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Project Report

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Augmented Reality Based Continuous Onboarding Framework

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Abstract

Augmented reality (AR) is an enhancing technological research field that is getting more and more popular in different domains. It becomes a promising technology used in various fields such as education, industry, entertainment, and military. However, its usage in software engineering is quite limited. The goal of our project is combining augmented reality and software development workflow process and providing continuous onboarding to software practitioners while performing their daily tasks. Software developers should be interactively guided using AR technology on the onboarding process continuously. Software teams may benefit from digitally enhanced working conditions provided using AR. “Augmented Reality Based Continuous Onboarding Framework” is an onboarding system for new-coming software practitioners for getting familiar with the colleagues, company culture and project meetings and information. After researching many different articles and sources, we deduced that there is lack of research about the combination of augmented reality, software engineering disciplines and onboarding processes. In this project conducted by Havelsan Inc, new comers to the company can continuously be oriented with this application that is run on smart mobile phones and augmented reality-based devices.

Key words: Augmented Reality, Onboarding, Software Engineering, Software

Özet:

Artırılmış gerçeklik (AG), farklı alanlarda giderek artan kullanım alanına sahip bir teknolojidir. Artırılmış gerçeklik teknolojisi, gerçek dünyayı dijital bilgi ve görseller ile zenginleştirir ve fiziksel çevreyle olan etkileşimimizi yeniden şekillendirir. Artırılmış gerçeklik; eğitim, sanayi, eğlence, savunma gibi çeşitli alanlarda kullanılan ve giderek yaygınlaşan bir teknoloji haline gelse de yazılım mühendisliği alanındaki kullanımı günümüzde oldukça azdır. Projemizin amacı, artırılmış gerçekliği ve yazılım geliştirme iş akışı sürecini birleştirmek ve günlük görevlerini yerine getirirken yazılım uygulayıcılarına sürekli adaptasyon süreci sağlamaktır. Yazılım geliştiricilerinin artırılmış gerçeklik teknolojisi kullanılarak işe alıştırma sürecinde etkileşimli olarak sürekli yönlendirilmesi gerektiğine inanıyoruz. "Artırılmış Gerçekliğe Dayalı Sürekli İşe Alıştırma Sistemi", işe yeni başlayan yazılım uygulayıcıları için takım arkadaşlarını, şirket kültürünü, proje toplantılarını ve yürütülen projeleri artırılmış gerçeklik kullanarak öğrenmeyi kolaylaştıran bir işe alıştırma sistemidir. Pek çok farklı makale ve kaynağın araştırılmasından sonra artırılmış gerçeklik,

yazılım mühendisliği disiplinleri ve işe alıştırma süreçleri konu başlıklarını bir araya getiren çalışmaların oldukça az olduğu sonucuna ulaşılmıştır. Havelsan şirketi ile yürütülen bu projede, şirkette yeni olan çalışanların, akıllı cep telefonları ve artırılmış gerçekliğe dayalı cihazlarındaki bu uygulamayla sürekli olarak işe alıştırma sürecini en etkili şekilde gerçekleştirmeleri hedeflenmiştir.

Anahtar Kelimeler: Artırılmış Gerçeklik, İşe alıştırma, Yazılım Mühendisliği, Yazılım

1. INTRODUCTION

1.1 Company Background

This project has been conducted with Havelsan, which is one of the software companies in Turkey's defense industry. Havelsan Inc. was established in 1982, as a Turkish – U.S Company using the name Havelsan-Aydın [1]. Company works for defense industry and most of their projects are military systems for both Turkish Armed Forces and some other foreign countries. In addition to military systems, they conduct civilian projects such as Cadastral Information System (TAKBIS) project. Company has four main departments, and these are Information and Security Technologies; Cyber Security and Cloud Computing Technologies; Simulation, Training and Test Systems; and Command Control and Combat Systems.

Our co-advisor is Dr. Eray Tüzün who currently works as a principal software engineer at Havelsan. He was graduated from Computer Engineering and Information Science department at Bilkent University in 2000. After that, he received the M.S. degree of Computer Science/ Bioinformatics department at Case Western Reverse University in 2002. Then he completed the PhD program at METU Information Systems in 2014. He has worked as principal engineer of Software Development Automation Unit in Havelsan [2]. Working with him during the project will be beneficial for us since he has knowledge and experience on agile project management, software development processes, software engineering and augmented reality [3]. We want to benefit from his software engineering, software development, and market experiences.

1.2 Problem Statement

Onboarding, in other words adaptation process of getting used to the company culture, new colleagues, and new projects, takes some time; however, it is becoming easier with some methods and tools [4]. A new approach to onboarding process is continuous onboarding which the adaptation period never stops, it continues as the employee works in the company and it keeps him engaged to the working process. According to Leaman, the employees who had a successful onboarding experience are more likely to stay with a company for a long period [5]. Even if the incoming software developers are highly skilled and experienced in the

sector, lack of knowledge about the new project that they are working on or lack of communication between their new team members may cause demotivation about the new job. Considering these information, onboarding process is an important part of adapting the working conditions of the new company for software engineers. Therefore, the onboarding process should keep on continuously as the time that software practitioners continue to work.

Combining the emerging augmented reality technology, we think that, using the virtual components placed on the physical environment, newcomers can easily learn the things about the company, team, and project that they will work. The purpose of this project is to provide continuous onboarding to software practitioners while performing their daily tasks by creating an enhanced version of spatial reality enriched by digital information and media so as to improve the software development workflow.

When all studies about AR are taken into consideration, there is certainly, a lack of academic and scientific research about the combination of AR technology and Software Engineering discipline, and ultimately there were no attempts for using AR with the onboarding processes.

1.3 Background or Related Work

Work in the field of augmented reality has just begun to increase and has not yet been used in the field of software development field in our country. We envision that the use of this technology, which is increasingly widespread and expanding in sectors, especially in the field of Research-Development (R & D) in our country, should increase productivity of work and production.

Business world is living and changes very fast. Therefore, business agility and adaptability are crucial for being afloat in the sector. Taking this facts into consideration, some companies work on real-time continuous training [6]. Software development industry is one of the most challenging industries for employee adaptation to job. Technology giants like Google, Apple, Microsoft are aware about this issue and work for creating solutions to this problem. Recently, Apple created an AR application in which while walking around campus they orient their new employee with showing how each department works using AR [7].

The most important element that differentiates the project from other AR projects is that it improves the software development process in the area of software engineering using AR and helps employees to better adapt to business and colleagues. According to the

literature review we made in the field of augmented reality, we have not seen a past project that combines these two fields. Although there are prototypes with some augmented reality used in the process of adapting to work, the difference of our project is that every employee in the company can use the application on their mobile device at any time. Our project is platform free; so, employees can use different mobile devices, without the need of any other equipment. In addition, this project aims to provide virtualized access and interaction to agile software development teams, especially in day-to-day meetings and task panels. No other software company has yet seen the use of such augmented reality application. So, the project can be described as one of the first project to be carried out in this area.

1.4 Solution Statement

Our project is proposed as technological solution to prevent the problems of development pressures by revealing the daily tasks of a software professional and take out the issues that might introduce by hectic delivery schedules. Transforming workflow assets to navigators of software development, our plan is to create a continuous onboarding schema.

One solution for continuously onboarding the software practitioners is providing them the information that they need by augmented reality components. In order to reach information about the colleagues, an orientation mode is planned to be used where the newcomer can scan a unique image that is placed on the workers' desk and get the information reflected on the real environment as an augmented reality component through the camera screen. That way, the newcomer can learn the specifications of the other workers and know who he will is going to ask help from. Furthermore, he can know their interests and communicating with them will be easier. Our plan is to visualize the profile of software practitioners, their skills, and their performances through task management using AR technology. Ultimately, an aim is to collect information from a set of different sources and visualize it using AR and creating a virtual war room. This approach enables clear and quick communication/collaboration among teammates by having multiple resources to feed in war room, creates a multiple data-feeding environment where software development issues can be quickly identified and resolved with less distraction with personalized enhancement of workflow. Also, the newcomer can reach the information about project, project meetings and the data that is collected from the meeting.

In the final product, the user experience objectives can be summarized as follows.

EO1: It can run on a wide range of consumer-level mobile devices.

EO2: It can automatically identify the data sources within a repository of software project.

EO3: It can reform the original appearance of the office by augmenting the user's reality as observed through the display of a mobile device, by visualizing the required parts of a project.

EO4: It can redesign the original office scene by augmenting the user's reality with design elements and pre-recorded information.

1.5 Contribution

The primary beneficiaries of ARBCOF (Augmented Reality Based Continuous Onboarding Framework) are software development teams, as it concurrently promotes the status of software development activities and ongoing efforts. ARBCOF will also create a demand for AR content, and in turn, high quality software production to support and transform software development communities to a new age. The research activities will also have other implication on worldwide such as contributing the dynamic AR content production and proposing AR-based business cases and implementations, etc.

Our approach aims to demonstrate the viability of pioneering software developer navigation device that recreates not only the original appearance of software development ecosystem but also its original atmosphere, by introducing pre-ordered 3D assets to a development scene.

The most important element that differentiates the project from other AR projects is that it improves the software development process in the area of software engineering using AR and helps employees better adapt to business and colleagues. According to the literature review we conducted in the field of augmented reality, we have not seen a past project that combines these two factions. Although there are prototypes with some augmented reality used in the process of adapting to work, the difference is that every employee in the company can use the application on their mobile device at any time, using different mobile devices, without the need for any other equipment. In addition, this project aims to provide virtualized access and interaction to agile software development teams, especially in day-to-day meetings and task panels. No other software company has yet seen the use of such augmented reality application.

In compliance with the technological guidelines, our proposal addresses the software development productivity issues through following deployment objectives (DO):

DO1: The deployment activities, office modelling and creation of the virtual dashboard requires only simple procedures and most commonly available hardware.

DO2: Once deployed the operation of the framework does not require a large investment in equipment or personnel, or an expensive training program.

DO1 and DO2 ensure that ALP is accessible to communities of interest that are lacking of high resources. However, ALP shall demand for AR content and accompanying digital services (e.g. application for training) by improving the productivity of software development by enabling emerging technologies.

2 LITERATURE SEARCH

Augmented reality (AR) is an enhancing area that is getting more and more used in different areas. This is a literature review that searches the previous works about augmented reality applications in some specific areas, and its combination with onboarding process. The purpose of this literature review is to be informed about the main two research areas which is augmented reality and onboarding, for our project named "Augmented Reality Based Continuous Onboarding Framework". The aim of our project is combining Augmented Reality (AR) and software development workflow process and providing continuous onboarding to software practitioners while performing their daily tasks. We believe that software developers should be interactively guided using AR technology on the onboarding process continuously. Similar to a GPS device that can guide you through point A to point B, our goal is to create software artifacts like navigation components, software teams may benefit from digitally enhanced working conditions provided using AR. After researching many different articles and sources, we deduced that there is lack of research about the combination of augmented reality, software engineering disciplines and onboarding processes. In this paper, we explained the current projects and usage areas of augmented reality, and examples of onboarding with their brief explanations.

2.1 Introduction

Regarded as one of the emerging technologies, Augmented Reality (AR) enriches the real world with digital information and media should reshape the ways we interact with our world. According to Azuma [8], AR is a technology, combines physical world with virtual

objects for a new kind of visualization that promises spatial interaction in real time. Even though studies about AR were initiated in the 1960s [9], the interest of people to this technology increased after the success of the Pokemon GO [10] game. Within the last two years, social media conversations about AR have gone up to the rate 33% [11]. Recently, AR becomes a promising technology is used in various fields such as education, industry, entertainment, military. Yet, the current AR market can still be considered as newly growing, meaning that technology and market maturity are still in their early adolescence [11]. AR technology still continues to progress. Up to now, it has valuable effects on the fields in which it is used. In the light of positive feedbacks, this technology can have positive impacts on different domains as well.

2.2 Augmented Reality in Literature

2.2.1 AR in Education

Thus, far, research has been conducted to explore the benefits of AR in education. One study is by Wojciechowski & Cellar [12], highlights that students tend to collaborate AR objects with real objects by using simple and cost-effective devices. Freitas & Campos [13] developed an AR application called SMART (System of Augmented Reality for Teaching) to visualize and introduce the objects such as cars, airplanes, and animals to primary school students. Application was experimented upon 54 students in three different schools, and the results showed that SMART improved their ambition about learning. AR is not only used for primary level students; but also for higher level educated students in universities and colleges to embody complicated theories and systems [13]. In biology lessons, an AR application that simulates the organs in human body with their names and explanations is used to demonstrate to the students for more realistic experience in classroom [13].

2.2.2 AR in Tourism

As AR technology widely spreads, there can be seen many examples of AR applications in wide variety of fields. One of the fields that AR can be used efficiently is tourism. Kounavis et al. [14] mention some of the AR applications for this field in their research. Tuscany+, the first AR application, is a digital tourist guide on Tuscany region. Augmented Reality for Basel which is also a special tourist guide for the city of Basel, gives its users valuable information about the city, and users can find information about museums, hotels, shopping centers, restaurants, events, etc. Urban Sleuth is one of the examples of AR applications for tourism field, but it is remarkably distinctive from the others because it

requires user participant in order to solve mysteries and accomplish missions while touring in the city and challenging with other teams. Last application is specially designed for demands of Museum of London and it is called The StreetMuseum. It makes users able to view historical places and information about them [14]. Han et al. [15] highlight the importance of AR technology in tourism by emphasizing that industry of tourism needs to draw attention of people and nowadays the most efficient way to achieve this is usage of mobile devices, therefore tourism industry must be kept updated by new investments.

2.2.3 AR in Entertainment

Carmigniani et. al. [16] express that using AR in entertainment industry may bring a breath of fresh air into it especially for the gaming applications, for instance, animations can be displayed when playing a board game. With AR technology, user experience of players can be improved. Augmented onboarding can be beneficial as a main component of a game, e.g. presenting how to play, showing tactics that are available, displaying ongoing characteristics of other players. Such a visual improvement makes games more attractive and interactive. As an example, Gandy [17] developed AR Karaoke game. Game allows player to play a scene from a movie. HMD (head-mounted display) was used for getting into the environment of the scene with virtual objects. Gamer can experience the movie scene in first-person perspective. Moreover, Santiago and Romero [17] developed a game with the theme about collecting pieces and solving puzzles. In this game, players collect virtual objects and the more object players collect, their chance for solving the puzzle increases. Entertainment sector has a tremendous advantage in AR because of the fact that borders of applying entertaining features to AR is not as limited as the other fields.

