IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-7, Issue-2, Feb 2019 E-ISSN: 2347-2693

Interactive 3D Model Construction From House Plans using Augmented Reality

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DOI: https://doi.org/10.26438/ijcse/v7i2.416420 | Available online at: www.ijcseonline.org

Accepted: 15/Feb/2019, Published: 28/Feb/2019

***Abstract*—** Augmented Reality is an interactive and real-world environment where the objects in the real-world are augmented by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, and somatosensor. Augmented Reality (AR) is a new interface technology which brings 3D model in the real time environment. To manipulate 3D models in real time environment through the Smartphone's Vuforia technology is used. Visualization of the model can be done by using HMD (Head Mounted Display). Develop a model which will forecast a dynamic 3D model from 2D house plans. The system assembles 3D models and overlays virtual model on the real 2D Blueprint of the house (Architectural/Hand-drawn). Harris corner detection algorithm is used and Detection of Doors/Windows are done through Template matching algorithm. It is mainly based on Image Processing by using OpenCV library functions.

***Keywords*—**HMD(Head Mounted Display), Computer Vision, OpenCV

I. INTRODUCTION

The Initial step is to extract values from the architectural plan (blueprint) through image processing to detect walls and identify corners of the floor plans that are extracted and written to a text file. The roof of the house is detected using intersection points of lines by calculating the angle. 3D modelling part is operated in "Unity" game engine using the coordinate values of the text file.

Image Processing and Augmented Reality Technologies will be used to achieve primary goals of this project. Augmented Reality (AR) is a technology which 3-D virtual objects are integrated into a 3-D real environment in real time. Augmented Reality (AR) is a technology that can generate an image on a user view of the real world. Image processing can be implemented by library like OpenCV and 3D engines. Functions provided by image processing library is OpenCV 2.2 have been used throughout this project to evaluate and find the most appropriate image processing techniques. HMD is used to navigate through all the rooms to showcase the architectural design. They can also add furniture items and can play around. The model which is currently in usage is not capable of show casting the standing models. The system mainly focus on three dimension view using Computer vision for wall detection and Wall modelling, Roof detection and Roof modelling.

Section I contains the introduction of Image Processing and Augmented Reality Technologies , Section II describes the related work of Text recognition and Automatic room ,wall detection and mobile augmented reality , Section III explains the methodology and the block diagram of the proposed system for the 3D model, Section IV describes Results and Discussion of the Harris corner detection of the 3D model , Section V describes about the Conclusion and the Future Work of the Augmented reality and the Virtual reality.

II. RELATED WORK

An Approach to Augmented Reality Technical Drawings

Augmented Reality (AR) technologies that enable creation of a new class of technical drawings called Augmented Reality Technical Drawings (ARTD). With this system the users wearing a see-through Head Mounted Display can visualize 3D CAD models co-located with 2D representations. The users have the possibility to translate, rotate and scale the overlaid 3D CAD [1] model by using a tangible user interface composed from indicative markers. Augmented Reality (AR) is a relative new research direction that allows creation of an interactive virtual space embedded into the physical world. Unlike Virtual Reality (VR) systems, in which users are completely immersed in th1e virtual environment.

Text Recognition and 2D/3D Object Tracking

Object detection and tracking are the main problem in computer vision with many applications such as, traffic monitoring, navigation and scene understanding. There are two computer vision problems (1) the detection and recognition of flat text objects in images of real scenes (2) the tracking of such text objects in a digital video. Computer vision can be defined as the parsing of digital images and videos in order to extract symbolic and quantities information.

SNOOPERTRACK algorithm is used for text detection and tracking algorithms that cover most of the existing solutions to this problem. The most efficient strategy was used in the SNOOPERTRACK algorithm that was described in 2011. SNOOPERTRACK combined the SNOOPERTEXT [2] detector and a T-HOG-based Particle -filter tracking algorithm. The T-HOG descriptor is used twice in this tracker: first, as an image region signature, to evaluate the similarity between the contents of two regions in successive frames; and, second, as an input to an SVM classifier to measure how much "text-like" are the contents of a predicted region.

Automatic Room Detection and Room Labelling from Architectural Floor Plans

Automatic system for analysing and labelling architectural floor plans. In order to detect the locations of the rooms, the proposed systems extracts both, structural and semantic information from given floor plans. OCR[3] is applied on the text layer to retrieve the meaningful room labelling floor plans contain information that collectively help an architect to express the actual dynamics of the building. During floor plan analysis, different types of information need to be interpreted at different points of time. Information segmentation performs fine segmentation of different type of information available in floor plan images e.g., walls, symbols, text etc.After detection of rooms the next step is to define the functions like Living room etc. In order to find the function of each room, the text layer from the information segmentation is connected component of the room is used. The text components which lie in the boundary of a room are taken into account. After extraction of the room text, horizontal and vertical smearing is performed on the extracted text to merge the neighbouring characters, resulting in the bounds for words

Object Detection and Pose Tracking In Augmented Reality

Object detection and pose tracking with a monocular camera for augmented reality applications. To visually merge a virtual object onto a real scene with geometrical consistency, a camera pose with respect to the scene needs to be computed. Object detection and pose Tracking have been incorporated in AR applications. 3AR Toolkit [4] is software that provides the facility to create AR systems. A fiducially marker based Augmented Reality system, the algorithms it uses and how it can be implemented.

