

Software Based Home Automation for Disabled People

Ms. Mrunali S.Sonwalkar

*Dept.of Computer science and Engg.
M.B.E.S.College of Engineering, Ambajogai. India*

mrunali.sonwalkar@gmail.com

Abstract - We are facing a problem in our daily life that elder peoples or physically disabled peoples, when left home alone cannot do their routine activities. They need to take care in their daily routine, including performing simple activities such as reaching out for switches and electrical appliances. This will lead to more demand for care takers and domestic helpers. With the popularity of mobile devices and the emergence of smart home devices today, it is possible to control and communicate with home appliances remotely. Augmented reality (AR) is one of the recent technologies evolved for automation of the home appliances. This technology gives a virtual view of the devices generating a real environment. This paper, will describe how augmented reality based software application, microcontroller and hardware devices such as actuators can be used to control various home appliances for elderly and disabled people. In this paper we will develop a home automation system that is operated via an AR app using any android mobile device. The system employs the integration of multi-touch mobile devices that has special sensors, arduino based microcontrollers, and actuators which will convert signals into actual physical output. We will give various instructions to arduino via mobile device, which is equipped with sensors and also provide interface between arduino and actuators which will then operate the actual devices. This entire system is used to control and manage various home appliances within the home.

Keywords- Augmented Reality, home automation system, AR application using blender and unity mobile devices, microcontroller, actuators.

I. INTRODUCTION

With the esteem of mobile devices today and the emergence of smart home devices, the general population is becoming more and more comfortable with their use. There have been multiple attempts to use these devices to control and communicate with home appliances remotely. Physically handicap people or old age people cannot do their daily activities by their own, even they find it difficult to use their daily appliances. Most of the home appliances which we use today are usually equipped with remote controllers; this facility also helps disabled people to manage their tasks. Major difficulties while handling these types of appliances is, use of correct remote controller and ease with its operation. A user has so many devices, as a result, they have too many remote controllers, and their management takes trouble. This is an important problem with household electric appliances. Disabled peoples need a single device with which they can handle all the basic appliances in their daily life. Mobile devices are the best device which any common person can easily handle. Now, the question is that how we are going to use these mobile devices to assist disabled and elderly people.

One of the solution to this problem is the use Augmented Reality (AR). Augmented Reality aims at simplifying the user's life by bringing virtual information to his immediate surroundings [1]. AR provides virtual view of object which is similar to its real view. Using virtual view of the object, user's especially disabled or elderly people can able to operate their daily appliances. Augmented reality can be implemented using combinations of different software and hardware devices interfaces. There are number of ways to develop AR based applications and also to interface this software with various hardware devices.

AR enhances the user's perception of and interaction with the real world. It can potentially apply to all senses, augmenting smell, touch and hearing as well. As well as can also be used to augment or substitute users' missing senses by sensory substitution, such as augmenting the sight of blind users or users with poor vision by the use of audio cues, or augmenting hearing for deaf users by the use of visual cues. AR objects are derived from computer generated images 2D and 3D over a live video generated by a camera.

There are three basic approaches for augmenting real world objects.

A. Augment the user

The user wears or carries a device, usually on the head or hands, to obtain information about physical objects. There are variety of devices for users to wear, letting them see, hear and touch artificially-created objects and become engrossed in virtual computer environments[2]

B. Augment the physical object

The physical object is changed by embedding input, output or computational devices on or within it. The commonly used approaches for augmenting objects are use of embedded bricks that contains simple electronic devices such as sensors (light, sound, touch, proximity), logic devices (and-gates, flip-flops, timers) and action bricks (motors, lights). Another approach is ubiquitous computing, in which specially-created objects are detected by sensors placed throughout the building.

C. Augment the environment surrounding the user and the object

In this method neither the user nor the object is affected directly. Instead, independent devices provide and collect information from the surrounding environment, displaying information onto objects and capturing information about the user's interactions with them. There are many approaches for augmenting environment such as computer-controlled animated character moved around a wall-sized screen in response to a person's movements in front of the screen. Also a person sits in a chair, points at objects that appear on a wall-sized screen and speaks commands that move computer-generated objects to locations.