2.2.4 AR in Marketing

Yuen et al. [18] touched on the point of AR technology in marketing with giving the example of automotive companies, which use real size AR virtual cars in their showrooms. With virtual buttons, customers can observe virtual model vehicles by opening doors, rotating them. They indicate that customers can gain more definite impression about the product with using the virtual models on their mobile phones. Augmented reality is commonly used for online advertising. As an example, car company MINI [19], developed an AR application advertised on some German magazines. In this special form of advertisement, readers show the related page to their webcams and a virtual MINI car appears on the screen [16]. Magic mirror is also an application about AR technology developed for marketing. In addition to this, Cisco's fitting room is another development for retail sales which AR technology is

involved. In these two applications, customers are allowed to try on virtual clothes instead of real products. With AR technology, they see how such clothing might look on them. This helps customer to make more accurate decisions during shopping [16]**.** Höllerer and Feiner [20] mentioned that there may be virtual billboards appear on the street according to user's profile and interests to advertise a product. In the light of these examples and tendency to using mobile technologies in every area like shopping, marketing is one of the fields that have a significant potential for AR technology investments.

2.2.5 AR in Military

AR can be used for training the military personnel. One usage of AR for military is tracking the medical issues on a battlefield. Authorized commander on a combat can get the information about the health status of a soldier whether he is injured and visualize the view and conditions of the field using AR [20]. Special AR helmets that contains 360 cameras and sensors are in developing phase to help ground soldiers to experience a real-life combat conditions with the warnings about the battlefield conditions such as an enemy or a danger spot warning [18]. In their study, Fenier and Henderson [21] developed an AR system that provides maintaining the systems and equipment in a bulletproof vehicle more quickly and securely, by a military mechanic wearing special AR glasses.

2.2.6 AR in Automotive Industry

Automotive industry is one of the sectors that AR is used. Many of the companies, especially car and airplane producer companies, work with some big, costly, fast changing and time-consuming products. Consequently, producing this kind of products and training people to learn and assemble the parts of products require large amount of time and money. Reiners et al. [22] mentioned that since the products change faster, and companies need to keep pace with the new technologies, AR can be used for training the service personnel in assembling and fixing the parts of a product. In their study, they worked with BMW Company in assembly of a door lock into a car door. As a result, their work enlightened prototyping and conducting tasks in a specific part of a car. Furthermore, Azuma [8] stated that a 3D model that simulates the real components of equipment is easier and more practical rather than manuals and pictures while following the instructions. Boeing, one of the largest airplane companies, used AR technology to guide the technicians about the electrical system of an airplane. Moreover, Feiner [23] claimed that architects can use AR to visualize the installation of a building by showing the electric cables and pipe systems inside the walls. Also, it can be used to display what would it be the view from the window if a new building is

built for the architect to see and analyze. For different sectors on the industry, AR can be implemented and adapted according to the different demands of the sectors.

2.3 Onboarding

Onboarding is the process of incorporating new employees into an organization [24]. Onboarding, in other words adaptation process of getting used to the company culture, new colleagues, and new projects, take some time; however, it is becoming easier with some methods and tools [4]. Unmistakably AR gives entrepreneurs boundless potential for putting learners in true situations and circumstances. Numerous representatives learn best by doing as opposed to seeing. AR is a glad medium between perusing about something in a book and doing the genuine article [25]. A new approach to onboarding process is continuous onboarding which the adaptation period never stops, it continues as the employee works in the company and it keeps him engaged to the working process. According to Leaman, the employees whom had a successful onboarding experience are more likely to stay with a company for a long period [5]. Yates [25], explained in her highly extensive Ph.D. thesis about software engineering and onboarding that onboarding process is really crucial for both developers who work individually or work in a team in order to understand the techniques, culture and the code-based work on the company. It is better to get the information about co-workers, documentation, codes and code artifacts by new employees to make the onboarding process more qualified. Also, it is more beneficial to ask for help.

2.3.1 AR for Onboarding

Business world is living and changes very fast. So, business agility and adaptability are crucial for being afloat in the sector. Taking this facts into consideration, companies work on real-time continuous training [6]. Software development industry is one of the most challenging industries for employee adaptation to job. Technology giants like Google, Apple, Microsoft are aware about this issue and work for creating solutions to this problem. Recently, Apple created an AR application in which while walking around campus they orient their new employee with showing how each department works using AR [7].

2.4 Conclusion

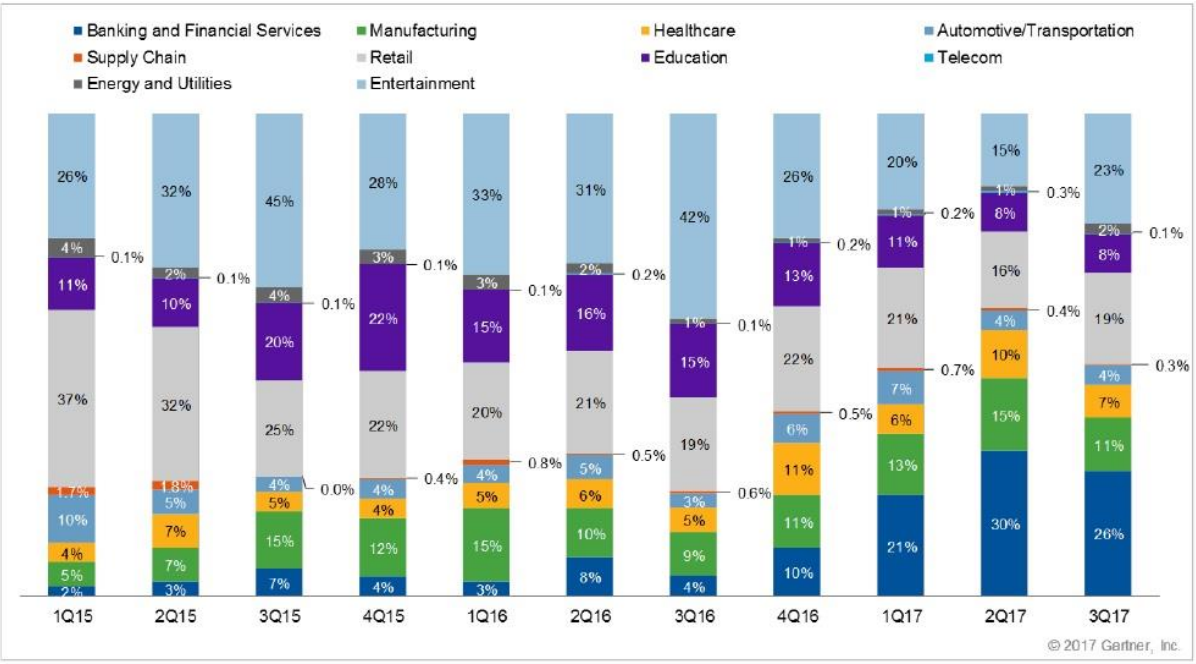

Figure 1: Verticals Driving the Social Media Conversations in AR [26]

To sum up, AR technology has a great potential in many different fields, such as education, tourism, entertainment, marketing and sales, military, and automotive industry as it can be seen in Figure 1. It shows how the conversations in AR has changed from 2015 to 3rd quarter of 2017 in various fields. Regularly, technology is evolving, and applications are getting more visualized and interactive. AR technology provides extended experiences to its users and instead of flat screens, keyboards, and external components, it more deeply connects people to the data they want to reach [27]. The ever-increasing evolution of mobile technology and the fast adaption to these devices by people have allowed AR to become reachable to the public [28]. At this point, AR technology has a considerable and promising role about recent advancements in application market. When all these workings about AR are taken into consideration, there is certainly, a lack of academic and scientific research about the combination of AR and Software Engineering disciplines, and also AR using for onboarding processes. The purpose of this project is to provide continuous onboarding to software practitioners while performing their daily tasks by creating an enhanced version of spatial reality enriched by digital information and media so as to improve the software development workflow. We believe that software developers should be interactively guided

using such an AR technology. Therefore, we characterize an environment includes AR for software development teams.

3 SUMMARY

3.1 Summary of Conceptual Solution

In augmented reality, we change the real-world data with adding some virtual data and represent this mixed content to user. We adapt the working principle of AR technology into our project. AR mechanism begins to work with getting the real-world data through camera or sensors. After that, positioning and adaptation are done, and data is ready to process. Positioning the data happens with anchoring. AR anchors get the world position and placed the data to that position using that position information. Processing of the data is the most crucial part for developing an AR application. Changing the real-world data is done in this step and mixed with virtual information. In the last step, content of mixed reality is represented to the user as video output.

Using that AR logic, we plan to scan a target image and then receive the desired information from our data sources. After that, that data is processed by our program and placed on the position that the camera points using anchors. After that processes, the user who is a new software practitioner, can get the information that he needs through the camera screen. This augmented reality onboarding experience will help them to access the information that they need during the adaptation process and make them more motivated about their work.

Successful achievement of these experiences and development objectives require, in turn, success in the following research objectives.

RO1: Real-time data display using multi-sensor camera tracking on a mobile device where it is the user's window to the augmented reality, and therefore system must deliver accurate and robust performance in a closed office environment. (Addresses EO1, EO3, DO2).

RO2: The first implementation of dynamic AR concept in software development context. Dynamic AR ensures the projection of 3D performances to a selected viewpoint selected from a user's position while interplay between AR assets, and the real scene with limited resources that are offered by a mobile device. (Addresses EO1 & EO4)

RO3: A practical dynamic scene reconstruction pipeline that can handle multiple users and data. The pipeline should require a standard consumer device. (Addresses DO1)

RO4: Efficient 3D performance representation to facilitate rendering, storage and display. (Addresses EO1, EO4, DO2)

RO5: A practical 3D office construction from a virtual dashboard which hosts dynamic and static AR assets. (Addresses EO1, EO2, EO3, DO1, DO2)

RO6: A workflow for 3D modelling of software office from the available records, logs, and documentation and generation for AR assets. This will be among the first productivity improvement efforts for software development in the literature. (Addresses DO1)

3.2 Technology Used

Vuforia will be used as an augmented reality tool for our project. Vuforia has been shown to be one of the leading augmented reality tools by developers, thanks to its hallmark multiplier features such as compatibility with popular gadgets, visuals of different kinds, perception of objects.

As a development environment, Unity 3D platform will be used. With Unity 2017.2, it can work with Vuforia in an integrated way, providing users with convenience in this area. Unity 3D is preferred for its ease of use and the advantages it offers in creating products that can work with different devices. It also provides flexibility to the user with the various programming languages it supports. Vuforia will provide enhanced realism properties, and virtual objects will be placed with Unity 3D to integrate the real and virtual models.

In the process of encoding the project, the C # programming language will be used. The code will be written in Visual Studio 2017 environment, which integrates with Unity 3D. The resulting product will work on mobile devices with an Android operating system. In this way, our product which will be presented to the use of more widespread material will also be offered with wide use by not limiting the persons to a certain environment due to the portability.

Also, system will retrieve data from data sources like Team Foundation Server, Microsoft Outlook, and Exchange Server. Data shall be transferred from these servers to the mobile device that uses the system.

4 SOFTWARE REQUIREMENTS SPECIFICATIONS

4.1 Introduction

This document is the software requirement specification document for the project titled as “Augmented Reality Based Continuous Onboarding Framework”. This system is an application that assists developers to adopt more easily to their working environment, and ultimately improve the software development process and work more efficiently.

4.1.1 Purpose

The purpose of this document is describing the Augmented Reality Based Continuous Onboarding Framework. Aim of the project is combining Augmented Reality (AR) and software development workflow process and providing continuous onboarding to software practitioners while performing their daily tasks. This document contains particularized information about the project and requirements of the project. The document indicates the recognized constraints and requested software functionalities. Furthermore, the SRS document explains how users collaborate with the application and explains how concerns of the stakeholders are met and SDD document explains the detailed design of the project. Moreover, this report has User Manuel to explain how to use the system and Compilation / Installation Guide which is describes how to install and compile the system.

4.1.2 Scope of Project

Software development is a process which has deep background consisting of various phases. Even though, there are different methodologies used in software development, it has never been a straightforward process. Developers should always be highly motivated and continuously focused on the project. Otherwise, they can easily be disoriented during the development process. All developers including juniors should always keep the pace of the process.

Software process is set of activities that is implemented with a structure to develop a system [29]. There are different software development models according to requirements and characteristics of a software. Some of the most used models are traditional and agile models.

The traditional approach can be illustrated with the waterfall model which consisting of project phases which are performed in decided time interval and all of them follow each other after one phase is completed [30]. Pfleeger and Atlee [30] report that waterfall method consists of the activities that are requirement analysis, design, implementation, testing, operation and maintenance. This model is a static and linear, in other words, it lacks of agility which is a problem about this approach model. On the other hand, agile software development provides more flexibility and changeability during the process of a software. It uses short time-boxes which last 1 to 4 weeks and it minimize the risks during the development phase [31]. The project is more likely to be used by agile methodology developers, since the process is dynamic, and employees tend to be disoriented if they miss an iteration or a meeting.

By creating a combination of augmented reality (AR) with software development workflow process, the goal of this project is to provide continuous onboarding to software practitioners while performing their daily tasks. Onboarding is the process of incorporating new employees into an organization [24]. Onboarding, in other words adaptation process of getting used to the company, new colleagues, and new projects, take some time; however, it is becoming easier with some methods and tools [4]. A new approach to onboarding process is continuous onboarding which the adaptation period never stops, it continues as the employee works in the company and it keeps him engaged to the working process. According to Leaman, the employees who had a successful onboarding experience are more likely to stay with a company for a long period [5]. We believe that software developers should be interactively guided using AR technology on the onboarding process continuously. Similar to a GPS device that can guide you through point A to point B, our goal is to create software artifacts like navigation components, software teams may benefit from digitally enhanced working conditions provided using AR. In addition, our plan is to visualize the profile of software practitioners, their skills, their performance and progression using AR technology. Ultimately, an aim is to collect information from a set of different sources and visualize it using AR and creating a virtual dashboard by putting all key stakeholders in a AR enhanced room with the motivation of producing usable software in a short amount of calendar time. This approach enables clear and quick communication/collaboration among teammates by having multiple resources to feed in war room, creates a multiple data-feeding environment where software development issues can be quickly identified and resolved with less distraction with personalized enhancement of workflow.

4.1.3 Glossary

Term	Definition
Augmented Reality (AR)	Augmented reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are "augmented" by computer-generated or extracted real-world sensory input such as sound, video, graphics, haptics or GPS data [32]
Stakeholder	A person who has interest or concern in the project
War Room	A term represents the decision and development phase in a meeting room while a software is producing by a team.
Onboarding	The process of incorporating new employees into an organization [24]
Scrum	Scrum is a management and control process that cuts through complexity to focus on building products that meet business needs [33]
Workflow	The series of activities that are necessary to complete a task [34]
Agile Development	Agile software development is a conceptual framework for undertaking software engineering projects by minimizing risk and using short timeboxes 1 to 4 weeks [31]
Software Management	Managing software processes by planning and leading. [35]
Dashboard	An interface that monitorize some tools and information from multiple sources [36]
Framework	A real or conceptual structure intended to serve as a support or guide for the building of something that expands the structure into something useful [37]
Scrum Board	Visual display of the progress of the Scrum team during development process [38]

4.1.4 Overview of the Document

This SRS is divided into subsections with numbers. Part 2 is Overall Description and it has the general concept, user types, and constraints of the system to understand it more

specifically.

