Augmented Reality Based Platform for Simulation of 3D Models, Generated with a Series of 2D Images, on Real Environment

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Abstract— With the need of an Augmented Reality based platform for simulation of three dimension models, generated with a series of two dimension images, on real environment, the main objective of this project is to build a platform for users to use both these functionalities. This is a mobile application which helps people to decide when they are buying household items, whether that item fits their desired place in the house. Three dimension models can be downloaded using the application and it will be simulated in the real time environment using the concept of Augmented Reality. A desktop application will be implemented for sellers to upload their three dimension models and to generate three dimension models using photographs. With the use of the technology people can make their lives easier, and this is another step the development team has taken to help that cause. Main goal is that with the use of this application people will be able to make their decisions easily when they are going to buy large household items.

Keywords - Structure from motion; Augmented Reality; Software Development Kit; Two dimension; Three dimension

I. INTRODUCTION

Shopping is a very common need of people in day to day life. Shopping is the activity of searching, selecting and ultimately purchasing products and services that fulfill the needs, wants and desires of consumer. There are so many things that the seller is offering to his consumers. This application specifically addresses items which are large scaled like furniture and large scale electric equipment.

As this application emphasizes on large scale shopping items like electric equipment and furniture it can be hard to choose which items would actually fit in the consumer’s house with other furniture already available in the specific room they intend to keep the new item.

There are no products available at the moment which would create three dimension models of consumer desired objects and project the items in the real environment using Augmented Reality. But there are several applications which project three dimension models in the real environment using Augmented Reality.

Main objective is finding a solution to the above mentioned problem. The solution – Envision 3D consists of a desktop application and a mobile application. The mobile application is an independent module from the desktop application. Mobile application focuses on the Augmented Reality segment whereas the desktop application focuses mainly on two dimension to three dimension reconstruction.

The main objectives of the project are:  
• Developing an easy way to create three dimension models using a series of two dimension images.  
• Helping consumers to project three dimension models in real environment using Augmented Reality.  
• Usage of real size projection to aid consumers.

II. METHODOLOGY

Final outcome of this research project will be a portal for construction of three dimension models using a series of two dimension images and simulation of three dimension models of large scaled household items on the real environment. The system will be consisted of the following modules. [1]. Since this paper focuses mainly on the Three dimension reconstruction the rest of the document will give a general overview of the Augmented Reality part of the research. A Detailed view of the three dimensional reconstruction will be provided here.

A. Two dimension to Three dimension Reconstruction

• Obtaining image sequences  
Get the object that you want to create a three dimension model. Take photographs of that object in different angles (minimum 6 photos).

• Structure from motion  
Here at the converse problem of estimating the locations of three dimension points from multiple images given only a sparse set of correspondences between image features is looked upon. While this process often involves simultaneously estimating both three dimension geometry (structure) and camera pose (motion), it is commonly known as structure from motion [2]. As result of the Structure from Motion the
application was able out put a Point Cloud of the three dimension object. Then the Point Cloud will be used to create a mesh and a complete model. The mesh creation will use proven methods such Poisson Reconstruction to achieve this. When analyzing it results showed that the application needs minimum of 8 images in order to get a quality 3D model. But when number of images increases it will take more time to do the processing. But when number of images increases it will take more time to do the processing. Also angles of the images have to be perfect and adjacent images should have common points in order to carry out this processing perfectly. This method also has to consider the lightings and camera quality when taking these images.

![Figure 1-Sample images](image1.png)

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![Figure 2-Results of structure from motion](image2.png)

B. *Storage and conversion of Three dimension models*

This component is a desktop application which allows users to upload already created three dimension models. These models need to be converted in to a suitable format to be saved in the database. And then the converted files need to be stored to be accessed from the mobile application. This includes,

- Converting three dimension models to an appropriate storable format.
- Storing converted Three dimension models in the server

C. *Simulation of Three dimension models on real environment*

- Render Three dimension objects to visualize them in the application
- Project on a real surface using a predefined marker object
- Real size projection
- Customize projected objects

III. *RESULTS AND DISCUSSION*

In order to start the development of three dimensional reconstruction extensive research had to be done on various methods available. The initial task was to find the most suitable method to reconstruction.

- Multi View Stereo correspondence, Stereo matching is the process of taking two or more images and estimating a Three dimension model of the scene by finding matching pixels in the images and converting their Two dimension positions into Three dimension depths. While matching pairs of images is a useful way of obtaining depth information, matching more images can lead to even better results. In this process, reviews were done not only for techniques for creating complete 3D object models, but also simpler techniques for improving the quality of depth maps using multiple source images [3]. Even though this approach was extensively used at the beginning of the research due to the limitations in this approach such as the need of a dual cameras prompted the analysis to move to Structure from motion to further continue.