Augmenting the environment surrounding user approach of AR will assist the physically disabled user to control the home appliances easily from their wheelchairs. The system proposed in this paper uses an approach which generates a virtual image of the real object in any of the android based mobile device of user. This image can be generated using AR app software which is combination of blender, unity and vuforia software. With the help of this app user can operate the home appliances. Arduino microcontrollers are used to provide actual instructions to the device. Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board which is also called as a microcontroller and a piece of software, or IDE. Arduino circuit boards are easy to manufacture and only uses an USB cable to provide hardware interface. The arduino programs are developed using simple C++ code. We can derive C++ modules for arduino as per types of sensors and actuators we are going to use in the system. Compared to flat 2D buttons found in current smart phone GUIs, these 3D virtual switches will give the user an eminent interface to control their home appliances. Also the application introduces voice and remote web control features to enhance the operation of these appliances over the mobile device[3].

The system also uses an important component that is actuators. Linear actuators are used to physically handle the actual devices. Arduino controls the actuators which are placed close to the device. Linear actuators are used mainly for the common types of movements where the operation of the device is controlled manually using remote controllers.



Fig. 1 Layout of Smart home

II. RELATED WORK

Home automation system using augmented reality approach is a feasible solution which helps elderly and physically disabled people to manage their task independent of any other. The major work done in this area uses many different methods as well as hardware devices, but key focus while developing these methods is on ease and convenience of the user and cost of the system. Home network based approach is used by Shinya Mihara et.al, [4]. They formed a home network architecture, where all the home devices are interconnected with each other. Since operations and function of each appliance is complex, it becomes difficult for user to find out their locations and work with them separately. To overcome this problem they have used, augmented Reality. AR technology can provide virtual graphics and apply additional information to specific areas through camera displays. AR marker made from a graphical image also called as an image marker is necessary to display the virtual AR graphics to the device identified location. They proposed an LED marker and considered an AR network home appliance operating system to intuitively and easily operate complex network home appliances in dark, bright, or distant home environments

Another approach suggested by Ahmad Kamil Abdul Hamid et.al,[5] uses TIARA, a tool aimed at home users for basic home network management. TIARA uses AR for visual identification of network devices during performing network management tasks. TIARA provides a unified UI and high portability while performing operations of the devices. This is AR assisted tool which uses android mobile phone and a wireless router. A home network consists of a TIARA server and TIARA clients installed using windows or Mac OS. TIARA clients are installed on the users mobile which send an request to TIARA server to perform the task. TIARA server manages the actual device thus the tool assist the user.

Ahmed Mohammad Ullah et.al,[6] proposed a home appliance controlling system named as touch based smart home which augments the users real life experience. They developed a prototype that uses the augmented reality based on touch controlling system to control the daily home appliances in a smart home. They have implemented the system using a smart phone, QR code to track appliances. The client mobile phone and a centralized controlling system. The central system communicates with the client phones using X10 protocol which is used to provide interface among various electronics devices.

Pranav Bedekar and Snehal Nargundi[7] used augmented reality to control home appliances. They suggested that with the use of smart phone devices users will be able to switch on/off the electrical appliances through internet or home network. This system also proposes features such as voice control and remote web control interface for controlling the appliances. This system will mainly help the disabled and elderly people to control the appliances giving them a real world experience.

Physically disabled peoples and elderly need to take care even performing their simple daily activities. With the popularity of mobile devices and the evolution of smart home devices today, it is possible to control and communicate with home appliances remotely. Leroy Zi Wei Tang et.al[8] suggested an approach based on augmented reality, voice control & web server to control these home electrical appliances for elderly and disabled. They proposed a system called as "ARCH - Augmented Reality Controlled Home" together with ARCHServ (a low power and low cost all-in-one backend server) will allow the user to control a physical switch simply by pointing their smart phone's camera to it from a distance. Different virtual switches will appear when the camera is pointed to different appliances, thus allowing the user to control different appliances easily and conveniently.