Section 3. Specific Requirements defines both functional and performance requirements of the system in more detail. In order to understand the functions that the different users use, use-case diagrams are shown in this section. Also, this section contains the design constraints and software attributes of the system.

At last, section 4 is the References where resources are stated.

4.2 Overall Description

The following section presents an overall description of the Augmented Reality Based Continuous Onboarding Framework. In particular, the product has been put into perspective through a detailed assessment of the system, user, and hardware interfaces.

4.2.1 Product Perspective

Augmented Reality Based Continuous Onboarding Framework is an augmented reality-based application project that has the purpose of adopting new software developers to their working environment, assisting developers to work more efficiently and making them able to keep trace of their projects and meeting digitally.

4.2.2 Development Methodology

During development process of this project we are planning to use scrum which is an agile development methodology. Due to volatile requirements, agility is important for project development. In contrast to traditional software development, scrum is an agile methodology which is incremental and iterative. Development process consists of sprints which includes its own task to be performed. Each sprint has equal iteration time 30 days on average. In daily, development team has meeting less than 15 minutes which is called daily stand up meeting. In scrum, there are three main roles which are product owner, scrum master and development team. Product owner demands requirements, scrum master manages the process and development team. And the development team has the role of working on project according to plan. The advantages of scrum can be summarized as follows; First of all, as a result of agility, changes that happened in development process can handled easily. In addition to that,

problems which occur during process can be negotiated immediately due to daily stand up meetings [39]. In the light of these facts, Scrum is suitable for development of this project.

4.2.3 User Characteristic

In Augmented Reality Based Continuous Onboarding Framework, there is only 1 type of users interact with the system: developers.

Developers must be employees of HAVELSAN A.Ş., they must read and understand English language due to system language is English and must have knowledge of software development and company culture. They can use the system for onboarding and analyzing meeting histories. Developers must be registered to the system in order to use it.

4.3 Requirements Specification

4.3.1 External Interface Requirements

4.3.1.1 User interfaces

The user interface will be worked on mobile devices.

4.3.1.2 Hardware interfaces

The system will work on mobile devices, tablets, and AR compatible devices.

4.3.1.3 Software interfaces

There are no external software interface requirements.

4.3.1.4 Communications interfaces

System shall communicate with Team Foundation Server, Microsoft Outlook, and Exchange Server via an internet connection. Data shall be transferred from these servers to the mobile device that uses the system.

4.3.2 Functional Requirements

4.3.2.1 Home Screen Use Case

Use Case:

Login to the application

Exit from application

Diagram

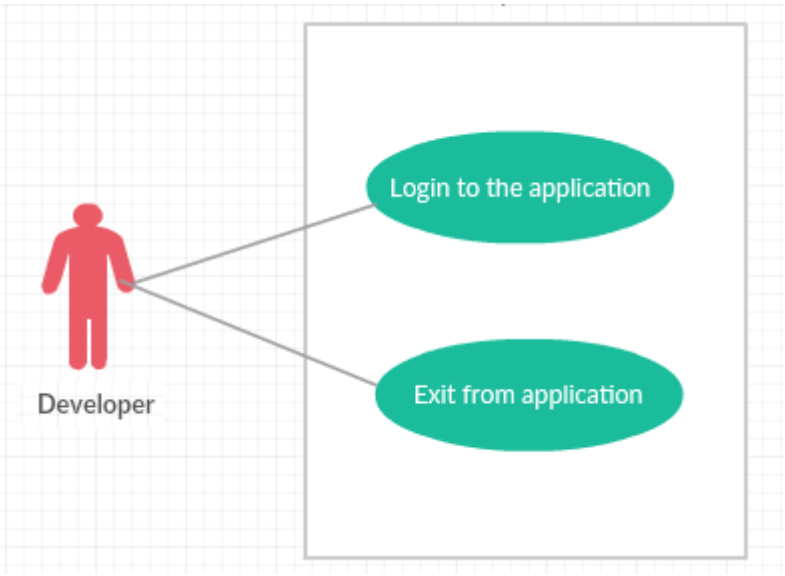

Figure 1: Home Screen Use Case Diagram

Brief Description

1. Application opens, and the Home Screen welcomes all users.
2. User enters username and password to login to the system.
3. If username and password match, user logins to the system successfully.
4. After a successful login operation user is routed to the Main Menu.
5. If user selects “Exit” option, application will close.

4.3.2.2 Main Menu Use Case

Use Case:

Switch to the Orientation Mode

Switch to the Operation Mode

Logout

Exit

Diagram

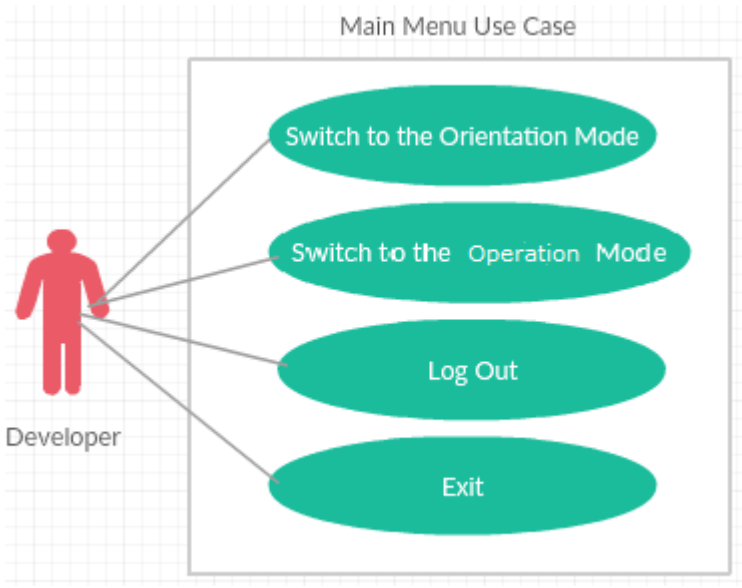

Figure 2: Main Menu Use Case Diagram

Brief Description

After successful login operation, developers can start to use system by choosing the related mode. System allows developers to choose the "Orientation Mode" or "Operation Mode". Also, developers can choose "Logout" or "Exit".

1. Main Menu is displayed.
2. User selects "Orientation Mode", "Operation Mode", "Logout" or "Exit".,
3. If "Orientation Mode" is selected, Orientation Mode is opened.
4. If "Operation Mode" is selected, Operation Mode is opened.
5. If "Logout" is selected, user is logged out from the system and application is directed to Login Screen.
6. If "Exit" is selected application will close.

4.3.2.3 Pause Menu Use Case

Use Case:

Resume

Main Menu

Exit

Diagram

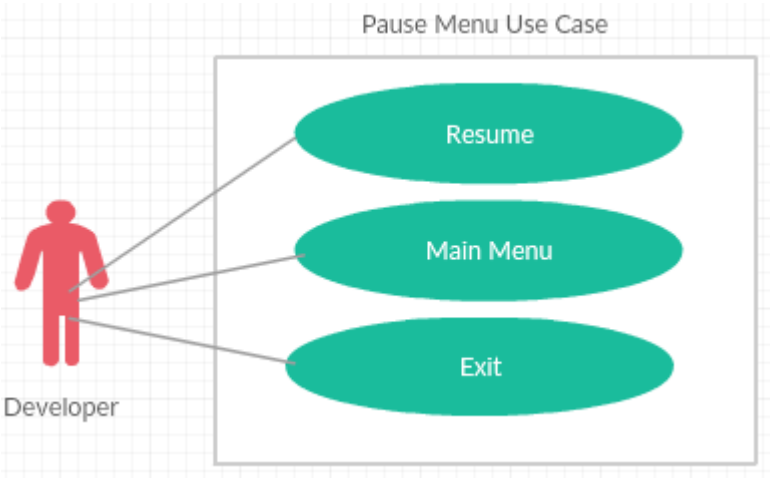

Figure 3: Pause Menu Use Case Diagram

Brief Description

After selecting "Pause" button in any mode user can go to main menu, exit from application or go back to his last scene.

1. "Pause" button is selected in any mode screen.
2. If "Resume" is selected, user goes back to his last scene.
3. If "Main Menu" is selected, user goes to main menu.
4. If "Exit" is selected, application will close.

4.3.2.4 Orientation Mode Use Case

Use Case:

Scan image (includes get information)

View related information

Exit from orientation

Diagram

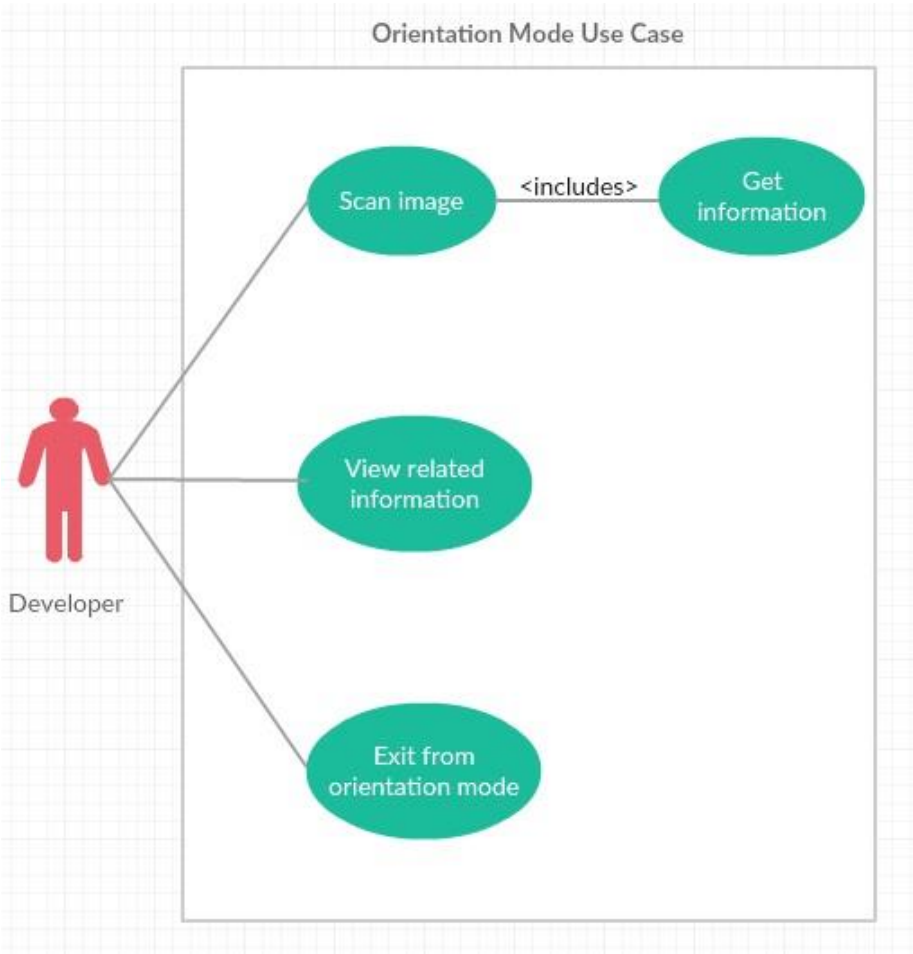

Figure 4: Orientation Mode Use Case Diagram

Brief Description

In this mode, user can access the profile information of the developer by scanning the unique image which belongs to selected developer. For every developer, a unique image is defined and exists in the system database and the information of the corresponding developer is reached from the data source servers.

1. Camera screen is opened.
2. If an image of a developer is detected by the camera, photograph/video, team information, and development ability of the chosen developer appear on the camera screen as an AR component.
3. If user selects exit, screen turns back to developer mode.

4.3.2.5 Operation Mode Use Case

Use Case:

Scan image (includes get information)

View related information

Exit from operation mode

Diagram

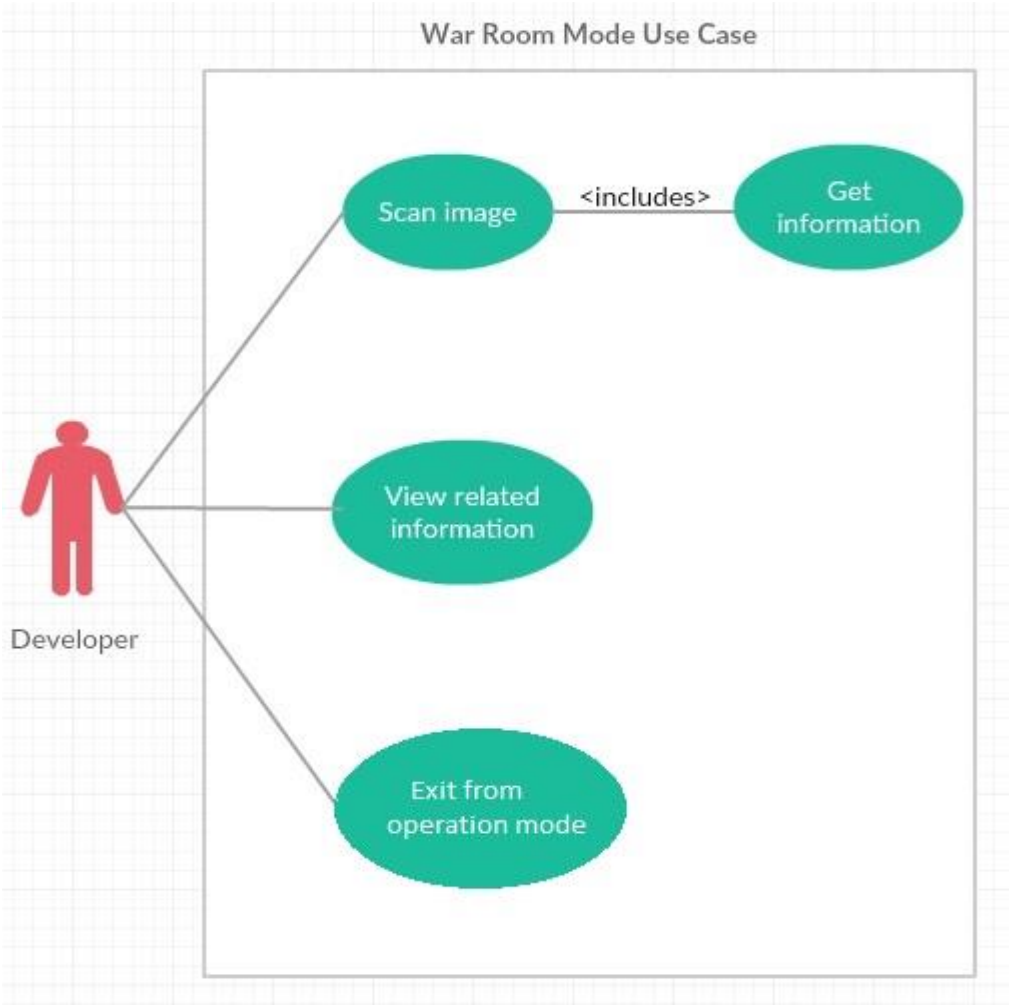

Figure 5: Operation Mode Use Case Diagram

Brief Description

In this mode, user can access the information about the work items which are defined in current sprint by scanning the unique image which belongs to selected task. For every task, a unique image is defined and exists in the system database. By scanning the related image, data about the task will be displayed on the camera screen. If user wants to see more detailed information about task, s/he can open TFS (Team Foundation Server) link of selected task on the web browser. In addition to task status, user can observe his team mates' current task

information by scanning the unique person image. Current task information of a developer includes statistical data about task types which he works on as feature, improvement or bug and total workload of identified developer. Also, in the situation of task sharing, system shows shared tasks of current user and selected developer.

