Workplace Assistant Augmented Reality

[Progress Report]

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ABSTRACT

Starting a new job in an office can be very stressful for an intern or a new employee especially if it is their first day in office. It takes time to learn what other employees' job is and how they can be beneficial for you and your adjustment. It might take some time for new members to learn the rooms and their purpose within the office building, as well as to understand and learn on how to use certain equipment, for example an automatic key lock or simply a coffee machine. The Workplace Assistant Augmented Reality will try to understand who the user is, through user profiling and provide the necessary process for the user to learn and understand the information relevant to him or her. The application will guide the interns through a process adjusted just for them to get to know the people around them, the building and any relevant equipment which they might make use of on a day to day basis.It will have user profiling implemented along with object recognition techniques using Vuforia to overlay new information on the tablet or their mobile phones. The application will provide some navigation to guide them through the building as well as information on every office, the people who might be working in that office as well as some additional information such as how to use the automatic key lock. The main expected outcome is that the users will easily get adjusted to the workplace through a user friendly immersive experience, provided by the augmented reality application.

Keywords
Augmented Reality, Workplace, Vuforia, User Profiling

1. INTRODUCTION
New employees and interns at several companies might be facing adaptability problems to new environments they find themselves in at work. The first month at the workplace might seem overwhelming especially if one is also trying to get used to the way they program and develop. The application will provide user profiling to identify why the user is making use of the application, and assisted information is provided to adjust to the workplace. The application will generally be used by new employees, interns and any workplace visitors. The receptionist may provide them with a tablet or a phone for them to navigate their way around the building. It could provide the interns with a short tour and procedure on who to speak with first and how to get to know other employees at work. This application could be very beneficial to shy interns, as it would avoid the intern with having to interact with a lot of people at once. It can also be beneficial for the receptionist, as it can help her deal with many new visitors at the same time, while she continues her usual work, without much interruptions. The application will run on a tablet or phone provided by the company. It is expected to run not so regularly, as very few new visitors visit the workplace, and interns join once or twice every year. It might be regularly used by the interns until they fully adjust to the place. The expected outcome is that the users will manage to efficiently and quickly get to know the place along with the equipment in there.

1.1 Motivation
A workplace is defined as a place where people work, for example a factory or an office. It is where people meet on a day to day basis to perform certain tasks, or it can simply be your own home. Starting or changing workplace is not an easy task. It comes with certain challenges; such a challenge would be to adjust to the new job and place. There has been a study linking the fitness of a person to a job in relation to job stress. "Whilst employees can be reasonably expected to adjust to changes in jobs over time, poor job or employee job fit can result in increased stress and inefficiency in organizations". [5]The study focuses on the idea, that if a person perfectly fits his job, then stress on the job is reduced and can allow the employee to easily adjust to their job. " When humans feel a loss of control this causes physiological changes which can exacerbate feelings of stress. "[5]Nowadays, several companies try to allow the employee to easily adjust to their job by providing training. "Any organization that wants to succeed, and to continue to succeed, has to maintain workforce consisting of people who are willing to learn and develop continuously"[11]. There are two types of training, on the job training and off the job training. On the job training is a method of imparting knowledge and training directly while on the job. Off the job training is a method of imparting knowledge and training while not on the place of work, for example through a site.

The idea behind it, is to minimise stress levels and allow the employee to improve without any pressure. "Training, which aims at empowerment, development, and qualifying employees through knowledge and skills, referrers to end-oriented, organized, logical, on-going planned attempts to bring about the desired, change in the knowledge, skills, capability and attitude employees. "[2].

2. AIM AND OBJECTIVES

2.1

The aim of the final year project is:

- The aim of the final year project is to research and develop a workplace assistant augmented reality application using image and object detection techniques filtered through user profiling methods.

2.2

The objectives of the final year project are:

- Create and apply a user profiling system to be integrated in an augmented reality (AR) app for an office-environment;

- Implement image and object recognition algorithms for natural features detection, and apply these to the AR application;

- Design an intelligent adaptive interface using the AR medium.

