



AUGMENTED REALITY IN RISKS REDUCTION

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ABSTRACT

This operational and maintenance of buildings paper shall focus on the use of augmented reality for reducing risks. The use of augmented reality has increased over the years especially since its cost has gone down over the years. In the past, the cost of using augmented reality software in reducing risks was prohibitive for use by engineers and other professionals involved in the operation and maintenance of buildings. Risk reduction is critical because once buildings have been put up, the safety of numerous individuals and equipment depends on the structures' safety. Whether the built environment is composed of bridges, schools, roads, social amenities areas, schools or business and industrial sites, they have a large impact on the daily lives of people. Numerous resources are also utilized in the putting up and maintenance of buildings which is prohibitive for many people. Therefore, it is paramount to use the available software such as augmented reality to ensure that risks are reduced. Safety is paramount in ensuring that the invested resources are put into great use to benefit the involved stakeholders.

KEYWORDS : Augmented Reality, Risks, Hololens

1.INTRODUCTION

Now, researchers and engineers are pulling graphics out of your television screen or computer display and integrating them into real-world environments. This new technology, called augmented reality, blurs the line between what's real and what's computer-generated by enhancing what we see, hear and feel. On the spectrum between virtual reality, which creates immersive, computer-generated environments, and the real world, augmented reality is closer to the real world. Augmented Reality (AR) can help mobile workers to obtain timely and accurate information related to maintenance targets [1].

The stakeholders such as owners and clients would want the buildings to be safe and pleasant to use. They would also want to experience convenience for the longest possible duration while using cost effective systems while the buildings remain in use. The involved professionals such as engineers and architects also ensure that high quality equipment, tools, and structures are utilized in the putting up buildings because it affects their future credibility and work [2]. The use of augmented reality is also contributes to the maximization of future building plans to mitigate risks for buildings. The parameters that are found to be effective in the operation and maintenance of current buildings can be replicated and integrated when constructing new buildings.

Using Augmented Reality (AR) to reduce the risks in buildings during operational and maintenance phase. Some devices support (AR) like Hololens Microsoft, iPad and iPhone.(AR) depends on 3D model for the buildings that create by some software like Revit architecture, Revit MEP from Autodesk and others. Managing and avoidance of possible risks in buildings is made easier through the augmented reality technology tools.

The maintenance of buildings is usually risky and involves multiple personnel from various departments such as administrative, technical, and managerial functions. The maintenance and operational function of a building involves preventive and operational functions to ensure proper maintenance of the available facilities.

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MEP from Autodesk and others. Managing and avoidance of possible risks in buildings is made easier through the augmented reality technology tools. Therefore, the professionals working on the project would find out whether they are on the right schedule and the measures that they should take to be on track. DARI Smart Helmet is also a popular augmented reality technology application [3]. Using the application, the workers inspecting a construction site or building can visualize data on pressure and temperatures in pipes. Based on the data readings from the pipes, the application can give the instructions to follow to attain the needed values.



Figure 1: Use of camera to attain digitalized image for maintenance

The use of an augmented reality technology application like Revit has been instrumental in assisting clients to give their input regarding projects that they invest in hence making them feel like part of the construction professionals. Revit is particularly utilized by architect in visualizing space planning and designing of projects [3]. During maintenance and operations changes, the same technological tool can be utilized in ensuring that clients are on board on the changes that are made. Revit application can be availed even to small-scale proprietors unlike in the past whereby hours had to be spent in making it properly aligned with 3-D models. Currently, 2-D and 3-D models can be accessed through some mobile devices such as iPhone and iPad when viewed in front of the site thereby making the project planning and execution accessible to all the involved stakeholders. The users hold the mobile device camera such as iPhone or iPad in front of the physical site or an image from the site and there is instant recognition. The technology application does recognition of the design and an overlay of the virtual model of what the potential completed model

appears. Drawings from Revit have to be imported into a compatible context (technology application).

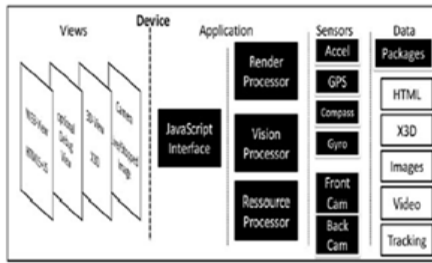


Figure 1: Representation of AR use

The maintenance of buildings is usually risky and involves multiple personnel from various departments such as administrative, technical, and managerial functions [4]. The maintenance and operational function of a building involves preventive and operational functions to ensure proper maintenance of the available facilities.