1. Camera screen is opened.
2. If camera detects a unique image of a task, the information of that task is displayed as summarized.
3. If camera detects a unique image of a developer, current workload and task status information is displayed.
4. If user selects exit, screen turns back to developer mode.

4.3.3 Performance Requirement

System's visual must run smoothly without any latency to keep the level of immersion high. This requirement is depended on many aspects of the user mobile device/tablet. System will be developed by using Unity3D and Vuforia; therefore, versions of Unity3D and Vuforia must support the mobile devices'/tablets' OS. Unity3D version must be the latest version (2017.2+). For Vuforia to be worked on mobile devices/tablets; Android OS must be 4.4.x+, IOS must be 9+ [40].

4.3.4 Software System Attributes

4.3.4.1 Portability

Augmented Reality Based Continuous Onboarding Framework is designed for mobile devices/tablets using Unity3D and Vuforia. Unity3D supports many of the mobile devices/tablets, so system can be used mobile devices/tablets if their OS versions are supported.

4.3.4.2 Performance

The distance between the camera and the image shall not be more than 0.5 meters to scan. Scan operation shall not be last more than 10 seconds.

4.3.4.3 Usability

The software is planned to be used by software engineers whom are expected to be experienced mobile device and application users. Even so, the usability should be as simple as possible since the screen of a mobile device is not big enough to place many information. New users are able to learn using the system in 5-15 minutes.

4.3.4.4 Availability

System shall be available to all its users in the company building. As long as the Team Foundation Server and Outlook server of the company are operational, system shall be able to collect with the accurate data from these servers. The servers and the internet connection of the device that uses the system shall be available while the system is working.

4.3.4.5 Scalability

Multiple users can use the system with their own mobile devices, tablets and AR compatible devices. The first version of the system is planned to be used by a team of 4-6 people.

4.3.4.6 Security

Security is one of the key elements of the project, since HAVELSAN works on defense industry, therefore company has strict rules about confidentiality. There shall be no login to the system other than the employees of the company.

4.3.5 Safety Requirement

Since the system is working on mobile devices/tablets and AR devices, user must be careful while they are moving around. System may show them virtual objects or images or texts which are not real, but these virtual objects, images and texts may appear on real objects. While using the system, users may not notice the real objects and these objects can cause injuries. Therefore, while looking at the screen and moving, user should watch out the area and take his eyes off the screen in every few seconds to check the real environment.

As it is known, too much mobile device exposure can cause occurrence of some symptoms of radiation such as headache, insomnia, tiredness, sleep disruption, eye strain and many more [41].

5 SOFTWARE DESIGN DOCUMENT

5.1 Introduction

5.1.1 Purpose

The purpose of this Software Design Document is to provide the details of project titled as “Augmented Reality Based Continuous Onboarding Framework”.

The target audience is software developers and teams in HAVELSAN A.Ş. Our approach will make them able to adapt new working environment easily in terms of knowledge, skills and behaviors and reach their projects’ information digitally. The newcomers to a software process will need to learn the team’s tools, processes, culture, and the existing codebase to be maintained. They must take in a great deal of social and technical knowledge in the company. Therefore, some tools and guidance can make the onboarding process more efficient.

The goal of the project is to provide continuous onboarding (i.e. organizational socialization) to software practitioners and enhance the daily workflow of software organization which make them effective members of software development organization.

While performing their daily tasks, practitioners should collect information from a variety of different sources. Here, our aim is to visualize this information using augmented reality (AR) technology by creating a virtual system dashboard for stakeholders. Consequently, we improve the software development process in a AR enhanced room with the motivation of producing software artifacts in a short amount of calendar time. This approach enables clear and quick communication/collaboration among teammates by having multiple resources to feed in war room creates a multiple data-feeding environment where software development issues can be quickly identified and resolved with less distraction with personalized enhancement of workflow.

5.1.2 Scope

This document is the description of the design of the project Augmented Reality Based Continuous Onboarding Framework.

Software development is a process that has deep background consisting of various phases. Even though, there are different methodologies used in software development, it has never been a straightforward process. Developers should always be highly motivated and continuously focused on the project. Otherwise, they can easily be disoriented during the development activities. All developers including juniors should always keep the pace of the process. By creating a combination of augmented reality (AR) with software development

workflow process, the goal of this project is to provide continuous onboarding to software practitioners while performing their daily tasks. Onboarding is the process of incorporating new employees into an organization [24]. Onboarding, in other words adaptation process of getting used to the company, new colleagues, and new projects, take some time; however, it is becoming easier with some methods and tools [4]. A new approach to onboarding process is continuous onboarding, which the adaptation period never stops, it continues as the employee works in the company and it keeps him engaged to the working process. According to Leaman [5], the employees who had a successful onboarding experience are more likely to stay with a company for a long period. In addition, our plan is to visualize the profile of software practitioners, their skills, their performance and progression using AR technology. Ultimately, an aim is to collect information from a set of different sources and visualize it using AR.

For the development, we have chosen Vuforia [40] integrated with Unity 3D platform [42] which is a game engine with 3D graphics and it is compatible with all different platforms and devices. Vuforia has been shown to be one of the leading augmented reality tools by developers, due to its remarkable features such as compatibility with popular gadgets, visuals of different kinds, perception of objects. For the coding of the project, C# language is used in Visual Studio 2017 integrated with Unity 3D.

5.1.3 Glossary

Term	Definition
Augmented Reality (AR)	Augmented reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are "augmented" by computer-generated or extracted real-world sensory input such as sound, video, graphics, haptics or GPS data [32]
Stakeholder	A person who has interest or concern in the project
War Room	A term represents the decision and development phase in a meeting room while a software is producing by a team.
Onboarding	The process of incorporating new employees into an organization [24]
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Workflow	The series of activities that are necessary to complete a task [34]
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Software Management	Managing software processes by planning and leading. [35]
Dashboard	An interface that monitorize some tools and information from multiple sources [36]
Framework	A real or conceptual structure intended to serve as a support or guide for the building of something that expands the structure into something useful [37]
Technical Debt	The consequence of implementing partial or quick software development solutions instead of time-consuming, yet more effective, long-term solutions [43]
Scrum Board	Visual display of the progress of the Scrum team during development process [39]

Table 1 Glossary of SDD

5.1.4 Overview of document

The SDD is divided into subsections with numbers. Chapters and their brief content is explained below.

Section 2 is the Architectural Design that explains the general architecture of the system by class diagram, activity diagram and design elements of the system.

Section 3 demonstrates the Use Case Realizations. It contains the general GUI design of the system, block diagram of the use cases that is described in the SRS document.

Section 4 contains Graphical Interface Design which explains the design of the system which the user uses.

Section 5 is the references that are used in the document. (In this document references are in “References” part)

5.1.5 Motivation

As computer engineering students who are enthusiastic about the new technologies and new aspects in today's fast changing technology world, we started to encounter with the term augmented reality more. While researching about augmented reality, we find out this technology is emerging in many different areas. Since we all will work in software development phases in our career, we want to make development process easier and more functional for software developers, especially for the ones who are new to the environment. After our research about augmented reality, we realized there is lack of study about AR and onboarding of software engineers and decided that combining these two areas will make the software engineers more motivated and more engaged to their work when they start to work in a new environment or a new project. Our aim is making onboarding process more efficient with the use of augmented reality by making some virtual visualization in the office environment.

We have chosen Vuforia which is the tool that has the most resources online in augmented reality are recently. Also, it has a plugin to Unity 3D platform which is the most popular game engine with its 3D graphics and compatibility with all different platforms and devices.

5.2 Architecture Design

5.2.1 System Design Approach

During development process of this project we are planning to use scrum, which is an agile development methodology. Due to volatile requirements, agility is important for project development. In contrast to traditional software development, scrum is an agile methodology, which is incremental and iterative. Development process consists of sprints that include its own task to be performed. Each sprint has equal iteration time 30 days on average. In daily, development team has meeting less than 15 minutes, which is called daily stand up meeting. In scrum, there are three main roles that are product owner, scrum master and development team. Product owner demands requirements; scrum master manages the process and development team. And the development team has the role of working on project according to plan. The advantages of scrum can be summarized as follows; First of all, as a result of agility, changes that happened in development process can handled easily. In addition to that, problems, which occur during process, can be negotiated immediately due to daily stand up

meetings [39]. Furthermore, agility is a high priority for our AR application, since AR is a new technology for industry. The examples and resources are not enough to analyze or observe the development phase of an AR application**.** Therefore, many problems can occur during development process due to lack of experience. Instead of getting the fully worked product at the end of the development phase, producing small working parts of the system will be more beneficial to decrease the technical debt [43]. In the light of these facts, to take the advantage of early diagnosis of problems, and control the process properly, scrum is suitable for development of this project.

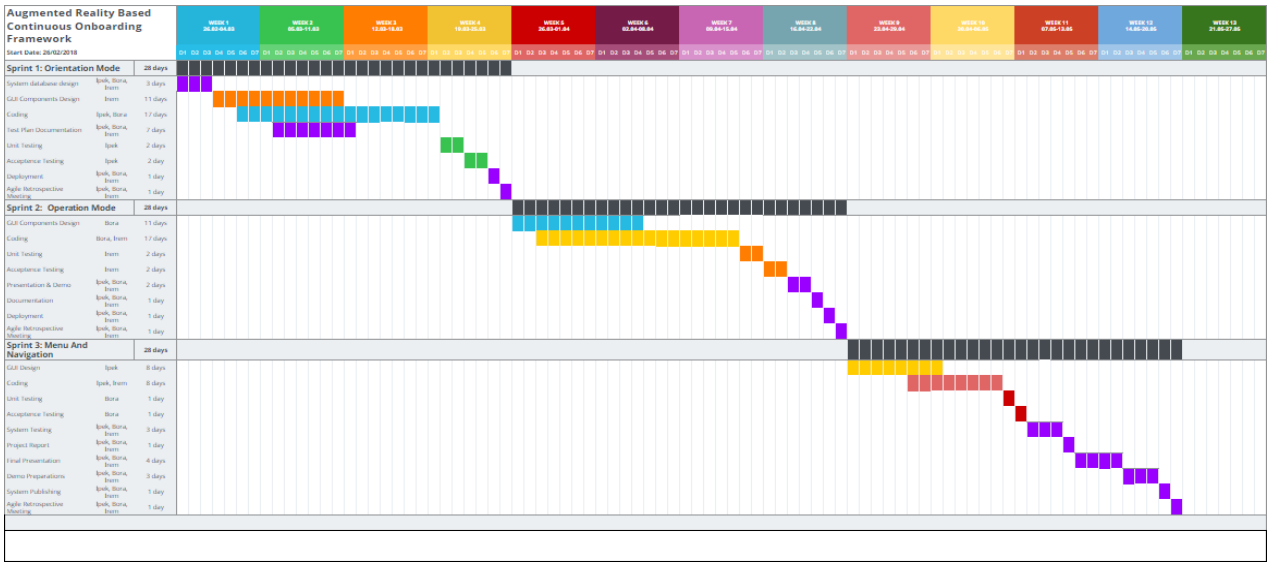

Figure 1 Work Plan

The tasks in the work plan (Figure 1) as follows;

The first process, which is not included in this work plan, was the researching and project specification phases. In that process, information about the related issues and projects related to this subject was investigated. We investigated: augmented reality in education, augmented reality in tourism, augmented reality in defense, automotive, entertainment fields, in marketing-sales, three-dimensional modeling, features of Vuforia and Unity3D software. After these investigations, we worked on feasibility of this project. We conducted meetings with company employees to determine the basic functions and specifications about project. After those meetings, we prepared documentations about requirements and design of the project.

After field researching and requirement analysis phases, with sprint 1, we will start to develop our project. In sprint 1, mainly we will work on “Orientation Mode” of our project. Firstly, we design system database. After that, GUI components will be designed. Coding will

follow the design. Then, current working product will be tested. When tests are also done, product will be deployed. After all these steps, at the end of the sprint we will conduct agile retrospective meeting to improve development process. With sprint 1, we will get a version of the application that can perform orientation mode.

In sprint 2, mainly we will work on the “Operation Mode” which is another main screen of our project. In this sprint, first job is again designing GUI components of the screen. Coding will follow the design. Then, current working product will be tested. When tests are also done, product will be deployed. After all these steps, at the end of the sprint we will conduct agile retrospective meeting to improve development process. With sprint 2, we will get a new version of the application that can perform orientation mode and operation mode.

Last of all, in sprint 3, we will implement menu and navigation components such as login screen, pause menu, main menu of our application. To do this, first job is designing GUI components of the screens. Coding will follow the design. Then, current working product will be tested. This sprint is the last one, therefore when it is completed, we will have final product. Before finishing the process, we test whole system and after these tests succeeded and completed we publish our application. And last of all we will conduct agile retrospective meeting to discuss what we have done with good and bad sides.

