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Semi-Dynamic Mobile-Based Virtual Reality System for University

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Abstract: Most of the Virtual Reality today is a static image in which the creator will manually replace it in the system and even replace it as a whole. There are several steps to obtain VR projects, namely: data processing, VR roles to follow, subsystems, data acquisition, data processing, 3D modeling, the object-oriented property of VR systems, and visualization task. This study aimed to develop and evaluate a Semi-Dynamic Mobile-Based Virtual Reality System for University. The system was developed using server side (PHP) and client side (JavaScript) scripting language for web-based Java, and PhoneGap for android application. Bootstrap and jQuery are also used in the development of the system with MySQL as the database so it can communicate with other platforms. The system can be downloaded git repository together with the android application the developer can use it for customization. A developmental-Evaluative survey method was used in gathering the data using the adapted questionnaire. The respondents are very satisfied with the performance level of the system in terms of functionality, compatibility, security, and maintainability. Therefore, it is an indication that the developed system is an excellent platform in file management.

Keywords: Virtual Reality, jQuery, PHP, Application, MySQL.

I. Introduction

Technology is at the point of a significant uprising from mobile to immersive computing. The last two years have seen the emergence of the third trend of devices employing Virtual Reality (VR), which could replace mobile computing [9]. Through technological advances, VR is now the new medium, in which considerable experimentation is currently taking place to find practical applications and more effective ways to communicate [16]. This study can contribute to image processing, emerging VR technologies, and the Information technology field. Hence this study is published as an open-source application thru an online repository. Moreover, many developers can use, enhance, and contribute to this project [5]. It can also help SLSU; hence, it is beneficial for tourism purposes, augments experiences, and later create opportunities for promising applications in areas for research and development.

There are vast amounts of digital format materials, including audiovisual content, electronic texts, multimedia applications, and geographical information systems. Up to now, these materials are barely utilized by digital guides, staying unreachable for the visitors. Moreover, existing multimedia presentations are far from the real-world environment [4]. With this, an organization can use the VR technology to solve the problems stated above. VR can significantly enhance interaction between the computer and human participants in diverse areas, including rapid prototyping, manufacturing, scientific visualization, engineering, and education [12]. [8] also stated that VR could use as an appealing form of advertisement that helps people feel like they are in the destination participating in the activities, thus generate positive feelings towards the target. However, creating a virtual reality is using a computer-generated environment and recreating a three-dimensional object, which can be explored and interacted with by a person. That person will immerse within that environment and, at the same time as there becomes part of this virtual world and be able to control objects or create a series of actions [17].

Most of the Virtual Reality Tour (VRT) today is a static image in which the creator will manually replace it in the system and even replace it as a whole. It will be a considerable problem in maintainability. Another process is to use a 3d rendered objects in which the VRT will not be the same as the actual physical environment, and the process of creating this system is timely and not easy to maintain [17]. The method of creating a virtual reality application will require visualization data preparation and processing. There are several steps to obtain VR projects, namely: data processing, VR roles to follow, subsystems, data acquisition, data processing, 3D modeling, the object-oriented property of VR systems, and visualization task to solve [19]. The available virtual Reality does not have a personal account and a platform where the user can communicate with other users.

To solve the gap of the VRT system available in public, the researcher created an open-source system that used semi-dynamic images that the moderators and users can contribute. Specific panoramic photos are submitted to the system to create a VRT without updating the whole system. In this system, the researcher also included a platform feature where users can download the entire system then have full control and customization of the System [18]. Users can also create an account and can communicate with each other. Southern Leyte State University's vision, which is to be a high-quality corporate science and technology university, is very suitable for this study. SLSU is an institution that does not have an existing University Virtual Reality Tour. Students and stakeholders can also use the virtual reality tour to promote the University to the public using the mobile application.

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Future stakeholders can even know in advance how the school buildings located strategically.