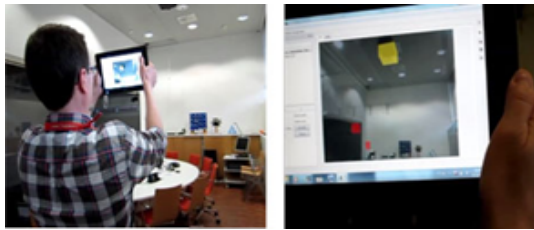


Figure 3: Mobile user finding warnings and alarms in a room (left). Alerts highlighted in mobile AR view (right).

2.AUGMENTED REALITY (AR) TECHNOLOGY WITH HOLOLENS.

The Hololens technology is a Microsoft based application that is best utilized when used with the Trimble Sketchup Viewer which is cloud based. The model to be used in the construction project is uploaded via the cloud and downloaded and viewed at any time through the Microsoft Hololens. The user can view the required project at the desired scale which can be full or reduced depending on the access point or location. The Hololens technology has contributed to various benefits in the building and construction industry. One of the advantages that have been noted from the use of the technology includes the attaining of work that is more precise and streamlined [5]. The professionals involved in the building have utilized the technology together with the Building Information Modeling (BIM) to create 3-D models. Contractors, designers, and engineers can therefore brainstorm, understand, and modify the design before construction based on the evaluations of the technology models. Parameters such as maintenance of required temperatures and operational safety can be discussed and modified based on current health and safety standards in the industry [3].

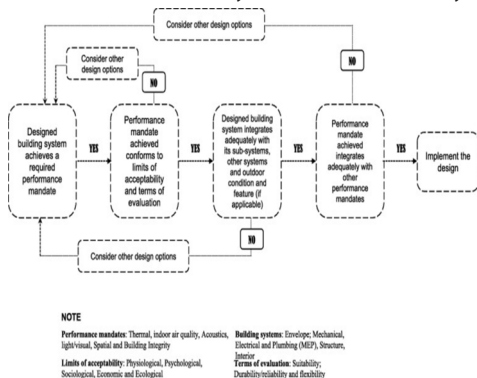


Figure 4: Conceptual framework of design process for building maintenance using AR technology.

The input that is given by the professionals is more complex because each of the professionals involved in the building process

have a higher understanding of the functional and operational systems of the involved building after utilizing the involved Hololens technology. The increased level of complexity has contributed to a higher level of accuracy in the prediction of the level of materials that are to be used in the construction of the involved buildings. Therefore, cost and labor can be properly estimated and budgeted for. The construction crew and professionals can also determine whether there is sufficient space for the required materials. The technology tool also allows an increased level of accuracy in ordering of materials which in turn cuts back on costs [6]. Many contractors now advocate and push for the use of the augmented reality technology based tools so that there are cut backs on what are considered as unnecessary costs.

Contractors also get a chance to group jobs in one category so that the bill of materials contributes to the saving of costs. The burden of resolving challenges that arise during dealing with hardware are also reduced because such issues have already been discussed at the initial stage of assessment by all the professionals and contractors. Therefore, the professionals can concentrate on their areas of expertise and save up on resources such as time. The client and other stakeholders can contribute to the changes of operational based functions such as the inclusion of lavatory facilities that can be accessed by disabled persons for every floor in a story building.



Figure 5: shows an architect taking a stakeholder to a tour of a potential project

Multiple augmented reality technology tools create state of the art convenience for available visions that allow the personnel working on building projects to access cyber information in the form of 3-D state. On-site based photographs and other vision based items can be utilized from mobile devices such as phones. Therefore, the professionals working on a project do not have to be on the site to ensure that a project is delivered to the required standards.

The augmented reality technology tools do not have to bear tracking based modules, attachments with external hardware, or optical fiducial markers for localization of the position of the user [7]. The images that are collected from the project on the ground from the personnel on site can be compared to the visual project images that were used in constructing the actual building. Therefore, the location of the user and the orientation of the existing images are utilized in making comparisons. Pre-collected site images are aligned and checked for differences with 3-D model photographs. To access and fully increase effectiveness, the mobile devices should possess the suitable software to view the 3-D project specific images such as iPhone, iPad, and Hololens Microsoft.