5.2.1.1 Class Diagram

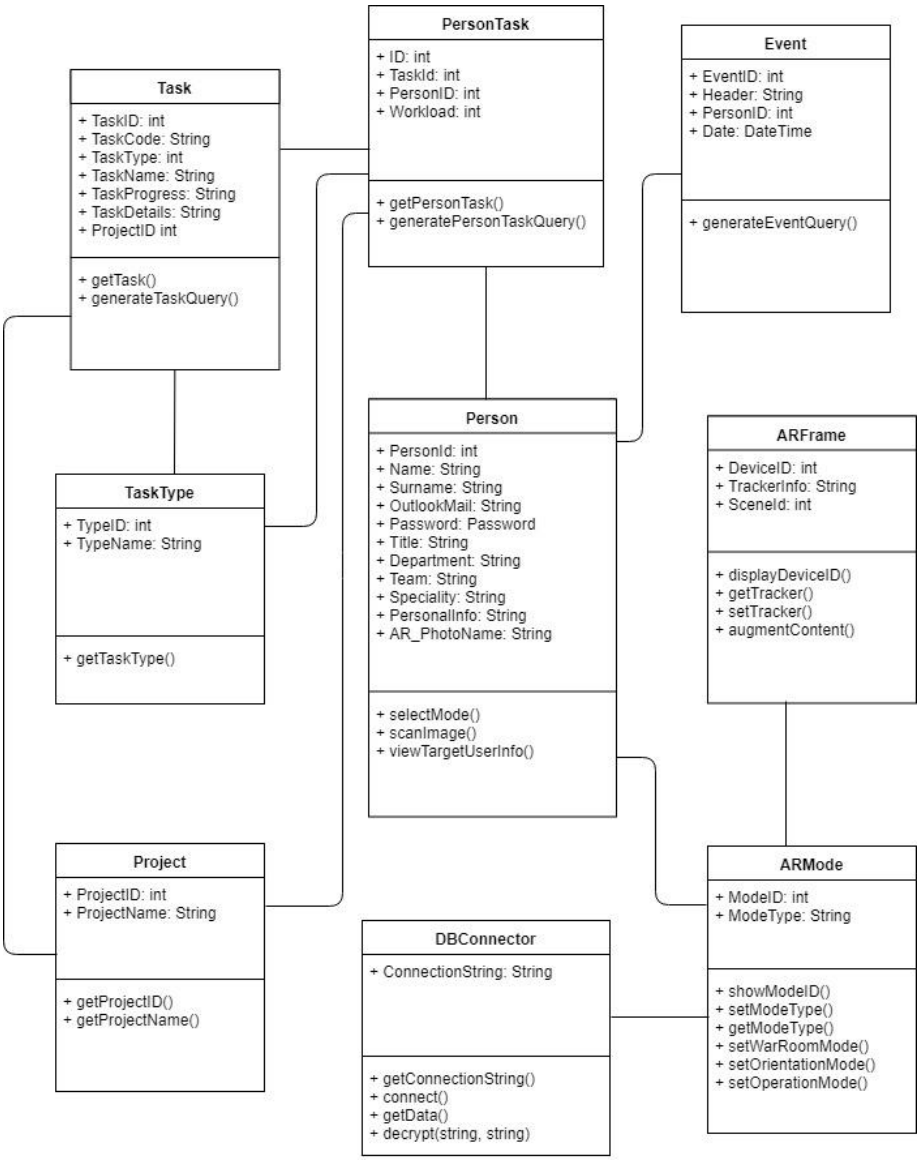

Figure 2 Class Diagram

Figure 2, displays the information about the connections between system attributes. System performs the task according to the modeID in AR Mode class. AR Mode class manages the mode that the system will work according to user's selection. Person class is the class that represents functions of the actor of the system. User selects a mode and views the information about the object according to the type of the objects which are either another user or a project. AR frame tracks environment in both modes. This class gets the information about scanned image and creates the augmented content. AR Anchor class is incorporated with AR Frame and according to the augmented content from AR Frame, it locates the content according to world location.

DBConnector class provides the required data information from the data sources that the system uses. According to the AR Mode operations, corresponding data is retrieved from the data source.

5.2.2 Architecture Design of System

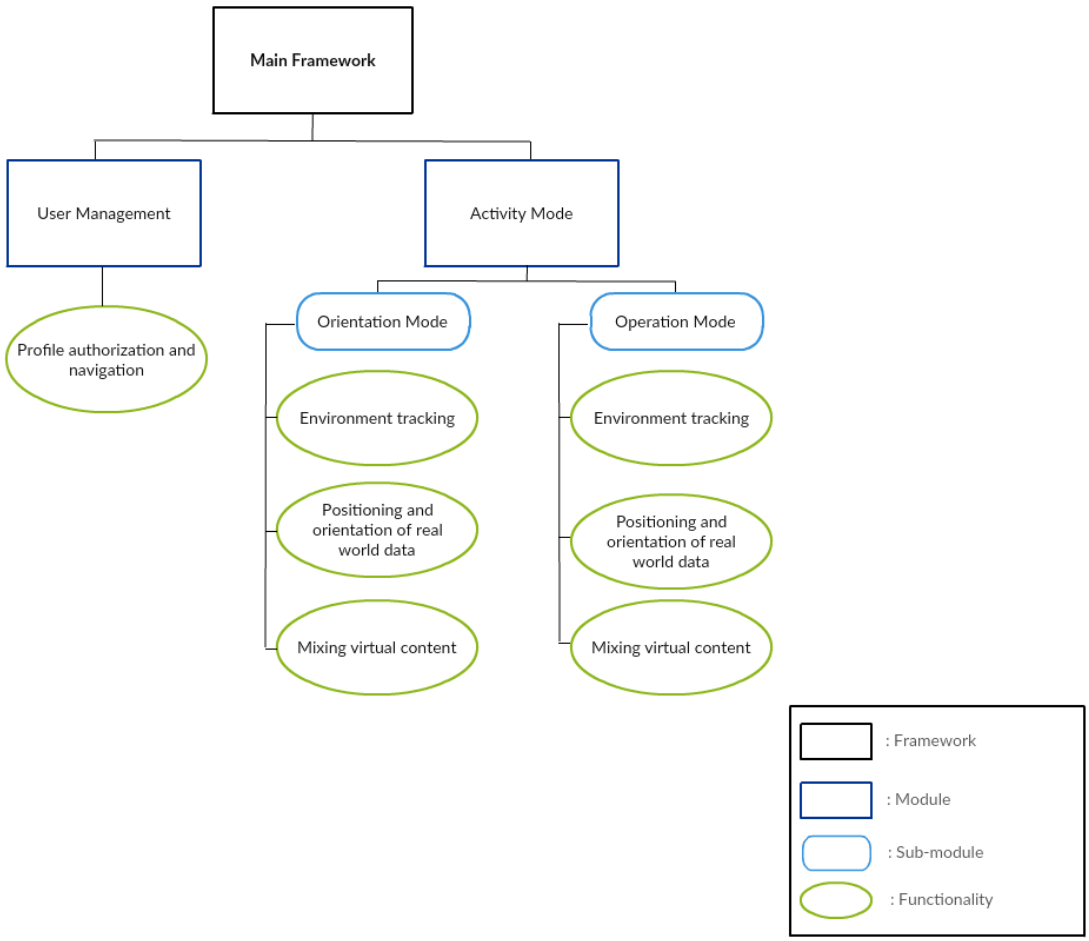

Figure 3 Modularization of System

According to structured modularity in Figure 3, system consists of two main modules which are user management module and activity mode module. User management module contains the functionality of profile authorization which controls and navigates users through system usage lifetime. The second module is activity mode module which comprises orientation mode and the operation mode of the system. These two submodules have their

own functionalities as environment tracking, positioning and orientation of real world data and mixing virtual content.

In augmented reality, we change the real-world data with adding some virtual data and represent this mixed content to user. AR mechanism begins to work with getting the real-world data through camera or sensors. After that, positioning and adaptation are done, and data is ready to be processing. Processing of the data is the most crucial part for developing an AR application. Changing the real-world data is done in this step and mixed with virtual information. In the last step, content of mixed reality is represented to the user as video output.

5.2.2.1 User Management

This system is available for company workers only. Standard users are the developers who working on software development. Developers can login, use orientation and operation mode, and exit from the system. First, user should run the application and login page is opened first. User is expected to be registered to the system by system coordinator who manages the database of the company so that he/she can login to the system. By inputting a valid username and password, user logins to the system and navigated to related page according to her/his authorization rights. Developers are navigated to mode selection page and from there they can continue with orientation mode or operation mode. Users can exit from the system with selecting exit option. When there is a database connection error, system can fail to login with giving an exception error with description.

5.2.2.2 Activity Mode

5.2.2.2.1 Orientation Mode

This screen is available for developers only. In this mode, user can access the profile information of the developer by scanning the unique image which belongs to selected developer. User must be logged in and switched to the orientation mode before accessing. Camera screen is opened, and environment is observed from the screen and application does environment tracking functionality. User basically tries to determine an AR target to get an information about a person. After determining a target, user scan the unique image which belongs to the target developer to get information about her/him. User sees these information on the screen mixed with augmented reality components. After information is seen, user can

scan a new image or can exit from the orientation mode by selecting exit option. When there is a database connection error, system can fail to login with giving an exception error with description.

5.2.2.2.2 Operation Mode

In this mode, user can access the information about the work items which are defined in current sprint by scanning the unique image which belongs to selected task. User must be logged in and switched to virtual system dashboard mode before accessing. Camera screen is opened, and environment is observed from the screen and application does environment tracking functionality. By scanning the related image, data about the task will be displayed on the camera screen. If user wants to see more detailed information about task, s/he can open TFS (Team Foundation Server) link of selected task on the web browser by clicking the task code. In addition to task status, user can observe his team mates' current task information by scanning the unique person image. Current task information of a developer includes statistical data about task types which he works on as feature, improvement or bug and total workload of identified developer. Also, in the situation of task sharing, system shows shared tasks of current user and selected developer. User can exit from the operation mode by selecting exit option.

5.2.3 Activity Diagram

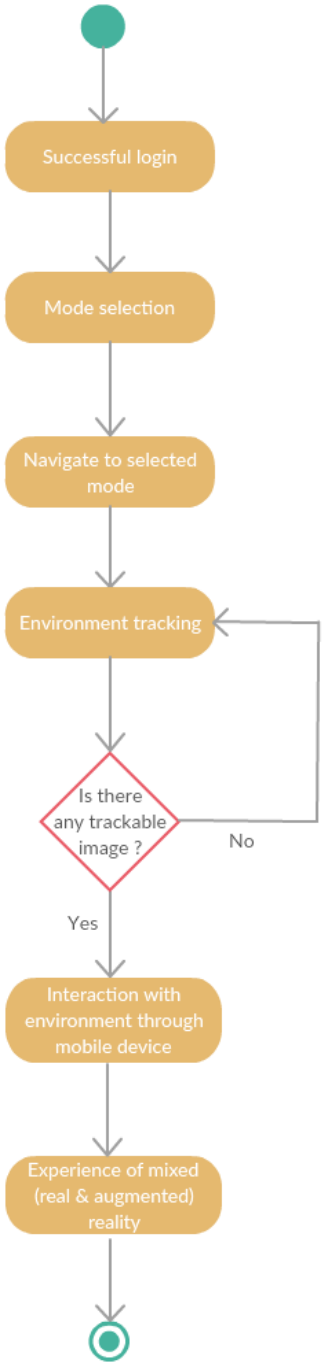

Figure 4: Activity Diagram

Figure 4 shows how the system works as an activity diagram. When the user opens the application, login form will open. After a successful login, user chooses the mode to use the system whether Orientation Mode or Operation Mode. After the mode is selected, user navigates the system according to selected mode. After the mode is selected, AR functions are

involved. Environment tracking is started. The environment that the camera sees is seen on the screen until a unique trackable image that is in the AR database is detected. If the trackable image is detected, interaction with the mobile device and the environment is started. Corresponding data is retrieved from the servers and these data is placed to the environment by the AR anchors which gets the world location and place the components into that location. After that, mixed reality experience is started, and user sees the real environment with the augmented reality components through the camera screen.

5.3 Use Case Realizations

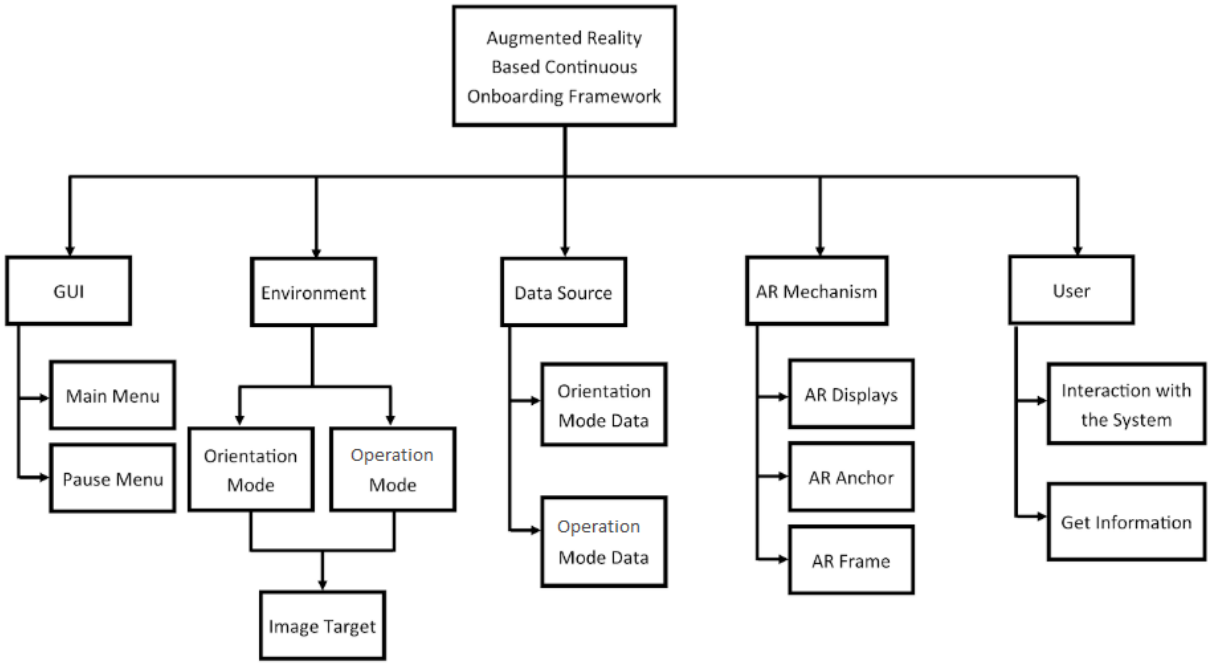

Figure 5 Use Case Realization Diagram

5.3.1 Brief Description of Figure 5

Components of Augmented Reality Based Continuous Onboarding Project are shown in Figure 5. The designed systems of the simulation are displayed in the block diagram in the figure. There five main components of the system and their sub-modules.

5.3.1.1 Graphical User Interface (GUI)

GUI module consists of the general design of the system. It manages and guides the user interactions with the system. There are two submodules of it and these are Main Menu

that guides the user in the system and Pause Menu that when the system is waiting for the response of the user.

5.3.1.2 Environment

Environment module represents the environment that the application is used. There are two submodules of environment and these are Orientation Mode and Virtual System Dashboard Mode. Orientation Mode takes place in the office environment and Virtual System Dashboard Mode takes place in meeting room. Also, their submodule is Image Target which is placed in the real environment for AR frame to detect and get the information.

5.3.1.3 Data Source

Data source module consists of the data that the system retrieves from servers to use in the two modes of the system. These modes are Orientation mode and Operation Mode. The data that is needed changes according to these modes. Therefore, there are two submodules of Data Source module.

5.3.1.4 AR Mechanism

AR Mechanism module is responsible for the functionalities of an augmented reality system. Its submodules are AR Frame, AR Anchor, and AR Displays. AR Frame tracks environment to detect an AR target. AR Anchor gets the locations and locates the AR displays according to world location.

5.3.1.5 User

User module is to determine the abilities of user. User can interact with the system using the functions of its class. After these interactions user gets the desired information from the system.

5.4 Graphical Interface Design

In this project, some augmented reality based virtual objects, texts, and etc. are placed on the screen of a device via the camera as if the objects were in the real environment.

5.4.1 Overview of Interface

User enters to the system from his/her account. After login, the camera screen opens, and the actual environment is seen through the camera on the screen. There are some instructions on the screen to guide the user. First, user chooses whether the application will be on “Orientation Mode” or “Operation Mode” by touching the screen. User follows the office environment from the screen.