Research Objectives

This study aimed to develop and evaluate a Mobile-based University Virtual Reality Tour. Specifically, it sought to accomplish the following specific objectives:

1. To design and develop a Mobile-based University Virtual Reality Tour platform;
2. To Evaluate the performance of the proposed system in terms of:

2.1 Functionality;

2.2 Compatibility;

2.3 Security; and;

Conceptual Framework of the Study

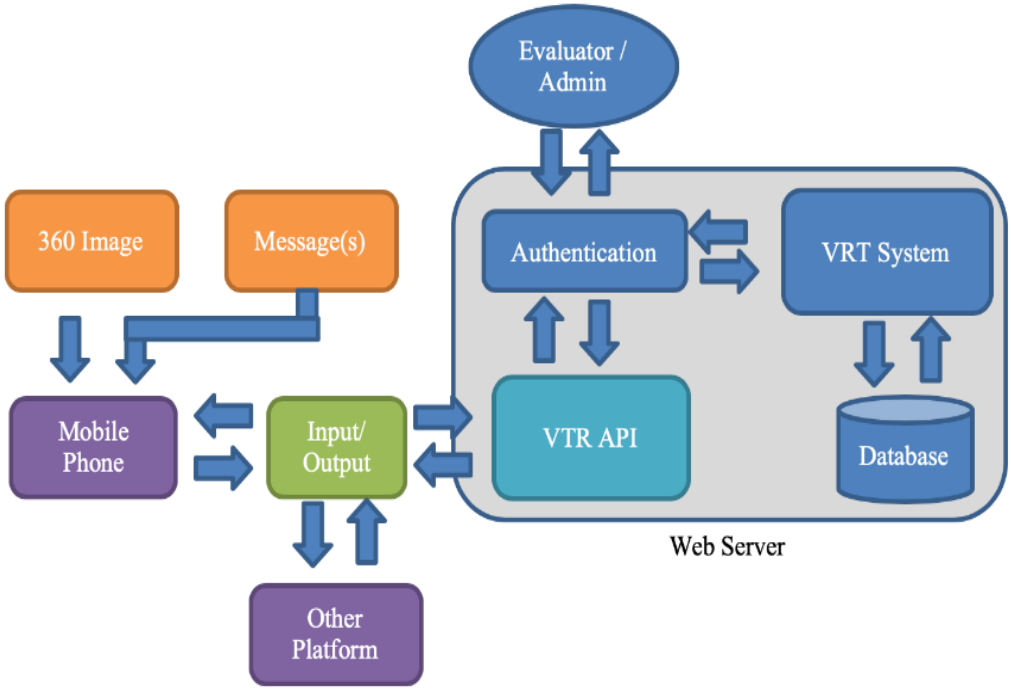

Fig. 1 Conceptual Framework of the Study

The agile model was used to develop a semi-dynamic Mobile-Based Virtual Reality System for University since it will require real-time development updates. The development starts with setting up all necessary requirements for creating a web hosting account such as web hosting, web server, and domain accounts. The system used Apache as the server software for HTTP requests, PHP for the code interpretation and image processing implementation. The database is also necessary for the user's accounts and the system's data.

II. Methodology

Research Flow

The first step was the Planning Phase. Upon gathering the data by identifying the current problem of the University that closely related to Virtual Reality Tour and Identifying the applicable features to be included in the proposed VRT system using a researcher-made questionnaire, the design, and development of the University Virtual Reality Tour commence. The VRT System Design and Development Phase started with acquiring the spots' location of the base panoramic images. This will be some initial panoramas that will be used in the system before users can contribute to it. Then it will use satellite imagery from Google Map and remote sensing geo-data for the points where the location of the images. This planning is important since it will determine where and how many panoramic images to be gathered. This plan will also be used later in the mapping and linking of the images in the VTR Software. After the capturing of panoramic images will be conducted. The gathering of 360 panoramic images is based upon the planned map points. Then it will use a smartphone with angular rate sensors or also known as a gyroscope, to capture 360 panoramic images thru every point of the campus. It will use a specific category of a smartphone with the following specification: A.) Android or iOS (formerly iPhone OS). B.) Full HD Camera C.) Gyroscope.

