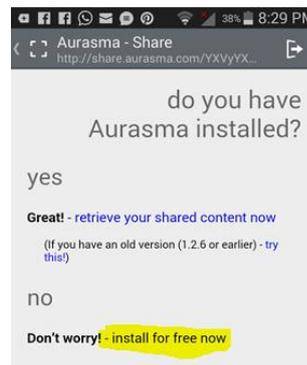


How to use augmented reality in VAMK?

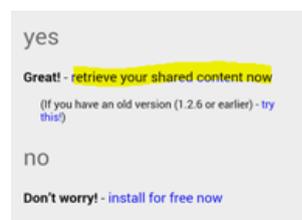
1. **Download a QR code reader** to your mobile phone (if you do not have it yet).
2. **Then scan this QR code below** with your mobile phone QR code reader in order to install Aurasma application on your Apple or Android device.



3. **“Install for free now”**– click on this. Install the application.



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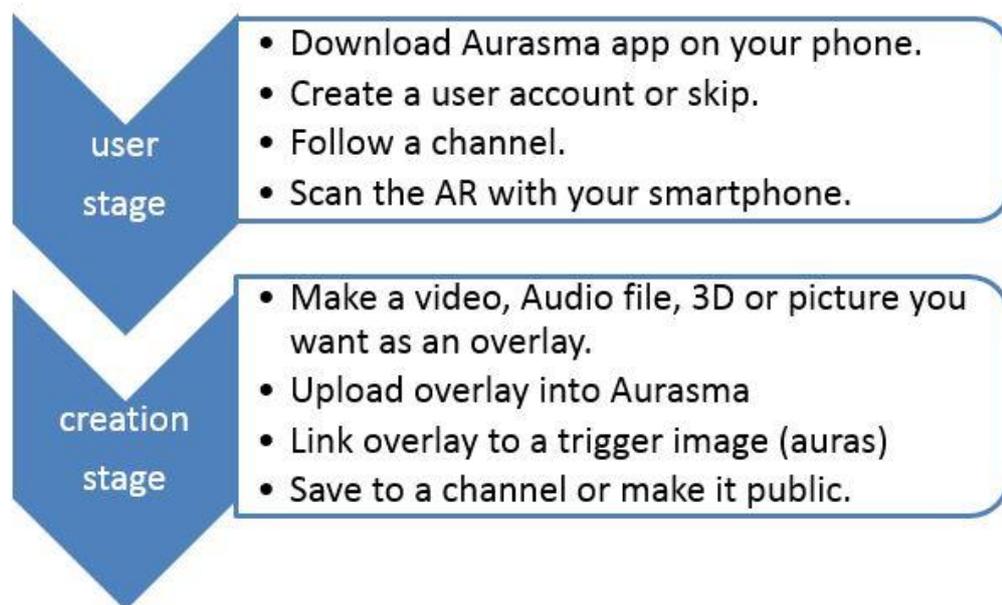


5. You can start using Aurasma application automatically: **Scan the pictures with Aurasma logo** start watching the When video is enter full screen.



(=big purple A) and then you can videos or listening to the sound files. playing double click it in order to

