# Design and evaluation of a prototype of augmented reality applied to medical devices.

## Summary

The study was aimed to incorporate all information regarding a medical device through augmented reality. This was done through a mobile application. The method of study had three stages; firstly, assessing user’s requirements through surveys and questionnaire and finding out any important information which will be included in the app such as what medical devices will be used, secondly, prototype development, and finally Software evaluation. The project was based on “Rapid Application Development” (RAD) methodology.

The application was usable on three medical devices and developed by qualified professionals. The human centred model was applied to develop the software taking into consideration the users, the environment in which they will use the application in, user requirements, design features and user assessment.

Results obtained were the following; firstly, 11 nurses and 280 healthcare professionals took part in the questionnaire where the majority agreed t include instructions, indications of use as well as descriptions of the medical device being seen in the AR app, secondly instructions and user friendly and readable description of the prototype application must be included within the app itself through text , images and videos and finally software evaluation .

When evaluating the software, the users described it as “very intuitive” since description of any medical device can be obtained very easily. The think aloud method helped in gathering only the relevant information which was needed in the prototype making it more likeable by the users. Three improvements were identified through the latter method, these were the following; virtual image vibration made the app difficult to use, no zooming function was applied in the application and finally the ability to still keep focus on device without having to keep scanning the actual device. The first problem was solved through dual aim and as a result fixing the virtual image fixed also the functionality of keeping focus on the device. The last problem was solved by including the zooming function.

The main limitation of the application was the process of updating information of medical devices without making use of any databases which in Spain (where the research was carried) did not exist. This results in having to manually updating the application through continuous maintenance.

# General Requirements for Industrial Augmented Reality Applications

## Summary

Technology has been widely and successfully applied to the fields of industry such as medicine. However, the phase of taking a technology out from the laboratory into the real world takes time and constant harsh testing. This paper tries to find what Augmented Reality Applications go through in order to be able to be used in the industrial world especially in cases where lives might matter as well as when used by the general public.

Industrial AR application perform well in the following areas; product design, plant design, training, production assistance, quality assurance, production logistics and remote maintenance. The AR applications must also follow as set of requirements such as the following; cost-effectiveness, data security, applicable regulations, set-up time, system reliability, accuracy of presentation, real-team capability and ergonomic.

The paper further mentions how an Augmented Reality application assists technicians to perform maintenance on a wind turbine. It further goes on to highlights the requirements for the AR app which were cost-effectiveness, data security, applicable regulations, low set-up time, reliability, accuracy, real-time capability and ergonomic.

The second application is an augmented reality training simulator for welders. The devices involved are a computing unit embedded inside a welding equipment, a helmet with cameras and speakers as well as a display. Training involved for such an application are joint training and training for a car chassis manufacturing plant of a German car manufacturer. Requirements for this AR app are the following; cost-effectiveness, data security, applicable regulations, set-up time, reliability, accuracy presentation, real-time capability and ergonomic.

Challenges and limitations faces were a variety for such two applications. Firstly, there was a variance of products and processes to encapsulate in an application. It required gathering a large set of documentation about the wind turbines to be displayed as efficiently as possible, as well as having the welding simulation limited to a predefined set of standard workpieces. Secondly, the working environment in which these apps are applied can be harsh and dangerous. Protective equipment has to be worn by the workers to ensure their safety as well as making sure that the devices concerned with delivering the AR do not interfere with their safety. Thirdly, a limitation encountered was data connection. To solve this the app can work offline, however optical tracking can be a problem in such case.

The results found was that the technology lacks a certain kind of maturity that can ensure full safety to the workers while working or training and making use of the app.

# Potential applications for virtual and augmented reality technologies in sensory science

## Summary

Recent advancements in Virtual and Augmented Reality have allowed us to capture a more vivid idea of sensory perception through immersive experiences. The paper studies the advancement of such technology with regards to complexities of human perception. Sensory data for many years has been tested under controlled conditions in labs. The technologies of nowadays are allowing us to collect new types of information. VR and AR are increasingly advancing as to add new levels of how we can get user output.