5.4.1.1 Orientation Mode Design

If the system is on the Orientation Mode, user looks for the identifier image on the employees' desks. When an image has matched from the database of the system, there will be seen a virtual button to extend the information about the owner of the desk. If the user presses that button to extend, first thing user sees is photograph, name, position, team, some personal information, specialty and current works of the person, that is the owner of the identifier image and position and department that he works on.

5.4.1.2 Operation Mode Design

If the system is on the Operation Mode, user can scan the identifier image of a work item on the scrum board or a unique person image. The panel which appears on the screen differs according the recognized image. If the image belongs to a task, screen panel shows the summarized information about the task as text through camera screen. In addition, if user wants to see more detailed information about task, s/he can open TFS (Team Foundation Server) link of selected task on the web browser. If the image belongs to a developer, the summarized information about to current task status of the developer will be displayed through camera screen.

5.4.2 Screen Images

Picture 1: Sample interface from the Orientation Mode

In the Orientation Mode, when user scans the unique image of some colleague and continues with the show information button, a window like Picture 1 that has the entries about selected developer's photograph, name, title, department, team, some personal information, specialty and current works of the person. Picture 1 is an interface sample that we planned to use as the general screen design when the target image of a developer is scanned and identified in Orientation Mode.

Picture 2: Sample interface from the Operation Mode

Picture 3: Sample interface from the Operation Mode

In the Operation Mode, there two possible screens, one of them includes data about task, and the other one includes data about current task status of a developer. When the recognized image belongs to a task, screen panel shows the summarized information about the task (Picture 2). When the recognized image belongs to a developer, the summarized information about to current task status of the developer will be displayed through camera screen (Picture 3).

6 TEST PLAN, TEST DESIGN SPECIFICATIONS & TEST CASES

6.1 Introduction

6.1.1 Version Control

Version No	Description of Changes	Date
1.0	First Version	March 13, 2018
1.1	Updated According to SDD Document	May 2, 2018

6.1.2 Overview

Use cases, graphical user interface features, system functionalities, and usability factors of Augmented Reality Based Continuous Onboarding Framework is planned to be tested. All the components of the project are going to be tested incrementally after a sprint [1] is finished and after all the components are completed, system will be tested.

6.1.3 Scope

This document includes the test plan, test design specifications and the test cases correspond to the test plan of the project named Augmented Reality Based Continuous Onboarding Framework.

6.1.4 Terminology

Acronym	Definition
AR	Augmented Reality
GUI	Graphical User Interface
SRS	Software Requirements Specification
SDD	Software Design Description

6.2 Features to be Tested

There are five main parts and they have some subfeatures that need to be tested. and this section lists and gives a brief description of all these major features to be tested. For each major feature there will be a Test Design Specification added at the end of this document.

6.2.1 Graphical User Interface

Graphical User Interface contains all the visual components that the user sees and uses in the system. There are texts, buttons, images, videos, panels, and some other visual objects seen while using the system. For this feature, each GUI component will be tested individually whether they are placed correctly on the screen and whether they provide the correct functionality that is expected.

6.2.2 Login Operation

User logins to the system from the login page. After the user inputs username and password, validation check is done, after valid inputs user starts to use the system.

6.2.3 Orientation Mode

In this mode, user can access the profile information of the developer by scanning the unique image which belongs to selected developer. For every developer, a unique image is defined and exists in the system database and the information of the corresponding developer is reached from the data source servers. During lifetime of the system, database connection should always be awake to retrieve data.

6.2.4 Operation Mode

In this mode, user can access the information about the scrum board by scanning the unique image which belongs to selected task item. For every task item in scrum board, a unique image is defined and exists in the system database. By scanning the related image, data about the item which was saved on this board will be displayed on the camera screen. Also, in this mode, unique images of the people that work in that project can be scanned to the camera and task information for that person is displayed. During lifetime of the system, data source connection should always be awake to retrieve data.

6.3 Item Pass/Fail Criteria

In this section, the general rule to use to decide when a test case passes and when it fails is described.

6.3.1 Entry Criteria

Below conditions must be satisfied before the project will accept the testing.

- 100% of the determined features in SRS and SDD document should be implemented.

6.3.2 Exit Criteria

Under the below conditions the testing of the product is considered successful.

- 100% of the test cases are executed
- 95% of the test cases passed
- All High and Medium Priority test cases passed

6.4 References

1. CENG408_Group1_SRS_V3.0, May 01, 2018
2. CENG408_Group1_SDD_V3.0, May 01, 2018

6.5 Test Design Specifications

6.5.1 Graphical User Interface (GUI)

6.5.1.1 Subfeatures to be Tested

6.5.1.1.1 Login Button (GUI.L_BTN)

User should login with his valid username and password to use the system. After "Login" button selected, information that user entered checked from database and user is navigated to main menu.

6.5.1.1.2 Login Page Quit Button (GUI. LP_QT_BTN)

User can close the application when the "Quit" option is selected on the login page.

6.5.1.1.3 Main Menu Orientation Mode Button (GUI.MM_OM_BTN)

User can start the orientation mode when the "Orientation Mode" option is selected from the main menu.

6.5.1.1.4 Main Menu Operation Mode Button (GUI.MM_OPM_BTN)

User can start the Operation Mode when the "Operation Mode" option is selected from the main menu.

6.5.1.1.5 Main Menu Quit Button (GUI.MM_QT_BTN)

User can quit from the application when the "Quit" option is selected on the main menu.

6.5.1.1.6 Main Menu Logout Button (GUI.MM_LO_BTN)

User can log out from the system when “Logout” is selected from the main menu and all the information of the user is cleared from the system and system directed to the login page until a new login operation is completed.

6.5.1.1.7 Mode Pause Button (GUI.MPS_BTN)

User can press the back or escape button to display the pause menu.

6.5.1.1.8 Pause Menu Resume Button (GUI.PM_RES_BTN)

User can go back to last scene when the “Resume” option is selected on the pause menu.

6.5.1.1.9 Pause Menu Main Menu Button (GUI.PM_MM_BTN)

User can go to system main menu when “Main Menu” option selected on the pause menu.

6.5.1.1.10 Pause Menu Quit Button (GUI.PM_QT_BTN)

User can quit from the application when the “Quit” option is selected on the pause menu.

6.5.1.1.11 Orientation Mode Related Data Display (GUI.OM_DATA_DISP)

User can see the related data about the developer after the image marker of the selected developer is recognized. The information is in the form of video and text.

6.5.1.1.12 Operation Mode Related Data Display (GUI.OPM_DATA_DISP)

User can see the related data about the task after the image marker of the task item is recognized. The information is in the form of text.

6.5.1.2 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.L_BTN.01	3.2.1	H	Select “Login” button. After selecting, application redirects user to main menu.

TC ID	Requirements	Priority	Scenario Description
GUI. LP_QT_BTN.01	3.2.1	L	Select “Quit” button. After selecting, application will close.

TC ID	Requirements	Priority	Scenario Description
GUI.MM_OM_BTN.01	3.2.2	H	Select “Orientation Mode” button from main menu. After selecting, application redirects user to orientation mode.

TC ID	Requirements	Priority	Scenario Description
GUI.MM_OPM_BTN.01	3.2.2	H	Select “Operation Mode” button from main menu. After selecting, application redirects user to operation mode.

TC ID	Requirements	Priority	Scenario Description
GUI.MM_QT_BTN.01	3.2.2	L	Select “Quit” button from main menu. After selecting, application will close.

TC ID	Requirements	Priority	Scenario Description
GUI.MM_LO_BTN.01	3.2.2	M	Select “Logout” button from main menu. After selecting, session data deleted and application redirects user to login page.

TC ID	Requirements	Priority	Scenario Description
GUI.MPS_BTN.01	3.2.3	M	Press back or escape button of the device. After pressing, application redirects user to pause menu.

TC ID	Requirements	Priority	Scenario Description
GUI.PM_RES_BTN.01	3.2.3	H	Select “Resume” option from the pause menu. After selecting, application continues to run on the current mode that is selected.

TC ID	Requirements	Priority	Scenario Description
GUI.PM_MM_BTN.01	3.2.3	M	Select “Main Menu” option from the pause menu. After selecting, application redirects the user to Main Menu.

TC ID	Requirements	Priority	Scenario Description
GUI.PM_QT_BTN.01	3.2.3	L	Select “Quit” option from the pause menu. After selecting, application will close.

TC ID	Requirements	Priority	Scenario Description
GUI.OM_DATA_DISP.01	3.2.4	H	Scan an employee image while the application is on Orientation Mode. After scanning a valid image marker, video and texts are displayed on the screen which are accurate with

			system database.

TC ID	Requirements	Priority	Scenario Description
GUI.OPM_DATA_DISP.01	3.2.5	H	Scan a task image while the application is on Operation Mode. After scanning a valid image marker, texts are displayed on the screen which are accurate with system database.

TC ID	Requirements	Priority	Scenario Description
GUI.OPM_DATA_DISP.02	3.2.5	H	Scan a target image of a person while the application is on Operation Mode. After scanning a valid image marker, current tasks and shared tasks as texts are displayed on the screen which are accurate with system database.

6.5.2 Login Operation (LO)

6.5.2.1 Sub features to be Tested

6.5.2.1.1 Standard user (LO_STD)

User should login to use the system with valid username and password. Login operation guarantees that only the authorized users can use the system.

6.5.2.2 Test Cases

TC ID	Requirements	Priority	Scenario Description
LO_STD.01	3.2.1	H	Enter valid username and password then select "Login" button. Application redirects user to main menu.
LO_STD.02	3.2.1	H	Enter invalid username or password then select "Login" button. Application gives warning and deletes user entry from login form.

6.5.3 Orientation Mode (OM)

6.5.3.1 Sub features to be Tested

6.5.3.1.1 Scan Image Target (OM_SIT)

While the application is on the Orientation Mode, camera screen is opened, and user scans the image marker that is specified for each individual person.

6.5.3.1.2 Play and Pause Informative Video (OM.PP_VID)

User can play an informative video of the person that the scanned image belongs to. User can play or pause the video.

6.5.3.2 Test Cases

TC ID	Requirements	Priority	Scenario Description
OM_SIT.01	3.2.4	H	Put device camera on the image target. After scanning and recognizing the target, application shows person information as video and text which are accurate with the system database.

TC ID	Requirements	Priority	Scenario Description
OM.PP_VID.01	3.2.4	H	Click “Play/Pause” button. Application plays informative video if it is stopped. Or, application stops video if it is playing.

6.5.4 Operation Mode (OPM)

6.5.4.1 Sub features to be Tested

6.5.4.1.1 Scan Task (OPM.ST)

User should scan the QR code of a task of the project at first to see any information about that task. The scanning is done with by device camera in the Operation Mode.

6.5.4.1.2 Scan Person Image (OPM.SPI)

User should scan the image of a person at first to see any information about the tasks information of that person. The scanning is done with by device camera in the Operation Mode.

6.5.4.2 Test Cases

TC ID	Requirements	Priority	Scenario Description
OPM_SP.01	3.2.5	H	Scan a task image on the Scrum board to see it’s detailed data. After scanning, application shows related data as text which are accurate with system data source.

TC ID	Requirements	Priority	Scenario Description
OPM_SPI.01	3.2.5	H	Scan an image of the person on Scrum board to see detailed data about the person. After scanning, application shows related data as text which are accurate with system data source.

6.6 Detailed Test Cases

6.6.1 GUI.L_BTN

TC_ID	GUI.L_BTN.01
Purpose	Performing login operation.
Requirements	3.2.1
Priority	High
Estimated Time Needed	5 Minutes
Dependency	Application should be started.
Setup	Application should be installed to the mobile device.
Procedure	[A01] Select “Login” button from home screen. [V01] Main menu will be displayed on the screen.
Cleanup	Exit

6.6.2 GUI. LP_QT_BTN

TC_ID	GUI.LP_QT_BTN.01
Purpose	Performing quit operation from the application.
Requirements	3.2.1
Priority	Low
Estimated Time Needed	2 Minutes
Dependency	Application should be started.
Setup	Application should be installed to the mobile device.
Procedure	[A01] Select “Quit” button from main menu. [V01] Application will close.
Cleanup	-

6.6.3 GUI.MM_OM_BTN

TC_ID	GUI.MM_OM_BTN.01
Purpose	Switching and starting the orientation mode screen.
Requirements	3.2.2

Priority	High
Estimated Time Needed	2 Minutes
Dependency	Main menu should be displayed.
Setup	Main menu screen should be prepared.
Procedure	[A01] Select “Orientation Mode” button from main menu. [V01] Orientation Mode screen will be opened.
Cleanup	Go back to main menu.

6.6.4 GUI.MM_OPM_BTN

TC_ID	GUI.MM_OPM_BTN.01
Purpose	Switching and starting the Operation Mode screen.
Requirements	3.2.2
Priority	High
Estimated Time Needed	2 Minutes
Dependency	Main menu should be displayed.
Setup	Main menu screen should be prepared.
Procedure	[A01] Select “Operation Mode” button from main menu. [V01] Operation Mode screen will be opened.
Cleanup	Go back to main menu.

6.6.5 GUI.MM_QT_BTN

TC_ID	GUI.MM_QT_BTN.01
Purpose	Performing quit operation from the application.
Requirements	3.2.2
Priority	Low
Estimated Time Needed	2 Minutes
Dependency	Main menu should be displayed.
Setup	Main menu screen should be prepared.

Procedure	[A01] Select “Quit” button from main menu. [V01] Application will close.
Cleanup	-

6.6.6 GUI.MM_LO_BTN

TC_ID	GUI.MM_LO_BTN.01
Purpose	Performing logout operation from the application.
Requirements	3.2.2
Priority	Medium
Estimated Time Needed	2 Minutes
Dependency	Main menu should be displayed.
Setup	Main menu screen should be prepared.
Procedure	[A01] Select “Logout” button from main menu. [V01] User session is deleted, and login screen will be displayed.
Cleanup	Exit

6.6.7 GUI.MPS_BTN

TC_ID	GUI.MPS_BTN.01
Purpose	Pausing the running mode.
Requirements	3.2.3
Priority	Medium
Estimated Time Needed	2 Minutes
Dependency	“Back” or “Escape” button should be displayed.
Setup	Application should be installed to the mobile device.
Procedure	[A01] Select “Back” or “Escape” button from device. [V01] Pause menu will open.
Cleanup	Go back to last application mode.

