APPLICATION OF AR IN EMPLOYEE TRAINING

Project Plan

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Background

According to Association for Talent Development’s 2017 State of the Industry Report, companies invest US$1,273 on direct training expenditure with an average number of 34.1 learning hours used per employee [1]. Organization value employee training and development as there are well documented studies on the benefits of training on improving job performance [2] and organization performance [3]. With the huge investment spent on developing employees, companies wish to achieve positive outcomes which adds value to the organization [4].

Traditional training methods, such as in-person or instructor-led classroom, paper-based learning, e-learning modules, and video learning, have been adopted as the main learning methods over the years. However, in recent years, increasing numbers of organizations are starting to endorse augmented reality training as one of their employee development technique.

Augmented reality (AR) is the concept of allowing a computerized virtual object to be overlaid directly or indirectly in a real environment and in real-time [5, 6]. The idea of using AR technology for education and training purpose is not new. Since the advent of AR in the late 1960s, people have been exploring the possibility of using AR to educate and train [7].

Considering the numerous advantages brought by training-oriented AR applications, the emergence of AR technology for training purpose is not surprising. Some researchers have suggested that AR have the potential to strength learners’ motivation for learning while providing educational and realism practices [8]. Moreover, AR also encourages engagement, interaction, and pleasure during learning [9].

Through supplementing a layered of information to the environment, AR can improve the extent and quality of information provided, making the training environment more education, productive and contextual [9]. As Johnson, et al. stated, “AR has strong potential to provide both powerful contextual, on-site learning experiences and serendipitous exploration and discover of the connected nature of information in the real world.” [10]

More importantly, AR is able to aid long term information recall from memory [11, 12], which helps to reduce the cost of retraining [13]. The combined usage of multiple senses including visual, spatial, and audio in AR technology amplifies learning advantages [14, 15, 16]. As a result, AR technology is appeared to be one of the effective ways for training and is used in a number fields including medical, industrial, manufacturing and maintenance, and military [17, 18, 19, 20].

Previous implementations and technologies limited the use of AR on costly head gear, which heavy investments were to be made in order to develop hardware and software for AR application. However, the improvement in mobile and information communication technologies enables people to experience AR with their mobile devices while providing a succinct, seamless and interactive learning experience [9]. Hence, allowing a wider range of adoption of AR applications for training purpose in the business context [9].
This project introduces a mobile application that integrates existing training materials with AR technology, allowing users to gain some degree of practical experience during their training process while stimulating their visual and hearing senses in order to achieve a better learning experience and effectiveness.

The rest of this paper proceeds as follows. Firstly, two previous works are offered to motivate the design and implementation of the mobile application. Followed by a detailed description of the objectives and scope of this project. Next, a short discussion on the implementation of the application is offered where the design, features, development platform and technologies are examined. After that, a list of risk and their respective mitigation strategies are presented. This paper closes with a proposed schedule including important milestones and project deliverables.
Previous Works and related studies

Below are two AR mobile application examples adopted in the business environment. More applications can be seen in [19, 20, 21, 22].

The first example, PhoneGuide, makes use of AR, object recognition and pervasive tracking to develop a museum guidance mobile system. Once exhibits were identified, related multimedia information were displayed. Benefits of using AR as an interface in the application includes effective communication with user through multimedia presentations, a more intuitive way of obtaining information, and low maintenance and acquisition costs [20, 23]. This project will try to exploit object recognition to identify instruments used in different training situations while incorporating it with AR to achieve the benefits as mentioned.

Another example is a Vuforia model targets application in aircraft maintenance for AVATAR Partners. Different aircraft models as well as their troubleshooting issues were used in the application as training material for the maintenance personnel. A lock on target feature was used such that the model would not drift as the user moves. The application also replicates the procedures of the maintenance manuals as well as providing additional information on resources and personnel requirements to perform the mentioned task in AR. Benefits of using this technology includes reduced training time, increase training effectiveness and reduced training materials transportation cost [24]. This project will make use Vuforia and its feature to construct training modules that follows the procedures of the exiting materials while providing sufficient information for users to perform their job in order to achieve the aforementioned benefits.
Objectives

This project aims to enhance the effectiveness of employee training as well as increase the learning motivation by incorporating AR technology to existing training materials.