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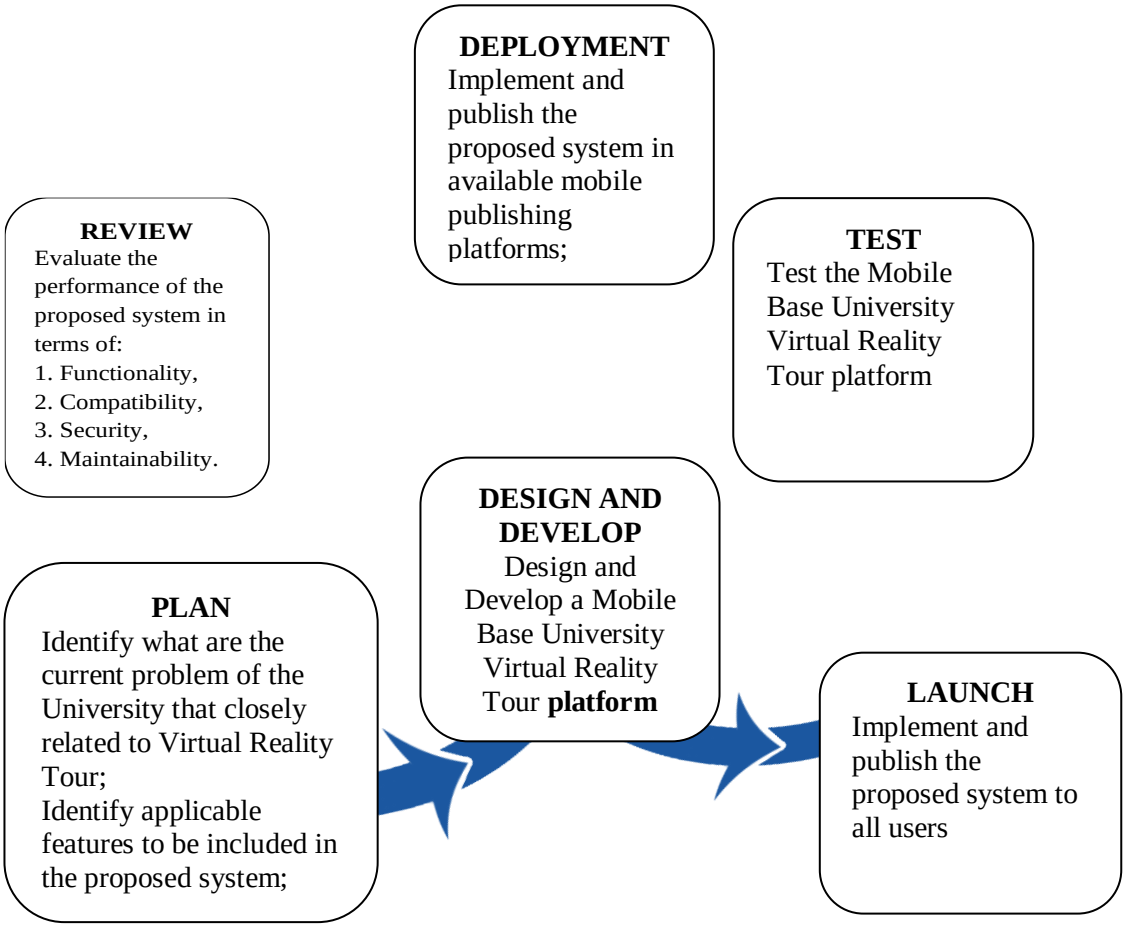

Fig. 2 The Research Flow of the Study

Android is a mobile operating system created and developed by Google. Android is compatible with Google Street Views. Google Street View is a feature of Google Maps that enables users to view and navigate through 360-degrees horizontal and 290-degree vertical panoramic street-level images of various cities around the world. The Street View feature can be used to take virtual walks, explore landmarks or find shops, restaurants, and hotels. It is also a standalone software from Google Maps available in Google Play, and it has a camera feature that can capture and generate 360-degree panoramic images.