6.6.8 GUI.PM_RES_BTN

TC_ID	GUI.PM_RES_BTN.01

Purpose	Resuming and going back to last application mode.
Requirements	3.2.3
Priority	High
Estimated Time Needed	2 Minutes
Dependency	“Resume” button should be displayed on pause menu.
Setup	Pause menu should be prepared.
Procedure	[A01] Select “Resume” button on pause menu. [V01] Last application mode will continue to play.
Cleanup	-

6.6.9 GUI.PM_MM_BTN

TC_ID	GUI.PM_MM_BTN.01
Purpose	Going back to main menu from any application mode.
Requirements	3.2.3
Priority	Medium
Estimated Time Needed	2 Minutes
Dependency	“Main Menu” button should be displayed on pause menu.
Setup	Pause menu should be prepared.
Procedure	[A01] Select “Main Menu” button from pause menu. [V01] Main Menu will open.
Cleanup	Exit

6.6.10 GUI.PM_QT_BTN

TC_ID	GUI.PM_QT_BTN.01
Purpose	Quitting from application while any application mode is playing.
Requirements	3.2.3
Priority	Low
Estimated Time Needed	2 Minutes
Dependency	“Quit” button should be displayed on pause menu.

Setup	Pause menu should be prepared.
Procedure	[A01] Select “Quit” button from pause menu. [V01] Application will close.
Cleanup	-

6.6.11 GUI.OM_DATA_DISP

TC_ID	GUI.OM_DATA_DISP.01
Purpose	Showing person information in correct forms.
Requirements	3.2.4
Priority	High
Estimated Time Needed	3 Minutes
Dependency	Image marker should be scanned and recognized.
Setup	Data panel of orientation mode should be prepared.
Procedure	[A01] Scan image marker of any person. [V01] After recognizing image, data panel will open. [V02] Observe the person information is displayed on panel accurately.
Cleanup	Exit

6.6.12 GUI.OPM_DATA_DISP

TC_ID	GUI.OPM_DATA_DISP.01
Purpose	Showing task and person information in correct forms.
Requirements	3.2.5
Priority	High
Estimated Time Needed	3 Minutes
Dependency	Image marker should be scanned and recognized.
Setup	Data panel of operation mode should be prepared.
Procedure	[A01] Scan image marker of task of a project. [V01] After recognizing image, panel is opened with information. [V02] Observe the task information is displayed on panel accurately.

	[A02] Scan image marker of a person. [V03] After recognizing image, panel is opened with information. [V04] Observe the task information of the person that is displayed on panel accurately.
Cleanup	Exit

6.6.13 LO_STD

TC_ID	LO_STD.01
Purpose	Logging in to application.
Requirements	3.2.1
Priority	High
Estimated Time Needed	3 minutes
Dependency	Application should be started.
Setup	User should be existed in system database.
Procedure	[A01] Enter valid username to the related field of the login form. [A02] Enter valid password to the related field of the login form. [A03] Select “Login” button from home screen. [V01] Main menu will be displayed.
Cleanup	Exit

TC_ID	LO_STD.02
Purpose	Logging in to application.
Requirements	3.2.1
Priority	High
Estimated Time Needed	3 minutes
Dependency	Application should be started.
Setup	User should be existed in system database.
Procedure	[A01] Enter invalid username to the related field of the login form. [A02] Enter password to the related field of the login form. [A03] Select “Login” button from home screen. [V01] Observe “Incorrect login information” message.

	[V02] Login form entries will be cleaned.
Cleanup	Exit

TC_ID	LO_STD.03
Purpose	Logging in to application.
Requirements	3.2.1
Priority	High
Estimated Time Needed	3 minutes
Dependency	Application should be started.
Setup	User should be existed in system database.
Procedure	[A01] Enter valid username to the related field of the login form. [A01] Enter invalid password to the related field of the login form. [A01] Select “Login” button from home screen. [V01] Observe “Incorrect login information” message. [V01] Login form entries will be cleaned.
Cleanup	Exit

6.6.14 OM_SIT

TC_ID	OM_SIT.01
Purpose	Scanning image target to reach person information in orientation mode.
Requirements	3.2.4
Priority	High
Estimated Time Needed	5 Minutes
Dependency	Orientation mode should be opened.
Setup	Orientation mode should be implemented, and image marker database should be up to date.
Procedure	[A01] Focus camera to an image marker of a person. [A02] Scan the image. [V01] Observe person information panel is appeared. [V02] Check information is accurate and in the form of video and text.

Cleanup	Exit

6.6.15 OM.PP_VID

TC_ID	OM.PP_VID.01
Purpose	Playing the informative video about a person.
Requirements	3.2.4
Priority	High
Estimated Time Needed	2 Minutes
Dependency	Image marker should be recognized, and informative panel should be opened, and video is not playing.
Setup	Orientation mode should be implemented.
Procedure	[V01] Observe information panel is opened on screen. [A01] Click “Play/Pause” button once. [V02] Observe video has started.
Cleanup	Exit

TC_ID	OM.PP_VID.02
Purpose	Pausing the informative video about a person.
Requirements	3.2.4
Priority	High
Estimated Time Needed	2 Minutes
Dependency	Image marker should be recognized, and informative panel should be opened, and video is playing.
Setup	Orientation mode should be implemented.
Procedure	[V01] Observe information panel is opened on screen. [A01] Click “Play/Pause” button once. [V01] Observe video has stopped.
Cleanup	Exit

6.6.16 OPM.ST

TC_ID	OPM_ST.01
Purpose	Scanning image target to reach task information in Operation Mode.
Requirements	3.2.5
Priority	High
Estimated Time Needed	5 Minutes
Dependency	Operation Mode should be opened.
Setup	Operation Mode should be implemented, and image marker database should be up to date.
Procedure	[A01] Focus camera to an image marker of a QR Code of a task on the board. [A02] Scan the image. [V01] Task information panel will open. [V02] Observe task information is appeared.
Cleanup	Exit

6.6.17 OPM.SPI

TC_ID	OPM.SPI.01
Purpose	Scanning image target to reach task information of a person in Operation Mode.
Requirements	3.2.5
Priority	High
Estimated Time Needed	5 Minutes
Dependency	Operation Mode should be opened, and an image marker is recognized.
Setup	Operation Mode should be implemented.
Procedure	[A01] Focus camera to an image marker of a QR Code of a task on the board. [A02] Scan the image. [V01] Person task information panel will open. [V02] Observe task information is appeared.
Cleanup	Exit

6.7 Traceability Matrix

	Requirements	Login	Exit	Switch Orientation Mode	Switch Operation Mode	Logout	Resume	Open main menu	Scan image marker	Pause
Test Cases										
GUI.L_BTN.01		X								
GUI.LP_QT_BTN.01			X							
GUI.MM_OM_BTN.01				X						
GUI.MM_OPM_BTN.01					X					
GUI.MM_QT_BTN.01			X							
GUI.MM_LO_BTN.01						X				
GUI.MPS_BTN.01										X
GUI.PM_RES_BTN.01							X			
GUI.PM_MM_BTN.01								X		
GUI.PM_QT_BTN.01			X							
GUI.OM_DATA_DISP.01									X	
GUI.OPM_DATA_DISP.01									X	
LO_STD.01		X								
LO_STD.02		X								
LO_STD.03		X								
OM_SIT.01									X	
OM.PP_VID.01									X	
OM.PP_VID.02									X	
OPM_ST.01									X	
OPM.SPI.01									X	

Table 1: Traceability Matrix

The traceability matrix in Table 1 includes all proposed requirements with test cases. Each test case has a relation with some requirement. This traceability matrix is used to check all test cases whether they are covered and none of the functional requirements is missing during the implementation.

7 COMPILATION & INSTALLATION GUIDE

7.1 Introduction

This document is the installation and compilation document for the project titled as "Augmented Reality Based Continuous Onboarding Framework". This system is an application that assists developers to adopt more easily to their working environment, and ultimately improve the software development process and work more efficiently.

Augmented Reality Based Continuous Onboarding Framework project is developed using Unity 3D Game Engine and Vuforia tool for augmented reality support. Language that is used for coding is C#. This project is developed to run on Android mobile devices.

7.1.1 Purpose

Purpose of this document is to explain how to install and compile the project called Augmented Reality Based Continuous Onboarding Framework. Required tools and conditions are explained in detail.

7.2 Compilation

7.2.1 Prerequisites / Tools

There are some prerequisites to install and run the project on a computer. Project is developed on platform Unity.

- Unity 2017.3.1f1 should be installed on the computer to run and compile the project. Other versions of Unity can cause some problems, since the project is developed with the features of 2017.3.1f1. This version of Unity is integrated with Vuforia, so while installing that Unity version *Vuforia Augmented Reality Support* should be chosen on the *Components* section.
- Since the project will run on Android devices, Android Studio should be installed to create *.apk* file from Unity.

7.2.2 Downloading the Project

Final version of the project is available at the link:
https://github.com/CankayaUniversity/ceng-407-408-project-augmented-reality-alp-and-framework/releases/tag/v1.0.1

It can be downloaded as a *.zip* file. Extract the files from *.zip* folder.

7.2.3 Opening the Project in Unity

- Open Unity.
- When Unity is opened, at home page click *Open* and then choose the *SeniorProject-AR* folder from the downloaded project folder.
- After the project is set and opened in Unity, from Assets folder, as seen in Figure 1, choose *Login* scene to start using the program from the beginning.

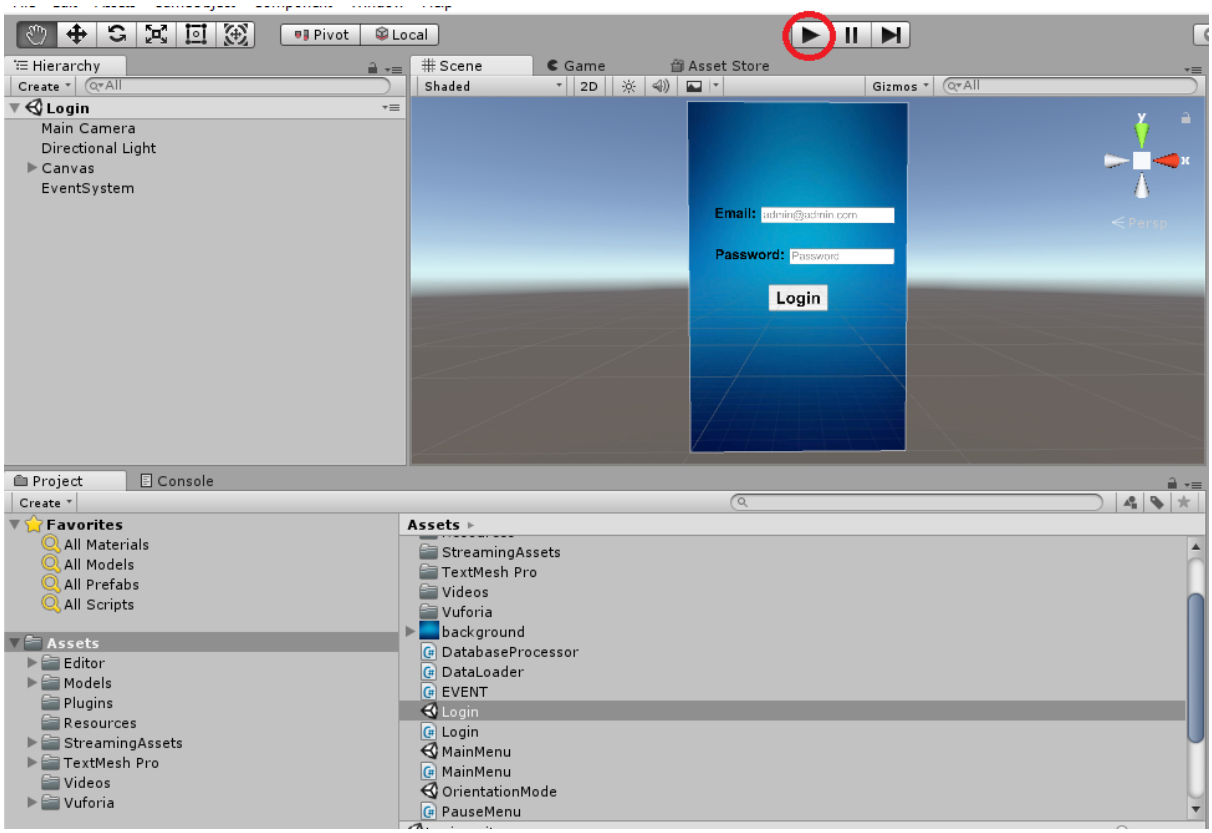

Figure 1: Unity page to run the program

- After the Login scene is chosen, press the Play button from the top, which is shown by a red circle in Figure 1. Then, program is built and run. (*)

7.2.4 Creating .apk File for Android Devices

System is run on Android devices; therefore, to transfer the project into Android devices, .apk file should be created. Android Studio should be installed in the computer to create the .apk file from Unity.

- Choose File -> Build Settings

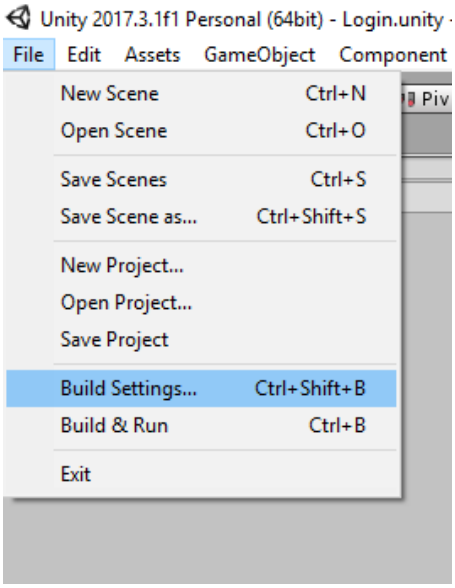

Figure 2: Opening build settings

- Connect your Android device to the computer.
- All the scenes in *Scenes In Build* panel must be checked and ordered as seen in the Figure 3.
- From *Platform* panel, choose *Android* and press *Switch Platform* button.
- After switch operation is completed, press *Build and Run* button.
- In the opening window, enter name of the *.apk* file.

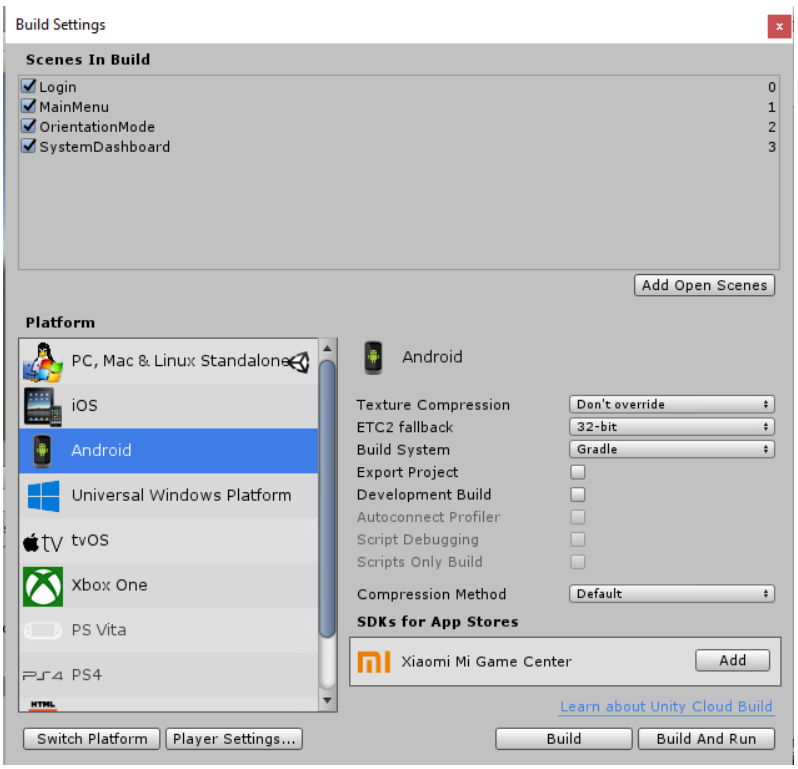

Figure 3: Build Settings

- *.apk* file is created and application is run on the android device after building is completed.