- Apply effective human-computer interaction techniques to the AR medium to facilitate usability and usefulness

3. BACKGROUND RESEARCH AND LITERATURE REVIEW

3.1 User Profiling

"User Profiling is the process of Extracting, Integrating and Identifying the keyword-based information to generate a structured Profile and then visualizing the knowledge out of these findings." [9] Through user profiling the system is capable to tailor the required information for the user to see and make use of. It is annoying for users to have to go through irrelevant documents or data to find what is specific to what they require. "User profile generation is done when we get users complete information while he registers into our system. We have identified different user attributes for profiling him into our system".[9] User profiling has taken the form of recommender systems, where the system provides user specific recommendations in a personalized form. There are two forms of User profiling. Explicit User profiling, "In this approach users' behaviour is predicted by analysing the user's available data" [8]. This is known also as static profiling, in which analysis of static and predictable user data is made. The second type is implicit User profiling, it "relies more on what we have known about user in future i.e. systems tries to learn more about the user." [8]. It is also referred to as Adaptive Profiling. After performing extraction , one might end up with redundant information. To clean the information and see unique pieces of information one has to perform filtering. There are three filtering techniques for

user profiling, rule-based, collaborative and content based filtering techniques. Content based filtering, "recommends items based on a comparison between the content of the items with a user profile and selects those items whose content best matches with the content of another item." [8] Collaborative Filtering is the process of grouping users with a similar search criteria. The filtering is based on previous sought items as well and items which they are more likely to search for next.

3.2 Augmented Reality

"Augmented Reality is a variation of Virtual Environments (VE), or Virtual reality as it is more commonly known" [1]. Augmented Reality is a new form of technology that focuses on displaying realistic overlays on reality to provide extra information and content to what we see with our naked eye. It is an enhanced version of a real-world environment, through the form of media devices such pictures, videos, 3D models and sounds. "Therefore, AR can be differentiated from Virtual Reality, given that the former overlays digital information in a real environment, rather than completely replacing it."[4]. There are different categories of Augmented Reality. The first category is, marker-based AR, where the augmented overlay is only displayed once a marker is detected through a camera. It is also known as image recognition. The second category is, markerless augmented, which makes use of an accelerometer, a GPS and velocity tracker to detect the location of the phone and display the AR overlay in that specific location, given its location is predefined. The third category is projection based which basically projects data in the form of light rays on objects, for example an augmented/ projected keyboard. The last category is superimposed AR, where the AR partially replaces the real view with an augmented one of that object, IKEA makes use of this application through their digital catalogues.

3.3 Augmented Reality Navigation

Navigation systems have become necessary in nowadays world, where everything has become one search away. Continuous research is made to improve navigation systems by how they present the information to the user, without having the need to also be distracted from the primary task such as driving. The improvement of AR can help provide navigation information without distracting the user from looking away to a secondary screen or view, "For example, showing navigation markers on the windshield of the car or augmenting the video camera output of a smartphone with the navigation path"[3]. One can display navigation information in several ways to the user, two ways how one can achieve this is either by providing arrows that point the user towards the direction they need to arrive to, or by displaying a birds eye view of the map along with the path they need to take to arrive to their destination. To providing an augmented reality navigation system there are several steps one need to take, "1. Acquire the real-world view from the user's perspective. 2. Acquire the location information for tracking the user. 3. Generate the virtual world information based on the real-world view and the location information. 4. Register the virtual information generated with the real-world view."[3]. One main challenge in augmented reality navigation is the process of registration. "Registration is the process of correctly aligning the virtual information with the real world in

order to preserve the illusion of coexistence."[3]. Although proper visual registrations must be met for the Augmentation to be as realistic as possible, one must not forget that the user still needs to focus on what is on his path. Added graphics and visualisations cannot block any real-world objects in view. The graphics added can be placed touching the skyline or making them translucent. " But it is also important to note that while context specific information is useful, it should not block the the user's view or clutter the display with excessive information."[3]. For outdoor navigation one can use the GPS for localisation. However, for indoor navigation this can be a problem. There are several ways how to provide indoor localisation. When can make use of beams either by Bluetooth signals or WIFI signals. This will provide the user with continuous mapping, but it has also resulted to be buggy at times. The alternate option to that is by using offline way-points. The user simply scans a marker to get a location or augment pre-programmed information within that location. "the user needs to update his/her location by scanning another way-point on the way."[3].