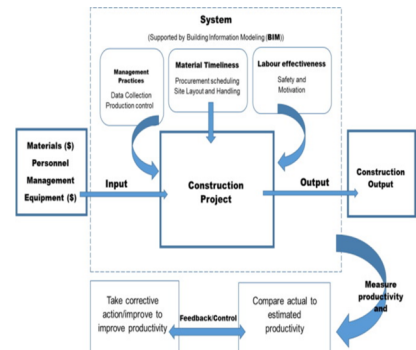


Figure 6: Framework for productivity improvement in construction

According to [6], the Augmented Reality based technology is highly efficient because it only uses the image from the site to identify the accurate orientation and location of the personnel. A set of algorithms that are vision based are utilized in identifying the actual location of personnel on the ground. The HD4AR is compatible with mobile devices that can take images such as tablets and mobile phones. Therefore, field engineers and other personnel can experience accuracy in their on-site actualization which increases the level of convenience while taking up minimal resources.

The AR based technology also offers convenience in that its access can be done by several technicians at one time which are unlike the traditional manuals that could only be accessed by one person at a time. The information about the required maintenance of the project at hand is also availed in real time and can be accessed by the specialists assigned regardless of their location. Therefore, even if the specialists offering advice on the project is physical unavailable, they can offer the required guidance and ensure the maximization of the resources being used in the project such as tools and time.

3. AUGMENTED REALITY TECHNOLOGY BENEFITS

The augmented reality technology contributes to the reduction of the mental workload experienced by engineers for AEC tasks. It also contributes to an increase in the level of performance for tasks assigned to engineers. The spatial cognition that is provided through AR is high for the design visualization and design process encountered by engineers and other site experts assigned on a project [8]. The information for on-site requirements for the building are available for the project professionals which lowers the duration required for the completion of the project. The professionals only have to wear the device that can allow them to access the 3-D images so that they can access the required site information. The professionals have an easier time because they can promptly access the required information to execute their assigned tasks with high levels of accuracy.

Augmented reality can be utilized in getting government authorization for operations and maintenance changes by contractors. Architectural and construction firms are aware of how a building is bound to function over time. They can use the augmented reality to explain all aspects of the building and the reasons as to why certain parameters need tweaking during the operations and maintenance. Some of the changes during and operations might be required due to social and environmental impacts that would be foreseen in future. The authorities would approve the execution of such projects because they would want to avoid the environment from being harmed. The government personnel authorizing the issuance of permits would have thorough knowledge of the risks that would be avoided through the use of the augmented reality applications. Such personnel could play a role in encouraging other professionals and contractors in the industry to adopt such technology applications based on the benefits that would be attained from its use such as risk mitigation.

There is risk mitigation during operational maintenance of buildings through the use of augmented reality. Clients get to see the drafts of computer generated images of their expected vision. Therefore, they can ask for changes to be made, and probable costs. Based on the expected costs, they can make decisions on whether to go on with the project or ask for it to be halted [9]. The consistent inclusion of the clients keeps them interested and ensures that there are heavy costs incurred through changes of designs after the projects have already started. The avoidance of stalling also results in the contractors finishing their tasks on time and leaving them free to pursue more projects.

4. SYSTEMATIC RISK MANAGEMENT

There are various ways that are effective in contributing to the reducing of risks when maintain or operating in buildings. The reduction of risks should be systematic and follow up from the pre-design to operation stages of putting up the building. The use of the augmented reality contributes to the evaluation of drawbacks and

risks that exist as the project continues [10]. The contractors usually utilize the existing plans during the invitation of bids stage. Therefore, the most creative professionals in identifying existing challenges and solutions can be contracted to join the team. Sub-contractors and professionals can utilize the opportunity to showcase their skills in utilizing augmented reality technology to contribute to high levels of effectiveness in maintaining and operating buildings.

There are various parameters that are utilized for assessing existing risks in buildings such as the probability of detection, how severe they are likely to present, and the probability of occurrence [11]. The augmented reality technology tools are effective in giving measured values and assisting experts to give their opinions on the given parameters. The evaluation creates confidence on the building project to be executed. The reality technology enables the use of stimulant tools throughout the risk assessment process. The quality of the building and its effects can be evaluated based on the quality of items used and HVAC components.