TEACHING MATERIAL



Slide 1



Slide 2



Slide 3



Slide 4



Slide 5



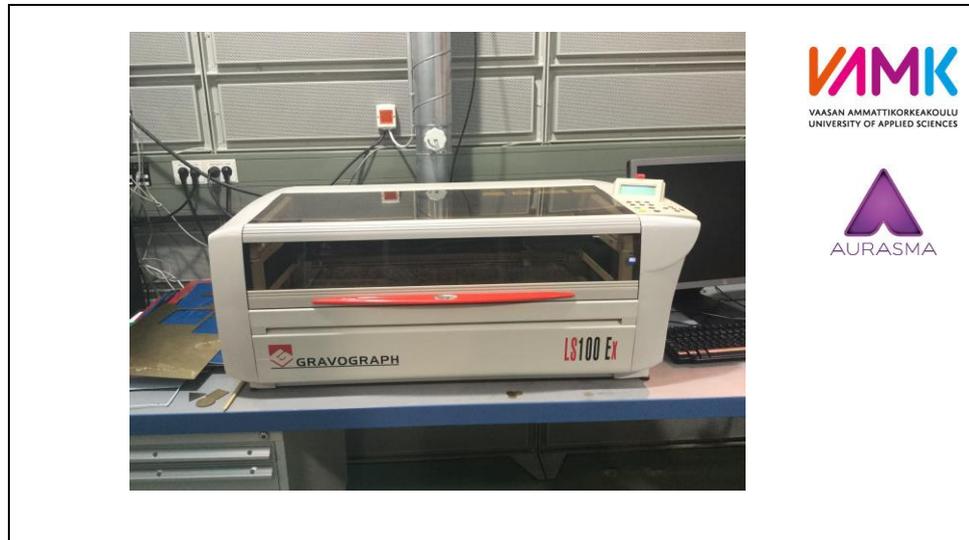
Slide 6



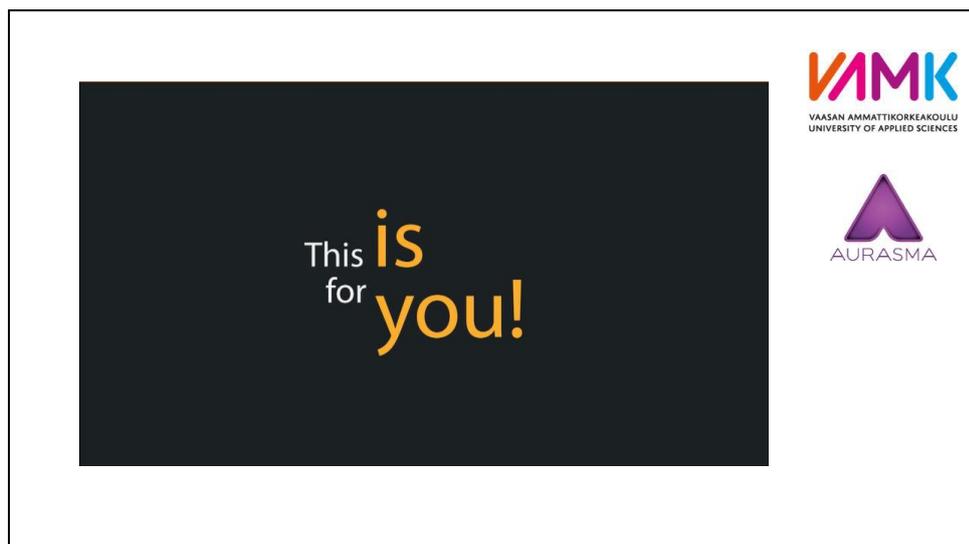
Slide 7



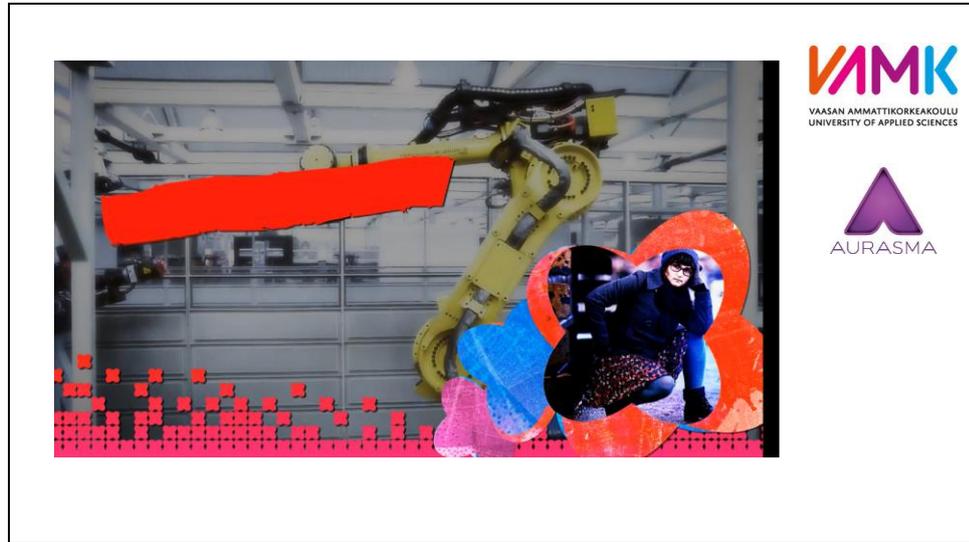
Slide 8



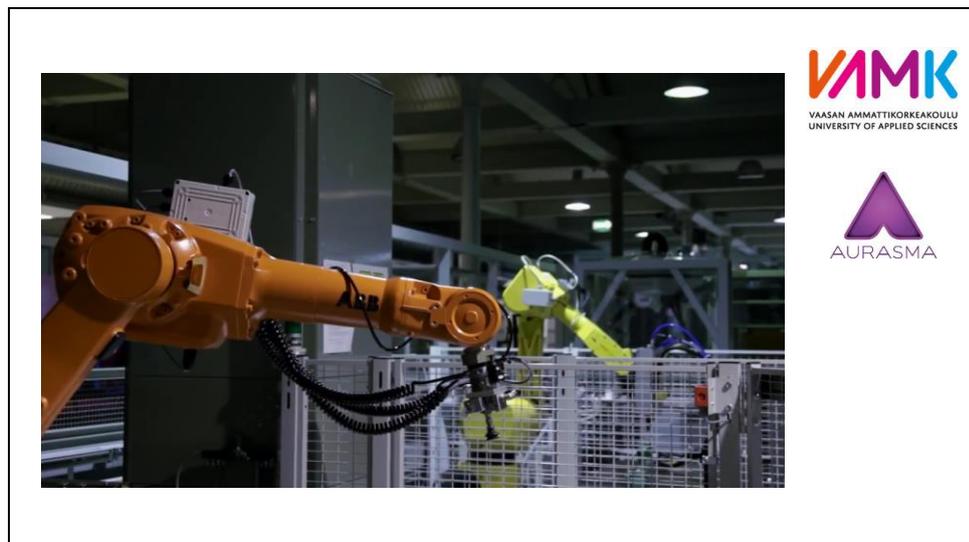
Slide 9