![Figure 3: System diagram of two dimension-three dimension process and augmented reality](image3.png)

![Figure 4: Stereo correspondence dual cam 1](image4.png)
Goals behind choosing Structure from motion algorithm over Multi View Correspondence will be as followed [11]. In most cases similar to this the goal is to obtain the geometry of the scene, for example, where objects are in relation to the camera and what their form is. Assuming the implementation already knows the motion between the cameras picturing the same scene, from a reasonably similar point of view, next step of the application would now involve reconstructing the geometry. In computer vision jargon this is known as triangulation, and there are plenty of ways to go about it. It may be done by way of ray intersection, where constructed two rays: one from each camera's center of projection and a point on each of the image planes. The intersection of these rays in space will, ideally, intersect at one 3D point in the real world that was imaged in each camera, as shown in the following diagram:

- The first liberty an analysis which involves in a research project like this should take is to oversee difference between stereo (or indeed any Multi View) three dimensional reconstruction using calibrated rigs and Structure from Motion. While a rig of two or more cameras assume that there is enough information to know what the motion between the cameras is, in Structure from Motion, it doesn’t actually know this motion and it wishes to find it. Calibrated rigs, from a simplistic point of view, allow a much more accurate reconstruction of three dimensional geometry because there is no error in estimating the distance and rotation between the cameras—it is already known. The first step in implementing a Structure from Motion system is finding the motion between the cameras. To find the motion the input images will be processed for Point matching between them [4].

- Now that the application has obtained matches between key points, it can calculate the fundamental matrix and from that obtain the essential matrix. Next step looks into the matter of recovering the three dimensional structure of the scene from the information the implementation has acquired so far. As it had done before, application should look at the tools and information it has at hand to achieve this (Matrices etc.). In the previous section application obtained two camera matrices from the essential and fundamental matrices using Point matching. Then, algorithm can go back to the matched point pairs to
fill in the equations with numerical data. The point pairs will also be useful in calculating the error the implementation gets from all these approximate calculations. This is the time to see how team could perform triangulation using OpenCV which has some very powerful set of libraries to achieve these targets.

- When constructing the three dimension model using two dimension images, initially a point cloud is created after processing the image series and a mesh object is generated using the point cloud. Then the model files which are in .obj format are first converted to .h files and then in to .txt to be saved in the database.

- These models can be downloaded to the mobile phone and rendered using OpenGL and previewed on the real environment to give a realistic view. Desktop application is implemented as a windows metro application using C#, .NET, Pearl technologies and the mobile application is implemented for the android platform using technologies including Vuforia Software Development Kit, OpenGL etc.

IV. CONCLUSION & FUTURE WORKS

The existing systems which provide the same functionality have a lot of shortcomings. They have been in the market for some time. They were either originally intended to provide the user with Two dimension to Three dimension reconstruction with ease of use and to project these models without much complications. Even though these goals have been partially achieved by some products they have failed in some areas.

The current systems which are available for three dimension reconstruction are in Beta state for Pc. Also the fully fledged applications which area available for this purpose as desktop applications require expertise from the user. User must have very good knowledge and technical skills to create these Three dimension models from the existing applications. But that problem is solved by this application. Even the basic knowledge in usage of desktop software will be sufficient.

Same ease of use can be expected from the Augmented Reality part of the application too. The existing applications which are available in the market are mainly used for fun and entertainment purposes. There doesn't exist a proper application which can work as a platform for vendors for B2B perspective. Here the vendor can customize the models which the user can view. User is also not limited to the set of three dimension models unlike the existing applications.

To provide the main of goal of ease of use for normal users team has chosen the android development environment. Also in order to give B2B perspective to the project it will also provide a windows web based application which will assist the vendors of large scale house hold items to upload their already created modules to their archive which in return will be used by the customers who download the application.

There was always a bit of uncertainty of doing all these operations in mobile environment during the research phase. Extensive research was done on these areas and have found feasible solutions for Augmented Reality projection. But a solution is yet to be found for three dimension reconstruction. Very reliable and stable libraries and Software Development Kits were used for the implementation phase. Vuforia Software Development Kit
for Augmented Reality and OpenCV for Three dimension reconstruction were used. When it comes to reconstructions the proven methods such as structure from motion and Poisson reconstruction will be put to use.

Future work on this research will include optimizing the algorithm which generates the point cloud. Also the major improvement to be done in future will include perfecting the mesh creation of the point cloud. Use of CGAL libraries and Poisson Reconstruction will play a major part in future work on this application.

Figure14: Poisson surface reconstruction

REFERENCES


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