The paper goes on to highlight recent advancements in virtual and augmented reality technologies. VR from being head mounted displays (HMD) have become more portable. It explains the history of origin of the first VR system and explains how the technology has evolved. On the other Augmented Reality is a recent form of emerged technology. Augmented Reality has been provided through two platforms AR Core, AR Kit and Vuforia. The paper highlights that both technologies originated from “swords of Damocles HMD” thanks to Ivan Sutherland.

The study delves into the potential uses of VRs and Ars in sensory science. The first form of technology is what is known as ‘Context enhancing technology’. It is the gathering of information when food or drinks are taken in a context or environment. The cheapest and least time-consuming way of performing sensory context testing is through VRs and Ars. Both forms of technologies create immersive experiences as to illicit similar stimuli when doing these activities and data through nowadays state of the art sensors can easily be gathered.

The next form of technology is Biometrics, which is a term for body measurements. This is normally done through rating your preference of something one ate or drank. This way of measurement seems fully dependent on the consumer’s hedonic and emotional perceptions to food stimuli. Brain Computer Interfaces are being used to collect signals from the brain during an AR and VR experience.

Food structure and texture is necessary to understand and appreciate what the consumers desire for their taste. VR and AR enable the users to clearly study into depths the structure and texture of food and step even into the molecular level of the food visualised.

This paper explains what VRs and Ars provide to the world of food and drinks taste testing. They are means of how we can achieve new, accurate and more detailed information from what the consumers feels during the consumption of a meal.

# Potentials of Augmented Reality in Training

## Summary

Technological advancements in respect with the world of work, have redesigned the way we train and learn in order to integrate in a job. In this paper it is discussed, the idea of using Augmented Reality as a medium of going past this barrier and meeting the requirements of digitalization. A 3-step methodical approach was used to reflect on this idea. Recommendations through results achieved from training on or near the job are provided for interested companies to make use of.

The paper described what Augmented Reality is and in what forms with respect to hardware it comes in. It describes the advantages it provides for the industrial world. Training on the Job is the ability to learn for a particular job in this case using Augmented Reality, On the other hand training near the job is when the person need to train in a protected environment as it involves a really dangerous job that does not allow room for errors as it can be life costly in this case as well using Augmented Reality.

The research applied was started at the institute of industrial management in 2017. A 3-step method was used for this research, the first step was the detailed assembly process using process management and analysis. The second step, potential of AR in correlation with the hardware used. The third step, learning objectives including methods for AR integration.

The Results are divided into separate steps; the first one is process analysis. It is furthers then subdivided into four sub-processes, warehouse removal, piston assembly, piston rod assembly and cylinder assembly. These are processes, a product from a warehouse goes through. Step two is AR potential analysis. An analysis of an assembly and quality control process is carried out, describing the individual activities according to similar tasks. The third step is the development of AR based training possibilities. It identifies the AR hardware along with their requirements.

To Conclude, recommendations and benefits are provided from using AR in relation with a job training. It describes how AR can be further improved in order to adjust it to the training it needs to perform as well as identifying how the training will also improve by benefiting from the fruits of this new technology.

# AugmentedrealityinsupportofIndustry4.0—Implementation challenges and success factors

## Summary

Augmented Reality is a tool for workers to interact with the digital world. This paper analyses the issues, challenges and benefits AR bring into the world of Industry. The technology, organisation and environment framework are used for the quantitative section of the questionnaire. The paper discusses how the AR market will grow in the coming years. AR will help in completing tasks faster and more efficiently, given a suitable task is chosen. The paper proceeds to give some general information regarding AR in contrast to Virtual Reality.