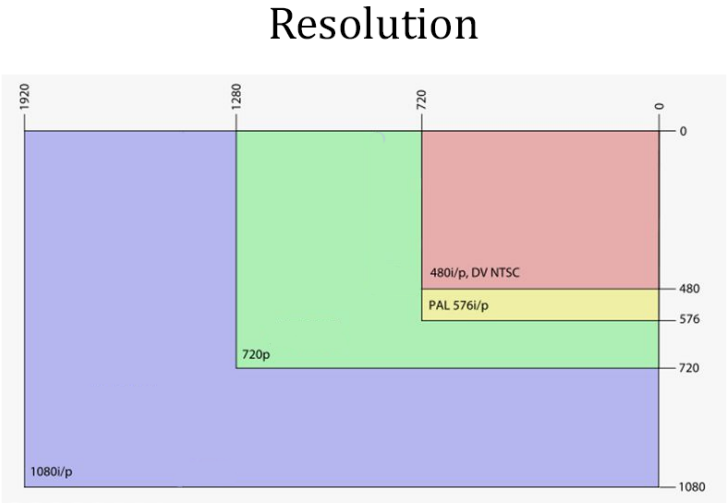

Fig. 3 Comparison of HD and Full HD Image Resolution

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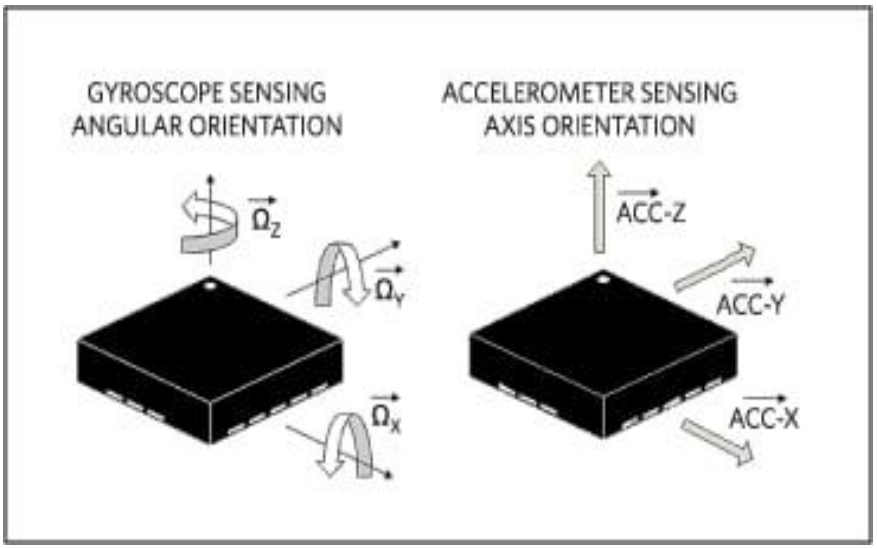

Fig. 4 Comparison of Gyroscopes Sensors and Accelerometer Sensors

The mobile phone must have a full high-definition camera feature. HD refers to cameras with a standardized resolution of 720p or 1080p (Figure 3). The numbers 720 and 1080 refer to the horizontal resolution. Therefore, 720p HD camera resolution provides images that are 1280 x 720 pixels (that adds up to 921,600 pixels, which means a 720p HD camera is not technically a megapixel camera), and 1080p HD cameras provide 1920 x 1080-pixel resolution or 2.1 megapixels. The HD video format also uses an aspect ratio of 16:9 (rather than 5:4 or 4:3), and the frame rate is standardized at 60, 50, 30 or 25 frames per second (Mistralsolutions.com 2018). The 1080p (1080x1920) or higher is recommended to be able to generate high-quality images.

Gyroscope (angular rate sensors) are devices that sense angular velocity. In simple terms, angular velocity is the change in the rotational angle per unit of time. Angular velocity is generally expressed in degrees per second. Although the smartphone has another motion sensor called an accelerometer, it is only limited to axis orientation, not angular orientation. According to [2r], accelerometer sensors commonly measure the displacement of a mass with a position-measuring interface circuit. That measurement is then converted into a digital electrical signal through an analog-to-digital converter (ADC) for digital processing. Gyroscopes, however, measure both the displacement of the resonating mass and its frame because of the Coriolis acceleration. When the system has gathered all the panoramic images, it will use a panoramic virtual tour software called Panotour for the creation of a webpage where the virtual tour is generated, and the 360 panoramic images will be converted to a web-based image tile.