Augmented reality can be implemented by using two types of technology: optical or video. Optical AR refers to a see through device (e.g. see through head-mounted display) that will allow the user to see the world but also see the superimposed graphics on the display. ARToolkit is a widely used AR fiducially marker system .It was one of the first programs used to develop AR systems. There are several others that have been based on ARToolkit, such as OSGART, FLAR Toolkit, NyARToolkit, and AR and others. Most of these programs are ARToolkit versions ported to a different platform/language

Mobile Augmented Reality for Building and Construction

Software architecture for providing mobile user at the construction site with two-way real-time augmented reality access to 4D CAD and BIM information [5] .The system allows the user to compare scheduled building information models with the situation at the construction site in real time, as well as to attach position and time aligned visual and other feedback to the building models at the office.

Building Information Models (BIM) is another main technology driver increasingly used for data sharing and communication purposes in real estate and construction sector. The camera tracking technologies open up further application scenarios, enabling us to implement mobile location based visual feedback from the construction site to the CAD and BIM systems and other comments to the virtual 4D model, with full awareness of the user's location in time and space. The 4D Studio software also provides a user interface to browse and visualize incoming reports from the construction site, created by the user with the OnSitePlayer.

Mobile Augmented Reality System for Construction Site Visualization

Mobile Augmented Reality (AR) system for construction site visualization and interaction. The mobile AR system [6] can be operated either stand-alone, or as a client-server solution scaling down to mobile phones and tablets based on lightweight tracking solution. The system is validated in field tests, covering architectural AR visualization with photorealistic rendering effects, up to construction time applications at a real building site.

Virtual building models are often too complex and large to be rendered with mobile devices at a reasonable frame rate. The Client-server extension for the Onsite Player Application. The client extension, Onsite Client, is used at the construction site while the server extension, Onsite

Server, is running at the site office or at some other remote location. Data communication between the client and server can be done using either WLAN or 3G.

III. METHODOLOGY

The image is captured and processed using OpenCV for Unity. The image is stored in the resource folder. The Hough line transform algorithm is used for image processing. The Hough line transform algorithm [7]is used to detect the roof angle and return the detected multiple line segments with slightly different perspectives and it is used to detect the edges of the targeted image. Runtime detection is also made possible using these assets. The Height From Texture Script is used to generate the height map from the detected image. The height map is created from the captured image and then it is applied to the Terrain game object. The terrain height can also modify by the user.

360 degree view is enabled to the user for navigating through house. Augmented Reality / Virtual Reality mode in the system which are enabled to view the terrain game object using head mounted display. Runtime Gizmos is added to translate, scale or rotate the game object during runtime. User can also able to add furniture in the house model. The overall block diagram of the process is shown below.

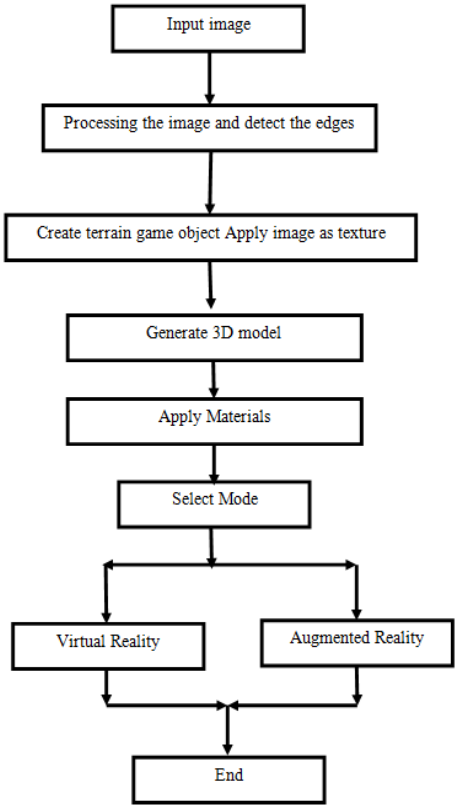

Figure 1. Block Diagram of proposed system

A. Recognizing text from the house plans

The text from the captured image is recognized using vuforia text recognition. The text from the image is replaced using 3D model. (i.e.) The Bed text is recognized from the vuforia, it will place the 3D model automatically into the targeted image. This is used to place the furniture inside the 3D model based on the text.

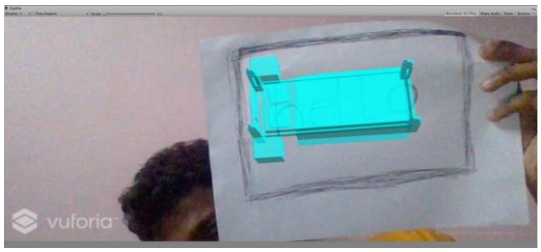

Figure 2. Recognizing Text from the Target Image

B. Detect the edges of the house plans

The edges of the house plan are detected using opencv for unity assets. OpenCV 2.3.1 for Android library, they also included samples image processing code using camera such as face detection and image processing.