7.3 Installation

From the guide above, created .apk file can be transferred to an Android device by simply dragging and copying the file.

Also, from the link below, .apk file can be downloaded. After the file is downloaded, it can be copied to the Android device and it is ready to run on the device.

https://github.com/CankayaUniversity/ceng-407-408-project-augmented-reality-alp-and-framework

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** For further information about the system, please check the project page.*

https://github.com/CankayaUniversity/ceng-407-408-project-augmented-reality-alp-and-framework

8 USER MANUAL

8.1 About This Document

8.1.1 Intended Audience

This document is intended to be used by developers, testers, team leaders and all other employees in the Havelsan Inc. This document will be used in concert with the Augmented Reality Based Continuous Onboarding Framework in order to guide the users about the usage of the system.

8.1.2 Additional Augmented Reality Based Continuous Onboarding Framework Documents

- For detailed information about the requirements of the system, see Augmented Reality Based Continuous Onboarding Framework Software Requirements Specification (SRS).
- For detailed information about the design of the system, see Augmented Reality Based Continuous Onboarding Framework Software Design Document (SDD).
- For detailed information about the test plan and test cases of the system, see Augmented Reality Based Continuous Onboarding Framework Test Design Specification (TDS).

All of these documents are available at: augmentedrealitybcof.wordpress.com/documentation/

8.1.3 System Requirements

- Android OS 4.4+
- ARMv7 CPU with NEON support or Atom CPU
- OpenGL ES 2.0+
- Internet connection

Note: '+' means later, higher versions

8.2 Overview of the Product

Augmented Reality Based Continuous Onboarding Framework is an augmented reality application that assists developers to adopt more easily to their working environment, and ultimately improve the software development process and work more efficiently. This is a system that will be used in the office environment to increase the communication between the newcomers with former employees and provide effective and efficient orientation process. Also, this system is used especially by Scrum development teams, to make the meetings and processes more effective by using augmented reality technology.

This system runs on Android devices, especially on Android mobile devices of the company employees. Employees should login to the system by their company accounts. System has 2 main modes which are Orientation Mode and Operation Mode. Switch between these modes are done by using a menu.

Orientation Mode is used for learning more information about the employees to create an easy communication with them.

Operation Mode has two different functions. One of them is to learn about people's tasks and shared tasks with the person himself. The other one is to learn about the tasks of a project by combining the Scrum board of the project with the augmented reality components using the data on Team Foundation Server.

8.3 Using the Augmented Reality Based Continuous Onboarding Framework

8.3.1 Download Augmented Reality Based Continuous Onboarding Framework

If you have not already downloaded the Augmented Reality Based Continuous Onboarding Framework application, you can download the apk from here:

https://github.com/CankayaUniversity/ceng-407-408-project-augmented-reality-alp-and-framework

8.3.2 Screens of the Project

8.3.2.1 Login

The system is only available for authorized people. To control the user access, there is a login mechanism in the application. Every user has a unique e-mail address and password which exist in system database. In this system, e-mail addresses and passwords are used as credentials for users.

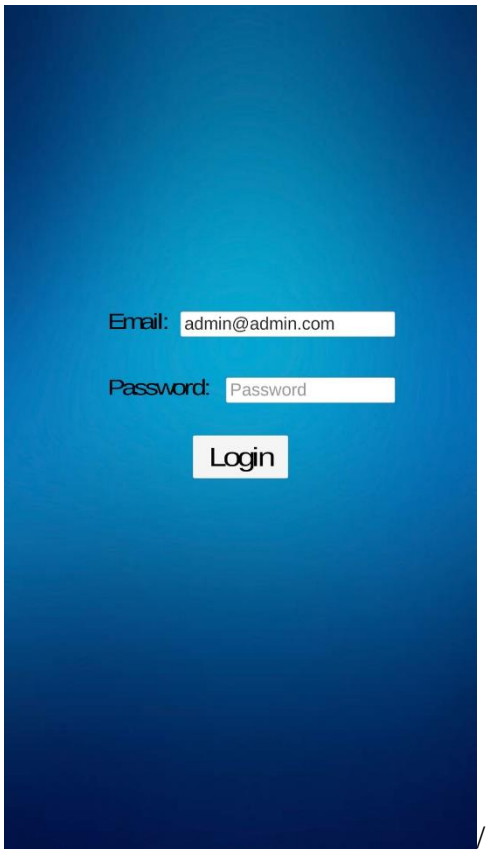

Figure 1: Login Screen

User Interactions

Name	Type	Explanation
Email	TextField	To access the system, user should fill the correct e-mail address which belongs the him/her.
Password	TextField	To access the system, user should fill the correct password which belongs the him/her.
Login	Button	After filling the e-mail and password fields, user clicks this button to enter the system.

Table 1: Login Screen User Interactions

8.3.2.2 Main Menu

After successful login operation, users are navigated to the main menu which includes mode selection buttons.

Figure 2: Main Menu

User Interactions

Name	Type	Explanation
Orientation Mode	Button	User can click this button to access the Orientation Mode of the system.
Operation Mode	Button	User can click this button to access the Operation Mode of the system.
Quit	Button	User can click this button to exit from application.

Table 2: Main Menu User Interactions

8.3.2.3 Orientation Mode

In this mode, user can access the information about his/her teammates. To get this information, user should catch the correct position to scan the unique image of selected teammate. After scanning the image target, system will recognize the image and informative

panel will appear through the device screen. User can learn about some professional and personal information about that person.

Figure 3: Orientation Mode

User Interactions

Name	Type	Explanation
Video Play/Pause	Button	User can click this button to play or pause the informative video about the person.
Pause	Button	User can click this button to pause the Operation Mode and open the pause menu.

Table 3: Orientation Mode User Interactions

8.3.2.4 Operation Mode

In this mode, user can access the information about the tasks which are defined in the current sprint. Also, in this mode, user can see the teammates workload. To get this information, user should catch the correct position to scan the image target. After scanning the image target, system will recognize the image and informative panel will appear through the

device screen. User can learn about task status or workload of his/her teammates depends on the image target.

Figure 4: Operation Mode Feature 1

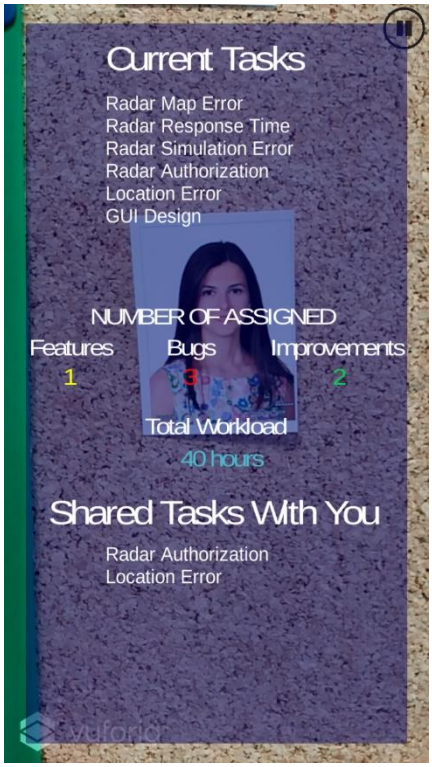

Figure 5: Operation Mode Feature 2

User Interactions

Name	Type	Explanation
Open in TFS	Button	User can click this button to open TFS link of the selected task on the default web browser.
Pause	Button	User can click this button to pause the Operation Mode and open the pause menu.

Table 4: Operation Mode User Interactions

8.3.2.5 Pause

User can stop the running mode and change his/her current mode or quit from the application.

Figure 6: Pause Menu

User Interactions

Name	Type	Explanation
Resume	Button	User can click this button to turn back the last running application mode.
Main Menu	Button	User can click this button to open the Main Menu.
Quit	Button	User can click this button to exit from application.

Table 5: Operation Mode User Interactions

9 CONCLUSIONS

This document includes extensive information about our project titled as "Augmented Reality Based Continuous Onboarding Framework". In this project, we have aimed to provide continuous onboarding to new coming software practitioners to make them more engaged to the new office environment. We used augmented reality technology on mobile phones and augmented reality-based devices. The purpose of selecting mobile phones as the main device is because we wanted this application to be reached and used by all the

workers on the company, since all individuals have their own mobile phone and they can access the system whenever they are in the office.

Augmented reality is a newly emerging technology. Vuforia which is the platform that we are developing our project is also a new tool that is still evolving. Therefore, there are definitely lack of information and examples to guide us. We have tried to find some large-scaled and similar AR projects as a reference, but we could not find a project apart from the demo videos or basic tutorials. Still, we learnt a lot of information about AR after researching different sources on the internet and after completing our literature search. After research part, we have planned a meeting with our stakeholders, and we have received the requirements. In the light of these idea exchanges and requirements we prepared SRS and after that we have identified some of the design information and explained them in SDD. We already have decided our development methodology and made a plan for our work packages for the development. We have created a basic prototype for our product according to the documents that we prepared.

The general disadvantage that we encountered is the lack of source about this technology. However, we got help from our advisors and internet sources. AR technology is an area that is getting wider and as an advantage, learning that area has been really beneficial for us in our future works, since there are not many people that knows about this technology yet. Other advantage for us is that, we do not have to use an external device, since we all have mobile phones. Also, Unity3D development environment is platform-free and the application that we create can be used in all kinds of devices. Therefore, our product is cost effective.

9.1 Code Metrics

Project is developed on Unity 3D platform using C# language in the scripts. After the implementation part is completed, metrics of the projects are assessed by a visualized code evaluation software which is called Understand. Understand is a tool that provides some information about codes of a project [44]. It can provide code metrics, reports, and graphs about a project.

We used Understand tool to observe some statistical data about our project. There are 3802 lines of code and 1483 lines of executable statements.

In Figure 1, dependencies between the classes of the project can be seen. For instance, Main Menu is dependent on Login page and Login operations are related with both Person and Database Processor classes. As seen on the graph, there not so many dependencies on the project and it affects the quality of code in a positive way so that, changes on the other classes not affect all the classes in the project.

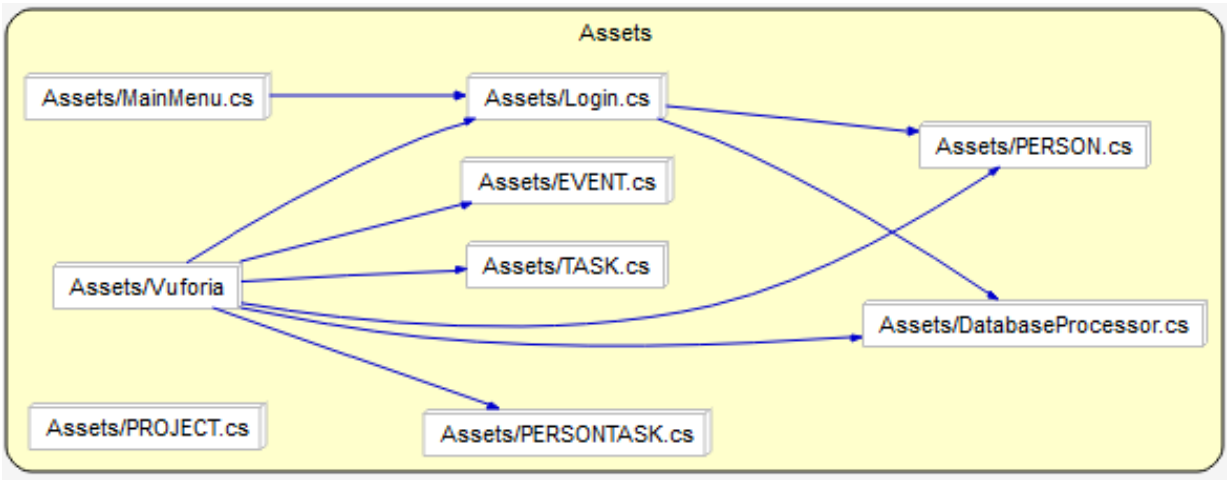

Figure 1: Dependency Graph of the project

In Figure 2, Cyclomatic Code Complexity graph from Understand is shown. Cyclomatic Complexity refers to linearly independent paths through a piece of code [45]. In other words, it measures the complexity in a quantifiable way. Higher cyclomatic complexity means the program is more complex and it gets harder to understand the code and risks are increased.

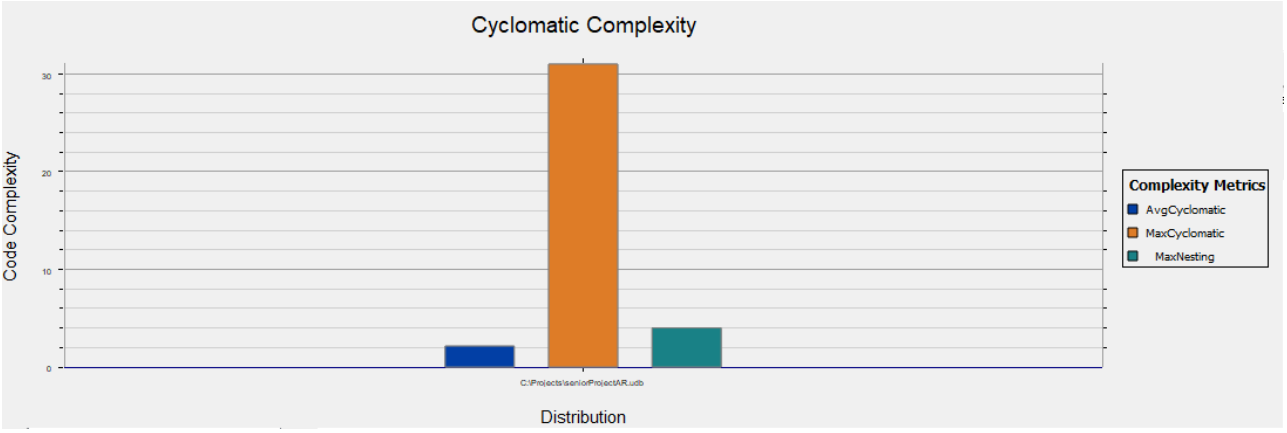

Figure 2: Cyclomatic Code Complexity

In this project (see Figure 2), average complexity is around 2 and the maximum complexity level that is calculated is 30. Average complexity being 2 means, the project has not complex code parts and it is generally easy to understand the code blocks. Also, risks are in an acceptable level.

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