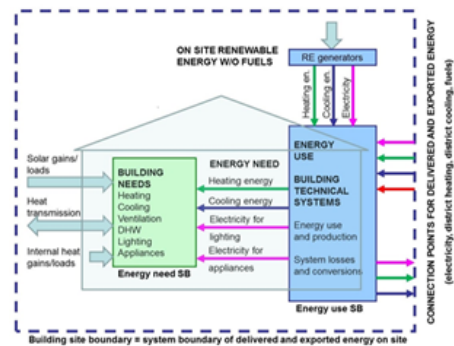


Figure 7: Showing energy consumption assessment of a building.

Engineering, architecture, and construction are some of the complex professional fields that have benefited from the wave of development in technology and its applications. The new and inspiring wave in technology has allowed the capturing, processing, storage, and display of geo-referenced data that was unprecedented in earlier decades. The data is utilized in producing stimulations that can be referenced in real time and allow the proper planning, maintenance, and preparation of construction for buildings [12]. Through the stimulations from the geo-references real-time data, the stakeholders that hold different backgrounds and interests cooperate in the proper planning and maintenance of buildings.

Advanced scene graph technology has been used with advanced and specialized technology applications such as occlusion accelerators for the purpose of accelerating graphics. These technology applications are easy to use and access and have been generated to contribute to orientation and positioning of aligning and generating the orientation of virtual objects. The use of augmented reality prototypes has been established in the construction industry through animated stimulations with the inclusion of activities that would be conducted in outdoor construction environments [13]. The augmented reality prototypes present a chance through which subsurface utility items such as cables and pipes presentations can be made for the outdoor construction outdoor environment. Augmented Reality architectural assemblies contribute to the development of prototypes that can be used to stimulate outdoor activities within the operations of construction projects.

4.1 Risks of using augmented reality

Augmented reality bears great potential in generating positive outcomes in the construction industry especially through increasing efficiency levels. However, the technology applications and tools also pose some challenges for professionals like architects and project managers in the construction, operations, and building

maintenance areas. Just like the use of mobile devices at work, the use of augmented reality technology tools such as a headset can be distracting [3]. Placing heavy reliance on technology related instructions rather than manual ones on the ground might also present a challenge for workers in the construction industry especially when the environment is very busy. A building site that is using augmented reality would have to ensure the strict guidelines and policies for the use of handheld devices to maximize safety and avoid wastage of resources [3]. The use of the augmented reality technology applications should not be used by the construction workers to make up for some needed competencies that they might not possess.

5.CONCLUSION

Many of the project management and construction companies are investing in technology such as augmented reality as a means of increasing efficiency in their work. Early adopters of augmented reality in their projects have experienced high levels of profitability and shorter timelines in construction. Clients that have worked or heard about the benefits of the augmented reality technology in the maintenance and operations phase are keen on working with professionals that utilize the application.

A high number of clients want to work with professionals that keep them updated on a consistent basis. The augmented reality allows professionals working on building projects to work with clients from the design to final stages. Therefore, the clients' interest is high and they contribute to the risk mitigation of drastic changes being made in the middle of the project because they give their input on the specifications that they would want in all the stages.

A technology application such as Microsoft HoloLens is being utilized to ensure that project mockups are accurately availed to the professionals on site. Headsets can be used via the application to show safety and work instructions at physical site locations. The application can also display the fatigue levels of the various employees and the checklist of materials that are available versus what is needed. The application also gives notifications of the project timelines. The measurements of the spaces to be used are given accurately using augmented reality technology. This lowers the risk of errors especially in the later stages of the project. Drones are usually utilized in data collection so that all the required dimensions are taken and incorporated in the design and later stages of the process. Therefore, the risk of poor structures being constructed is avoided, and the construction manager ensures that costs are cut back. If the owners are not consulted, there might be loss in communication resulting in some of the parameters being dissatisfactory and leading to poor reviews for the contractors. Therefore, the contractors should ensure that they involved the contractors throughout the project so that their wishes and opinions are taken into consideration. Such inclusion would ensure that all the involved parties contribute to risk reduction using augmented reality.

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