Augmented Reality has the capability to help us in tasks like design, maintenance, supervisory control and data acquisitions. The methodology proposed is in relation with the six design principles of Industry 4.0; interoperability, virtualization, decentralization, real-time capability, service orientation and modularity. AR will be provided as an interface that will replace any paper based or hardware/ machinery-based architecture.

The technology obviously like everything else come with a certain bag of challenges. Reported challenges were of the following; hardware and software issues, weight, ergonomic issues, limited user acceptance, might be unhealthy at certain number of hours to user, data problems, security issues, reliability and cost.

The technology adoption and implementation model were used as an implementation framework. It is suitable for companies without any knowledge of AR or VR. It consists of three elements which are; the technological context, organizational context and environmental context. The technological context is about currently used technology within the firm. The environmental context is focused on having external entities increasing the knowledge with regards to AR. Organisational Context relates to assets of the firm itself.

The research approach was made through a qualitative and quantitative approach through surveys and questionnaires. Data collection involved a total of 365 participants were the criteria for participation was only if the individual was involved in AR development or projects. The qualitative part was aimed to fill gaps of information not gathered through the quantitative one.

As a discussion the papers compares the quantitative and qualitative results. It shows striking differences such as user acceptance, information visibility and user-centric improvement. Several explanations are provided as to why that is so. Several limitations were discovered, for example the scalability of the technology. The technology is recent and still needs further development. However, through industrial implementation interest will increase and the technology may become more applicable to important tasks.

# Towards augmented reality manuals for industry 4.0: A methodology.

## Summary

Augmented Reality is a promising technology for manual to instruct and train employees in their field of work and industry. AR manuals can take the form of 2D graphics using the Darwin Information Typing Architecture (DITA) and Information Mapping (IM). Industry 4.0 is the 4th Industrial Revolution and along with this revolution emerged Augmented Reality. The design principles of technical documentation are the following; interoperability, virtualization, decentralization, real-time capability, service orientation and modularity.

The methodology used to manage existing technical instructions for their use in visual manuals consists of; optimizing text use, using ASD Simplified Technical English, the conversion of text instructions to 2D graphic symbols and the organization of information using DITA and Information Mapping. The paper mentions two ways how AR can help the operator and in which tasks; localization of components and procedure to carry out. Visual elements for AR technical documentation can be categorized into fixe parts; 2D simple graphic elements, icons and symbols, multimedia elements, 3D navigable models and 2D technical drawings and illustrations. Information mapping follows a certain amount of principles. The principles are the following chunking, relevance, labelling, consistency, integrated graphics, accessible detail, hierarchy.

Two case studies were performed both from real maintenance manuals. First case was generating an AR manual from a real manual. Second case study involved creating a visual manual for user validation. The limitation in this study was that the person who needed to make use of this AR manual needed to have the pdf manual translated to a language of his own county. The instructions were presented in bullet form to improve readability. To determine whether the methodology used is effective or not user preferences were evaluated, without comparing the GUI but rather compare user acceptance. Validation comparisons were made through visual manual, PDF and iFixit. A questionnaire involved seven questions were at the end of each question users answered the question with point, were ‘1’ meant ‘Strongly Agree’ and ‘7’ meant ‘Strongly Disagree’. The questionnaire was presented to 22 volunteers and the average age was 36.5 years.

The technical documentation presented through the Augmented Reality involves less text and more graphical and visual interactive objects. The same application can be applied to documentation which involves a lot of text as well, which makes it very beneficial to implement and use. The documentation provided is compliant with Industry 4.0 and its principles; Interoperability, Virtualization, Decentralization, Real-Time capability, service orientation and modularity. The implementation was tested with a real maintenance manual of hydraulic breaks. Users complained with the PDF version. However, iFixit seemed to not have any problems.

To conclude, the methodology provided support technical writing which can be used for Augmented Reality. The implementation was made on two case studies to provide proof that this can be successfully applied in industry. A subjective user study was made for feedback. As a result an improved GUI will be created to improve accuracy, scalability and user friendliness.