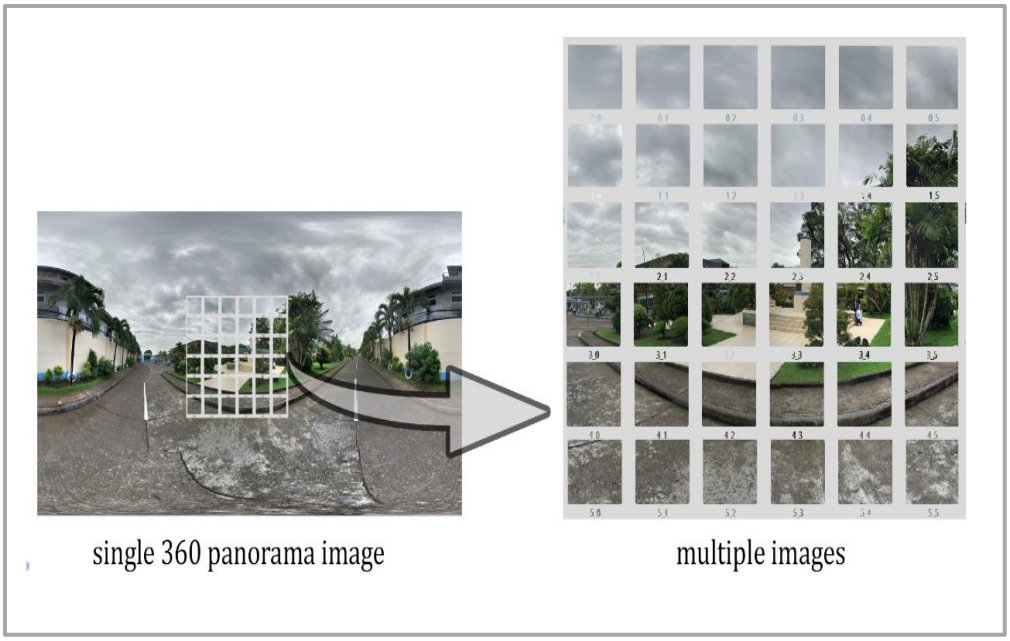

Fig. 5 360 Panorama Conversion unto a Web-Based Images Tiles

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The images are to be sliced into small images tiles for the purpose of web rendering performance and to be able to create the illusion that the images are as one in the view of the user (Figure 6).

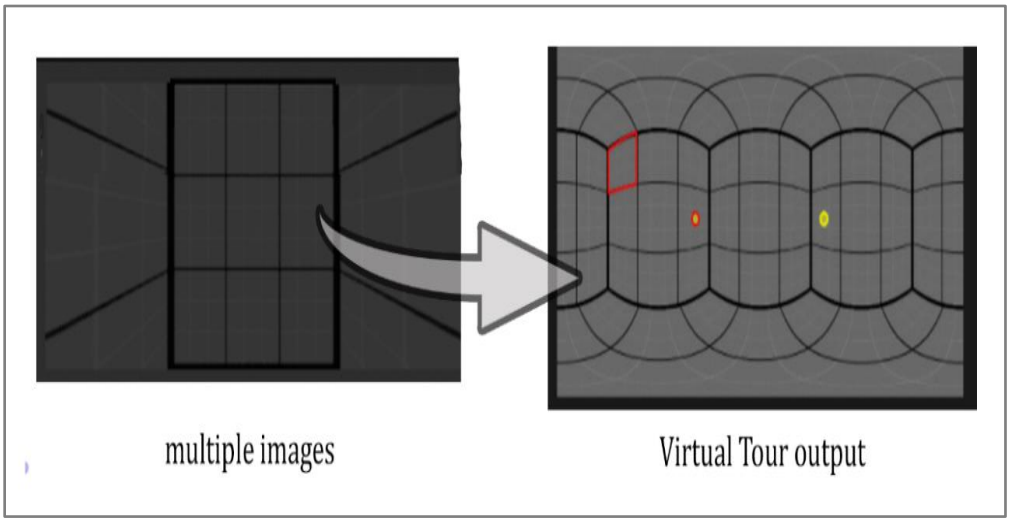

Fig. 6 Joined sliced images using Kpano JavaScript Library.

The system will use HTML, CSS, and JavaScript front-end, .and will use PHP as backend. PHP is a server-side scripting language designed for web development but also used as a general-purpose programming language. PHP originally stood for Personal Home Page, but now it stands for PHP: Hypertext Preprocessor. Together with the database, MySQL, an open-source relational database management system (RDBMS), will be used as the backend for the semi-dynamic feature of the University Virtual Reality Tour. When the system is on its way to completion, a domain name is needed. The system will use web hosting services and a domain name for synchronizing and for the semi-dynamic features of the system. The system will also use Google play for publishing the mobile application. The system will be tested and reviewed internally using Google Play alpha testing.

The Testing Phase was simultaneously conducted alongside with the development of the system. To ensure all of the functions will be tested, a bug report management (Trello software) will be used to manage all of the necessary functions as planned. It will also perform unit testing to ensure that the whole system will work according to the goals of the project. The Deployment Phase was conducted when the system is finished. It will accumulate a GNU license for open-source publication then the code and documentation will be uploaded to GitHub and in Google Play Store for android application publishing. The Review Phase used an adopted questionnaire and use the convenient sampling with ten (10) IT experts to evaluate and review the system according to Functionality, Compatibility, Security, and Maintainability. The final phase was the Launching Phase of the VTR Platform. It will be available to different users. The application can be downloaded to the mobile platform. User can create their accounts. Users can use their virtual reality headset to view the university virtual reality tour system.