Edge detection is an image processing technique for finding the boundaries of an objects within the image. This provides the Computer Vision technique to unity. The Hough line transform algorithm is used to detect the roof angle and return the detected multiple line segments with slightly different perspectives and it is used to detect the edges of the targeted image. Runtime detection is also made possible using these assets.

Figure 3. Detect the edges of the house plans

C. Elevate the 3D module form the detected edges

The terrain game object is created in the unity environment. The height map get generated using the Height map from texture Script inside the terrain. The terrain will elevate based on the height map values. Apply materials to the terrain object. Every corner is depicted and all points of corners are extracted and graphically represented using a

graph. After analyzing all coordinates, it was clear that four coordinates were received per one corner. Detect only the longest line segment pixel coordinates to remove all of the "double thickness" lines caused by detection of both the inside and outside of a wall[8]. All extracted coordinate values are written to a text file to construct walls.

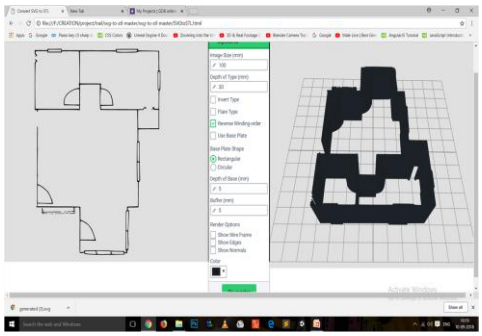

Figure 4. Elevation of 3D Model from House Plane edges

D. Enable VR/AR mode in 3D environment

Virtual reality (VR) is an interactive computer-generated experience taking place within a simulated environment, that incorporates mainly auditory and visual, but also other types of sensory feedback like haptic. This immersive environment can be similar to the real world or it can be fantastical, creating an experience that is not possible in ordinary physical reality. Augmented reality systems may also be considered a form of VR that layers virtual information over a live camera feed into a headset or through a Smartphone or tablet device giving the user the ability to view three-dimensional images.

Augmented Reality (AR) is an interactive experience of a real-world environment where the objects in the real-world are "augmented" by computer-generated perceptual information ,across multiple sensory modalities, including visual, auditory. Augmented Reality offers a real visualization of the final product for customers, enabling clients to create their dream homes. The 3D model can be generated dynamically from an architectural house plan without human assistance to provide values manually. Augmented reality is related to two largely synonymous terms: mixed reality and computer-mediated reality. The image is captured the wall detection and door is detected using with their coordinates the image is imported in 3D model in the Unity Environment .The AR / VR mode is used to switch the 3D environment into the AR/VR environment. The user can view the generated 3D model using Head mounted display.

Figure 5. Captured a Plan

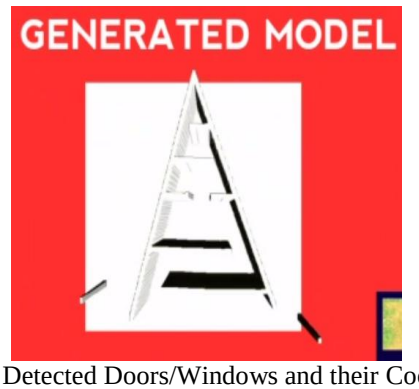

Figure 6. Detected Doors/Windows and their Coordinates

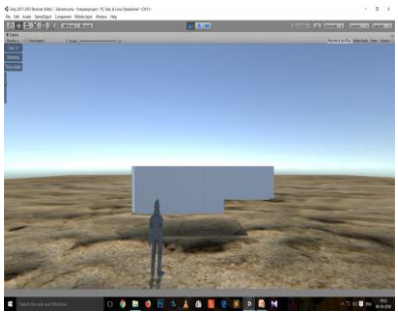

Figure 7. Augmented virtual model

Figure 8. Importing 3D model in the Unity Environment

IV. RESULTS AND DISCUSSION

Harris corner detection algorithm is used to detect the corners of the target image. But the Height map is generated here to generate the 3D model from the targeted image. So that text is filtered using the height map from texture script. It is applied to the Terrain game object. The terrain height can also modify by the user. Image processing techniques

can be used for the detection and extraction of the architectural symbols. Only walls, windows and doors, symbols are oriented horizontally and vertically have been considered while building the system. 360 degree view is enabled to the user for navigating through house.

V. CONCLUSION AND FUTURE SCOPE

The system is use to extract values from 2D blueprint of a house (architectural or hand drawn) and to create 3D models in real time. The main outcome of this is to create 3D models dynamically and give customers the ability to customize their prefabricated home interiors while maintaining the design of the exterior structure. 3D model can be generated dynamically from an architectural house plan. Augmented Reality offers a real visualization of the final product for customers, enabling clients to create their dream houses. This proves that a 3D model can be generated dynamically from an architectural house plans without human assistance to provide values manually.

The Future scope is to convert the 3D model into Augmented Reality and Virtual Reality. 360 degree view is enabled to the user for navigating through house.

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