Slide 10



Slide 11



Slide 12



NOVIA Joakim Ingman, maskin- och produktionsteknik

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AURASMA

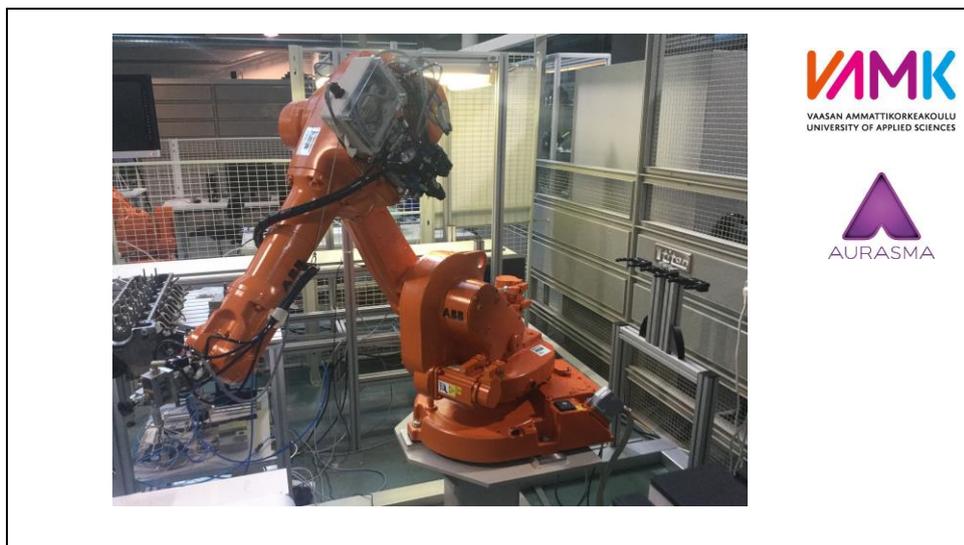
Slide 13



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Slide 14



APPENDIX 3: Installations