Research Design

This study utilized the Developmental-Evaluative Design utilizing the questionnaire as the main tool to collect the necessary data from the respondents. The developmental-evaluative design supports the development of innovation and adaptation in dynamic environments. An integrated web-mobile platform will be generated using HTML5, JavaScript library, PHP, Database Management System (DBMS), and Java programming language. To produce a Semi-Dynamic Mobile-Based Virtual Reality System for University. The Agile Model was also used in developing the system. It follows the standard for evolving software development through a collaborative effort. This phase involves making modifications to the system or an individual component to alter attributes or improve performance. It also supports activities correcting errors and adapting the system to new requirements in minimal time. The questionnaire is based upon the ISO/IEC 25010:2011 Systems and Software Quality Requirements and Evaluation (SQuaRE), where functionality, compatibility, security, and maintainability were bases on the evaluation of software product quality.

Research Environment

The study was conducted in SLSU-Sogod Campus. And all of the images will be submitted and processed inside the campus. With the help of moderators and assign evaluators, they can help filter the correct data that will be contributed by the users. SLSU Sogod Campus will conduct its yearly information drive to promote and encourage the graduating high school students and college degree candidates to enroll in the said school. It will be helpful to the students who are not familiar with the institution. By this, the students can experience and can tour the campus using the university virtual reality tour system virtually.

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Research Respondents and Sampling Procedure

The respondents of this study were the faculty, staff, students, alumni, and parents from the Southern Leyte State University. A Non-probability Sampling technique was used for selecting the participants in this study, specifically convenient sampling since it was impossible to obtain a complete list of the respondent. Table 1 shows the distribution of respondents as well as their corresponding percentage based on the total number of respondents.

Table 1. Respondents of the Study

Respondents	Frequency		Percentage
Faculty	10		16.67%
Administrative Staff	10		16.67%
Expert	10		16.67%
Student	10		16.67%
Alumni	10		16.67%
Parents	10		16.67%
TOTAL	**60**		**100.00%**

Research Instrument

The instrument used in this study is an adapted questionnaire. The questions were based on the statement of the problem. It is divided into two phases: the first phase will focus on the first objective, which is identifying the current problem related to the Virtual Reality tour and identifying applicable features to be included in the Propose VRT system. The second phase will focus on the evaluation of the performance of the proposed system. Each part has several sections. 5-Strongly Agree, 4-Agree, 3-Neither Agree nor Disagree, 2-Disagree, 1-Strongly Disagree.

Data Analysis Procedure

In the analysis of data, the descriptive statistic was used in this study. The mode will be used to evaluate the performance of the proposed system in terms of functionality, compatibility, security, and maintainability.

III. Results and Discussion

Design and Development of the System

The software development of the system is based on the agile framework. Agile has been proposed to solve problems resulting from the turbulent business and technology environment faced by organizations engaged in software development [10]. This involves making modifications to the system or an individual component and alter attributes or improve performance. It also supports activities correcting errors and adapting the system to new requirements in minimal time. The system is an open-source application where developers can download, customize, and contribute to the development. Open source employs agile methods and focuses on concurrent development and fast production (sprints) over gated production [6]. The illustration in figure 7 shows the public git repository where the system development setup started. Using a GIT repository improved the management and storing the code source [1].