3.4 Vuforia

3.4.1 General:

Vuforia is the "most popular SDK for developing AR-applications on a wide selection of devices."[6] Similar to ARCore and ARKit, Vuforia can be used on multiple devices to recognise images, objects and text.One can use third party engines such as Unreal or Unity to display overlays to create Augmented Reality apps.

3.4.2 Image Recognition:

Image recognition works by detecting natural features such as edges and corners in an image. "the feature tracking algorithm can determine what is a feature and map the positions of these features in the image." [6]. By shifting the positions of the image features like edges are intensified, even more corners as their position changes after shifting. Vuforia thus, makes use of Pose feature detection technique where it takes into consideration the position and orientation of the natural features. It can make use of extended tracking, where the engine detects surrounding features as well. A proper image with high quality feature detection is an image that contains uniquely distinct features, which are not repetitive. For example a dark circle is difficult to recognize and establish uniquely features.

3.4.3 Object Recognition and Model Targets:

Object Recognition in Vuforia works in several ways. The first method is by using a scanning plane , which acts as an image target.Once it is recognized, " provides the scanner with the XYZ-coordinates of the detected features on the 3D object."[6]. The latest form of object detection is by using their latest release, modelling targets. They have, added a new feature for target modelling using their own database on the cloud, where it contains multiple views and/or multiple objects with automatic recognition. It makes use of a deep learning library which is added as an SDK. One only needs to train an model target database where your 3D model is uploaded to the Cloud for training purposes.

3.4.4 Text Recognition:

Text recognition in Vuforia makes use of Optical character recognition tools. The image cause through segmentation and the characters are extracted from the image background.

3.5 Human Computer Interaction Techniques and Methods

3.5.1 Design Approaches

There are several approaches to Human computer interaction designing.Firstly, the Anthropomorphic Approach, which is the designing of a human like interface. Secondly is the Cognitive Approach, which takes into consideration cognitive abilities of the human for interfacing. Thirdly is the Empirical approach, which compares usability of multiple conceptual designs. This involves performing Human task performance measures and A/B Testing. Finally the last approach is Predictive Modeling Approach. It is the an examination of the amount of time the user took to complete a task using the interface provided.

3.5.2 Research Methods

There are eight research methods with respect to mobile HCI research. The first one is case studies. Case studies are intensive empirical studies using groups, organizations, individuals, systems or tools. Data is collected to qualitative and quantitative approaches. The second is Field studies, "Ethnographic field studies are characterized by researchers spending significant amounts of time in the field and, to some extent, immersing themselves into the environment they study."[10]. Third one is Action research, fourth one is Laboratory Experiments where a controlled environment is used for research purpose, Fifth is survey research, sixth one is applied research where it "builds on trial and error on the basis of the researchers capabilities of reasoning through intuition, experience, deduction and induction."[10].The final two research method are basic research and normative writings.

4. PROPOSED SOLUTION

4.1 Overview of WAAR

The Workplace Assistant Augmented Reality application is the proposed solution to the aim and objectives which as well face many Companies right now especially with regards to interns or new employees settling in within a new environment. The application will provide the users with a short form to fill in. It will take details that concern with the users need for making use of the application. The form will translate that input into relevant augmented information which will already be stored on a local database within the application itself. The user will be provided with three scenes in this case. The first scene will be just the main menu, the second one will be the form and finally the third scene is the Augmented Reality scene. The application will make use of different AI methods that involve user profiling, artificial vision techniques and deep learning techniques provided by the Vuforia Library for model targets. It will also provide a simple form of navigation which may direct the users to endpoints to which they may need to refer to when they require to find a particular office. The application will be based mainly on the bottom floor where most of the offices are found.