The use of AR technology allows users to gain real life experience, which improves the practicability of the training, such that users have a better understanding on how to apply their training. At the same time, the quality of training could be enhance through embedding contextual elements in the layered reality. In addition to the computer-generated imageries and rich contents, the effectiveness of learning can also be improved by stimulating other senses such as hearing to complement visual elements as it can enhance the realism of the experience and allow a longer memory retention. To measure the effectiveness of the training modules, the performance of the user will be tracked and instant feedback will be provided after each module.

To increase the learning motivation, AR is used to make the learning process more immersive. Besides, training modules should be easy to follow and as interactive as possible while remaining educational.

In the long term, this project will try to promote the use of AR technology in business environment which provides on-site job training and guidance by supplying instant feedback and information required to complete their job duties.

Scope

In this project, a mobile application consisting several AR training modules will be developed. The design of the learning modules is based on the training materials provided, therefore, the details and coverage of the learning modules are still in discussion. Material selection criteria includes the feasibility and necessity in realizing the materials by AR technology. For simplicity, each learning module will only support the language as provided. In addition to the main components, a tutorial is given at the beginning to allow users to be familiarized with the learning model.

A scoring system will also be implemented, however, the provision of it along with a login system for performance tracking is subject to the discussion with the company. Due to the time and resources constraint, there will only be approximately 2 learning modules implemented, hence, a searching function is still under consideration. Other features such as feedback system may be developed in the future.
Methodology

The development process will be divided into two parts in which the training modules will be implemented first, followed by other supporting features.

Training modules
Game Engine
Vuforia Engine in Unity will be used for developing the application as it satisfies the requirements for this project. It makes use of computer vision to recognize and track a wide range of 2D images and 3D objects. At the same time, it enables the development of AR applications in Unity which can be easily ported to iOS and Android platform. Therefore, the AR application developed using Vuforia is compatible with iPhone, iPad, and Android phones and tablets.

Training Module Design
The training modules will be in the form of completing tasks with users choosing the correct option while performing the correct steps in executing that option. Throughout the module, the score of the user will be tracked and he/she must reach a certain benchmark in order to successfully complete the training. If the user choose the correct option or execute the steps correctly, their marks will increase; however, marks will not be deducted for each wrong action. Once the training module is finished, feedback will be given based on the users’ performance and their score will also be shown on the screen. For users who have unsatisfactory marks, they will be required to revisit the current training module.

Other supporting features
User interface
A navigation bar will be implemented at the bottom of the application. Three tabs will be available, namely “Training”, “Tutorial” and “Setting”.

In the “Training” tab, training modules will be organized in alphabetical manner and may be grouped into chapters based on their topics. Modules which are not yet available will be disabled and shown in grey. If the search function is implemented, a search bar will also be provided at the top of the tab allowing users to search for the desired training module.

In the “Tutorial” tab, a tutorial module will be provided to user to familiarize with the controls and operating model of the application. A separate tab is maintained for the tutorial allowing users to revisit at ease as they may not be acquainted with AR technology and its controls.

In the “Setting” tab, some in-application settings will be given for adjustments along with an “about” page on the brief introduction of the application on its rationale and objectives. If the login and feedback function are implemented, they will be realized in this tab where the user profile will be shown and a feedback option will be presented.
Search Function (Optional)
This function may not be implemented. If it is developed, it will be used for easier exploration within the application. Users will be able to enter the title/code of the training module. Results fulfilling the search criteria will be shown sorted by relevance. Hence, information related to training modules (e.g. module code, title, duration, and topic) will be required to store in a reliable database (refer to Database System and Sever below).

Login Function (Optional)
This function may not be implemented. If it is developed, it is used to record each users’ performance which will be reflected to the management levels for effectiveness and performance assessment and tracking. Each user’s data and training progress will be stored in a reliable database (refer to Database System and Sever below). Information collected during the account set-up includes employee id, password, name, age, gender, and job position.