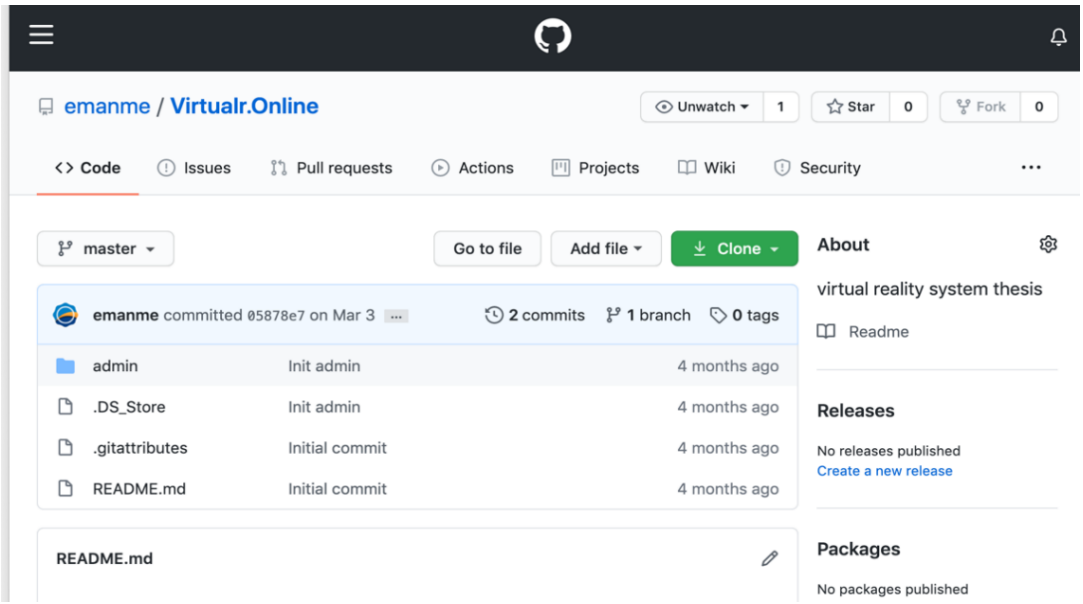

Fig. 7 Git Repository of the Open-Source Application

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Hardware

The hardware is one of the vital tools needed in creating the system. Hardware is the physical equipment of a computer system. Below is the following list of components used. Intel ® Core i5 Processor, 1 TB HDD, Mouse, Monitor, Keyboard, LAN Card, Uninterruptible Power Supply (UPS), Internet Modem, and Android Mobile Phone.

Software

The system used the listed software specification to make the development possible. HTML is the presentation of the web components with the help of Scripting Language both server-side (PHP) and client-side (JavaScript) the data can now be dynamically displayed for each individual user. The styling of the system used CSS, and with the help of Bootstrap, the system can be viewed in any browsers and any platform without design failures. jQuery also improves the user's experience and system performance in the development of the mobile (android) application, the Android Studio, together with the PhoneGap Command Line Interface (CLI). A Frame converts 360 Images to Virtual Reality, both WebView and Android OS. MySQL helps the storing data and make all of the platform connected to each other. Lastly the hosting services with is Hostiger.ph. It stores the data and allows the system to run in the cloud.

Evaluating the Performance of the System

The evaluation of the performance of the Semi-Dynamic Mobile-Based Virtual Reality System for University used adapted questionnaires in terms of Functionality, Compatibility, Security, and Maintainability.

Functionality

Table 2 shows the data on the performance of the developed system in terms of functionality. The data represents the five subcategories of functionality, particularly head movement, image loading, dynamic images, account creation, and user interaction.

Table 2. Performance of the Proposed System in terms of Functionality

Items	Frequency					Modal Response
	SA	A	N	D	SD	
The VRT System moves along with user's head movement	52	3	4	0	0	SA
The VRT System loads Images correctly.	58	2	0	0	0	SA
The VRT System has semi-dynamic images.	58	2	0	0	0	SA
The Users can create individual accounts.	55	5	0	0	0	SA
The Users can interact with each other.	52	2	5	0	0	SA

Legend: SA-Strongly Agree | A-Agree | N-Neither Agree nor Disagree | D- Disagree | VD-Strongly Disagree

The table shows that majority of the respondents strongly agreed on the system's functionality, specifically the head movement, image loading, dynamic images, account creation, and user interaction. According to [15] the system functionality determined by data consistencies, response times, infrastructure stability, functionality of the component, and customer satisfaction. Base on the modal response in all the subcategories of functionality, it was found out that the performance of the developed system in terms of functionality is very satisfying.

Compatibility

Table 3 shows modal response data of the Performance of the developed System in terms of Compatibility. The data represents the five subcategories.