4.2 User Profiling

Every user using the application will need to fill in a short form at the start. Except, when needing to find the emergency exit, as it is assumed that one may need it in times of emergency. The form will be quite short and data shall not be stored anywhere. The data collected will be used only to display relevant markers on the augmented reality application. Once the application is closed all data shall be forgotten about the previous user, at least for our testing purposes only. Later on, such an application can be further developed to provide advanced user profiling. The user profiling method used shall be implicit. Implicit user profiling is predicting user's behaviour "by analyzing the user's available data. This data comes usually by filing the online forms or from surveys etc. This is also referred to as static profiling or factual profiling." [8] This means that data collected is analysed through the form only and no other external sources. Problems such as duplicate data shall be avoided by having the user selecting data through a drop down rather than having them input it themselves. One must remember that these people might be with high probability new to the place, and therefore they might not exactly know what or who they are looking for. So filtering techniques might not be needed for this scenario.

4.3 Augmented Reality

Augmented Reality "overlays digital information in a real environment, rather than completely replacing it."[4]. For Augmented Reality it has been decided to make use of Vuforia's technologies as it has some features which the application can well benefit from. It "enables businesses and app developers to quickly spin-up high fidelity, mobile-centric, immersive AR experiences." [12] For our research, use of its image and object segmentation shall be used to identify office workplace markers, along with Unity, the proper content shall be overlayed using gameobjects. There shall be cases where model target along with Vuforia's deep learning techniques shall be used to scan some objects in 3D. Vuforia is ideal because it can develop augmented reality application for Android and IOS devices. So in case any company that would want their employees to have this application on their phone, then no form of hardware limitations shall be faced.

4.4 Navigation

Indoor navigation can be done in several ways. One can use GPS signals, beacons, RSS or WIFI signals, or simple Augmented Reality itself. Now Augmented reality can be location based or marker based. So the proposed solution for our problem would be using Augmented Reality marker based navigation. Several markers around the office building will be used to segment images or objects and the proper directions will be displayed by recognizing the markers in view. This will allow the company to keep the application useful for offline use. For scenarios when WIFI or any other signals are down, user can still make good use of the application, for example in case one might need it during an emergency to find the fire exit.

5. EVALUATION PLAN

5.1 Evaluation Strategy

A company has given me permission to develop and test the application for them. The application will have to be
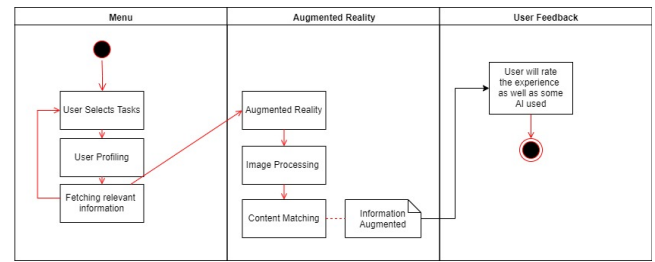

Figure 1: Application backend and user evaluation process.

tailored in respect to their environment, it will be tested on their first floor, since it will not distract most of the employees working on the second floor. Each participant will be handed a few number of tasks to perform while using the application to help them out. An explanation will be provided to each participant before making use of the application. The tasks planned will be designed and created once the application is fully developed so that the application is fully tested to its limits. The tasks involved will be the following:

- Visiting particular offices.
- Utilizing a workplace machine.

Participants will be provided with a maximum of two tasks each , and at the end of reaching the destination or finishing the test they may click 'done'. If they are not able to finish the task given of a particular problem with the application they may click 'quite'. Each participant will be provided with a score where at the very end they must provide it in the survey form.

Figure ?? Application and user evaluation strategy.

5.2 Overview of Testing and Evaluation Process

5.2.1 Analysis of Results

The results will be analyzed through the score obtained and the survey done through the participants. The participants will be asked whether they managed to complete the tasks and how much was the application helpful in finishing the tasks. The participants will rate the application for several features which they personally made use of as well as providing any recommendations on how it can be improved. All analysis made will be based on the application features and no form of primary data is needed to be collected. The survey will only consist of user feedback so as to analyse the limitations of the application and how it can be further improved.