Feedback Function (Optional)
This function may not be implemented. If it is developed, it is used to collect users opinion on the application and the design of the training modules. Information collected includes basic information of the user (e.g. gender, job position, and age group), and type of opinions (e.g. application design or feature, and training module design). Data collected will be stored in a reliable database (refer to Database System and Sever below) as reference for future development.

Database System and Sever (Optional)
If the above supplementing features are realized, a database system and sever will be required. The database system will be implemented by MonogDB while the sever will be implemented by node.js. Both database system and sever will run on the Amazon Relational Database Service provided by Amazon Web Service.
Risk, Challenges and Mitigation Strategies

Table 1.1 below identifies some risk and challenges that may be encountered and recommends some mitigation strategies.

<table>
<thead>
<tr>
<th>Risk Identified</th>
<th>Mitigation Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changing requirements from client</td>
<td>Maintain a close communication with the client throughout the project while having sufficient involvement of the client during all stages especially at the testing stages. Prototypes of the flow and design of the application may be presented before the start of the implementation phase to ensure the final deliverables meet the expectation of the client.</td>
</tr>
<tr>
<td>Required audio or imagery may not be available</td>
<td>The required audio or imagery may be recorded or generated by myself when this happens.</td>
</tr>
<tr>
<td>Not all languages will be supported</td>
<td>Although it is more desirable if the application can support both Chinese and English, only one of the languages will be selected for use in this implementation due to time constraint. Whether Chinese or English will be chosen, will have to depend on the choice of the client. However, it is possible to develop the application in other languages in the future.</td>
</tr>
</tbody>
</table>
Schedule and Milestones

Milestones
Three major milestones are included for this project, namely the design phase, implementation phase, and testing and finalizing phase.

The design phase is planned to be completed by mid-November 2018, where the design and flow of the application will be finalized; followed by the implementation phase where all training modules and functions will be implemented. This stage is proposed to be completed by the end of March 2019. The testing and finalizing phase will start after where testing will be carried out and adjustments are to be made. It is expected to be completed by mid-April 2019.

Project schedule
Table 1.2 below shows the proposed project schedule.

<table>
<thead>
<tr>
<th>Date</th>
<th>Work Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 September 2018</td>
<td>First deliverables</td>
</tr>
<tr>
<td></td>
<td>• detailed project plan</td>
</tr>
<tr>
<td></td>
<td>• project website</td>
</tr>
<tr>
<td>20 October 2018</td>
<td>Finalized business requirements</td>
</tr>
<tr>
<td></td>
<td>Learning modules design</td>
</tr>
<tr>
<td>30 October 2018</td>
<td>Frontend UI design</td>
</tr>
<tr>
<td>10 November 2018</td>
<td>Database system design and sever setup</td>
</tr>
<tr>
<td>25 December 2018</td>
<td>Main learning module and functions</td>
</tr>
<tr>
<td>5 January 2019</td>
<td>Stage 1 user acceptance testing</td>
</tr>
<tr>
<td>7-11 January 2019</td>
<td>First presentation</td>
</tr>
<tr>
<td>20 January 2019</td>
<td>Second deliverables</td>
</tr>
<tr>
<td></td>
<td>• preliminary implementation</td>
</tr>
<tr>
<td></td>
<td>• interim report</td>
</tr>
<tr>
<td>30 March 2019</td>
<td>Remaining learning module(s) and functions</td>
</tr>
<tr>
<td>5 April 2019</td>
<td>Stage 2 user acceptance testing</td>
</tr>
<tr>
<td>10 April 2019</td>
<td>Final adjustments</td>
</tr>
<tr>
<td>14 April 2019</td>
<td>Third deliverables</td>
</tr>
<tr>
<td></td>
<td>• finalized implementation</td>
</tr>
<tr>
<td></td>
<td>• final report</td>
</tr>
<tr>
<td>15-19 April 2019</td>
<td>Final presentation</td>
</tr>
<tr>
<td>29 April 2019</td>
<td>Project exhibition</td>
</tr>
</tbody>
</table>
References