Table 3. Performance of the Proposed System in terms of Compatibility

Items	Frequency					Modal Response
	SA	A	N	D	SD	
The VRT System can be embedded in web-based application.	31	29	0	0	0	SA
The VRT System is compatible with Smartphone device.	16	43	1	0	0	A
The Web-based VRT and Mobile-based VRT are connected to each other.	52	8	0	0	0	SA
The VRT system will accept JPEG and PNG images.	47	13	0	0	0	SA
The VRT system will can process full 360 panorama Images.	58	2	0	0	0	SA

Legend: SA-Strongly Agree | A-Agree | N-Neither Agree nor Disagree | D- Disagree | VD-Strongly Disagree

Most of the respondents agreed that the proposed Semi-Dynamic Mobile-Based Virtual Reality System for University is compatible with their smartphone. In contrast, more than half of the respondents strongly agreed that the proposed system could be embedded in web-based applications. A large number of respondents in the remaining Items, namely: connection of Web-base and Mobile-based, JPG, PNG compatibility, and the processing of 360 panorama images, strongly agreed that they are compatible with the system. In total the system is confirmed to be compatible and supported by to [13] that compatibility is the ability to run software on any machine. [7] reinforced that compatibility is the ability to move program from one system to another without any changes, ability to send data from

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one program to another with only automated changes, and lastly ability to combined diverse source files into an integrated database.

Security

Table 4 shows the data on the performance of the developed system in terms of security. The data represents the five subcategories of security: account creation, collaboration, privacy, storage, data encryption.

Table 4. Performance of the Proposed System in terms of Security

Items	Frequency					Modal Response
	SA	A	N	D	SD	
User's has its individual accounts.	55	5	0	0	0	SA
User interaction can be viewed only by the collaborators.	52	8	1	0	0	SA
User's personal data are accessible only by login user.	50	10	0	0	0	SA
The VRT System data are stored in protected location.	60	0	0	0	0	SA
The VRT System data are encrypted.	60	0	0	0	0	SA

Legend: SA-Strongly Agree | A-Agree | N-Neither Agree nor Disagree | D- Disagree | VD-Strongly Disagree

Table 4 shows that all of the respondents Strongly Agree that the system data is protected and encrypted. While few respondents agree that the system can create individual accounts, collaborate, and have privacy, most of them Strongly Agree about the system's features. Based [11] cloud computing security and privacy must have user confidentiality, authentication, privacy protections, monitoring and reporting. Hence, the developed system is secured and provides privacy features so that the data are protected.

Maintainability

Table 5 shows the data on the Performance of the developed System in terms of maintainability. The data represents the five categories of maintainability: head movement, image loading, dynamic images, account creation, and user interaction.

Table 5. Performance of the Proposed System in terms of Maintainability

Items	Frequency					Modal Response
	SA	A	N	D	SD	
The VRT System is available in an online Git repository.	52	8	0	0	0	SA
The VRT System can be used in other University.	55	5	0	0	0	SA
The VRT System Data are easy to modify without creating system defects	18	26	16	0	0	A
The VRT System Data are updated in real-time.	58	2	0	0	0	SA
The User of VRT can contribute his/her own panorama images.	18	34	8	0	0	A

Legend: SA-Strongly Agree | A-Agree | N-Neither Agree nor Disagree | D- Disagree | VD-Strongly Disagree

The table shows that the respondents have distinct satisfaction, but the majority of them agree that the system can be modified without creating system defects. There are respondents that answered neither agree nor disagree since based on them they did not try to modify the system. Likewise, in the contributing their own panorama eight of the responded did not upload their images and so, they decided to not to agree nor disagree. In the item about the contribution of own Panorama images, they also have a distinct response, but still, the majority of them Agree about it. The other item, namely: availability of an online GIT repository, can be used in other Systems or University and can update real-time are answered with a "Strongly Agree" by most of them. According to [3] maintainability has four factors: (1) ability to identify the fault or failure within the software, (2) capability to modify software products, (3) ability to avoid unexpected effects from changing the software, and (4) capability to test and validate the modified software product. Data shows that the developed system is maintainable.

IV. Conclusions

The development of the Semi-Dynamic Mobile-Based Virtual Reality System for University should always be published and managed using the GIT repository to enable the developer to maintain and follow the development time table, especially when it uses an agile framework in development. Based on the findings of the study, the researcher concluded that; the proposed system enables the developer to use a semi-dynamic image compared to the VRT available in public. However, this system uses an agile framework. It can significantly help to enhance the system during production. Agreeing to [11] that incremental improvement further polishes the design, coding and testing at all levels of production. And with the use of GIT repository, the system can benefit from contributions from the community early on [14].

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