5.3 AI Evaluation

5.3.1 User Profiling

The first form of AI as described will be user profiling. Firstly, this AI will be evaluated using the survey, in order to get feedback from the user as to how an implementation impacted the testing of the application. Secondly, user profiling will be evaluated according to which content was displayed more frequently with respect to the tasks the participants had to perform during the testing phase. The more

frequently a content was displayed in the Augmented Reality the more likely that piece of information will appear later on in the application. Such frequency will be based as to how much the same piece of augmented information appears in direct proportion to the number of images.

5.3.2 Image and Object Segmentation

Image and Object Segmentation will primarily be done through the Vuforia Library. Vuforia use an algorithm similar to Sift. Firstly, the evaluation of the algorithm will be taken from the user feedback as to how the algorithm impacted during the testing phase. Secondly, the algorithm will be evaluated as well by making small changes in the image and seeing how well the image is still processed and recognised. This can be done simply by manually checking if the image is recognized directly by the Vuforia library and checking the final result, as well by verifying that the same number of markers and features are detected and how much of a difference it made due to the small change in the image. Finally the algorithm will be evaluated with "BRISK" (Binary Robust Invariant Scalable Points) "It's fast and efficient enough to serve as base of the overall "SLAM" approach of simultaneously locating the camera position and mapping the real world."[7]

5.3.3 Navigation

Navigation will not involve any form of coordinates or path finding problems. The Augmented Reality application will simply analyse the image, process it and display the direction to which the user will want to go with respect to what the user profiler filtered out. This project will not evaluate indoor navigation problems, but will simply evaluate the problem whether simply using image and object recognition techniques can one manage to implement and scan an indoor environment using just images to implement a small navigation system. So the evaluation done on the image processing navigation problem will be based solemnly on evaluating the image and object segmentation techniques discussed previously with respect to implementing the Workplace Assistant Augmented Reality Application. Therefore evaluation performed will be firstly taken from user feedback as to how algorithm impacted their task they performed. Secondly, evaluation will be done on the algorithms applied with segmenting and processing the images.

6. CONCLUSION

The main expected outcome of this Final Year Project is to help new employees and maybe visitors become used to the new environment they find themselves in. This improvement will be noted from the user feedback and score provided from the users and application respectively.This outcome is due to overlayed information about their surroundings provided from the Augmented reality. The app aims to provide users with information that is relevant to their tasks at hand and improve efficiency on performing tasks which may be new to them.The application will be most helpful when there is no receptionist available for them to ask for help and information.The application will be limited to how much information it can provide. When it comes to navigation since a 3D mapping of the building is difficult to obtain, with just using images for this experimentation it might present its own limitations, but it is expected to be as efficient as possible. The application in itself will test

whether using just images, indoor navigation is possible or not, and how limited is the navigation provided, without using any form of signals from GPS, WiFi or Bluetooth. It will also test whether through model segmentation the correct instructions are provided to utilise an equipment from work. The equipment can simply be a coffee machine or even a punch clock in this case. The application in itself shows potential to be taken further. However, for now it is best to simply test and experiment with its core functionality.

7. REFERENCES

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APPENDIX

30th October 2019

Mr. Gabriel Camilleri
Software Engineering Intern
CCBill EU Limited
Palm Street
Paola

Dear Gabriel,

Re: Final Year Project, WAAR app

Reference is made to your request to conduct a study at CCBill in connection with your final year project as part of your Bachelor's degree in Information Technology (Artificial Intelligence). The study in question is to develop an Artificial Intelligence Workplace Assistant Augmented Reality application (WAAR app).

CCBill gives you consent to carry out this study provided that we have a royalty free license to use the WAAR app globally and in perpetuity. Your signature below is confirmation of your consent.

Yours sincerely,

Cindy Anastasi
Human Resources Director

Gabriel Camilleri

cc Michael Bonello, Bjorn Scorey