Bilal Ghazal and Khaled Al-Khatib [9] proposed a smart home automation. This is achieved using a single controller for monitoring and the controlling many interconnected appliances such as lights, power plugs, HVAC system, humidity and temperature sensors, gas, smoke and fire detectors, audio, video and home theater as well as security and emergency systems. It consists of remote control supported by command buttons and provided by alert LEDs and a LCD for showing messages. The unique master board toggles the ON/OFF switches of the appliances by means of relays. The remote control and its base are communicating with RF signals realized by XBee transceivers.

Suraj Joshi et.al, [10] proposed system that will allow the user to control a physical switch simply by pointing their smart phone's camera to it from a distance. Different virtual switches will appear when the camera is pointed to different appliances. These 3D virtual switches will give the user an intuitive yet familiar interface to control their home appliances. They have also introduced voice and remote web control features to enhance the operation of these appliances over the mobile device. The basic algorithms to be used to show augmented view are thresholding, sobel algorithm (edge detection), line fitting, pose algorithm. As an output of these algorithms an augmented image of object is generated which matches the real view.

II. PROPOSED SYSTEM

The system architecture is a low cost and less power consumption model as it is designed for elderly and physically handicapped people. It is an assistive smart home system which can be controlled and monitored remotely. A smart home consist of collection of various equipments that can be controlled and managed through remote controllers, sensors and other hardware devices and software applications. It commands the on and off of domestic devices such as fridge, TV, washing, cooking, and cleaning machines, as well as electrical devices as motors, pumps also[6].

The system uses various sensors that identifies particular device and signal that device with the help of arduino microcontroller. One of the major benefits of using microcontroller is due to their less complexity and support to portable devices, which can be operated through batteries. The architecture uses an android based mobile device that allows users interaction with the actual devices. Android based mobile phones are available in variety of cost ranges, user can use any suitable among them, or even can use their existing mobile phones. This reduces the hardware cost of the system. The objects for actual home device is created software and installed in mobile phone. Images of all the devices are stored in a target image database, which is then uploaded in user mobile. Whenever user wants to operate any particular home appliance, its object image is retrieved from target image database and fed as an input to arduino via sensors. Finally actuator gets these input signals from arduino and converts them to actual physical output, which starts operation of the device. In this way the home appliances get operated. The disabled or elderly people just sitting at a position can manage and control the working of device independently.

A. Working:

With the help of this automation system, the elderly or physically disabled person's can directly interact with home appliances using remote controllers [7]. These controllers are connected to sensors which pick up the signals and provide them to actuators, which send these signals to actual controlling switches or plugs. The input to the sensors is through a software application, which developed in AR. This software app provides an image view of all the home appliances to the person. The person just sitting at one position can use the devices with the help of this app[8]. AR app is developed by using three software's as blender, unity game engine and finally Vuforia. With the help of these three software, the exact image of the object is created. 3D effect is applied to the object image to make it real life image.

Various home appliances are considered as the objects whose images are generate in blender. The blender image can be performed using following operation as shown in Fig. 2

1) *3D modeling*: This process creates a 3 dimensional view of the object which when viewed from the mobile device appears as if it is original object.

2) *Texturing*: This is the process in which some textured patterns as applied on to the surface of image created using 3D modeling. It is necessary as original objects in the scene or real life may contains some textured patterns or may have different color combinations. With the help of which the objects are separated from each other. We are also applying these patterns so that our AR app can differentiate the objects of home appliances easily.

3) *Rendering*: Rendering is the process n which an image is generated from 2D or 3D model with the help of computer programs. It converts the description of scene into actual image. The scene is described in a simple format, and then with the help of blender the color code of the image is calculated. Thus the pictures of switches, sensors and various devices are converted into colorful image format.

4) *Animating*: Finally animation process implements the desired effects on image which make that scene real. These effects impose some movements to the objects and assign sound effects where ever necessary. 3D animation also maintain synchronization between the object movement and sound effect.

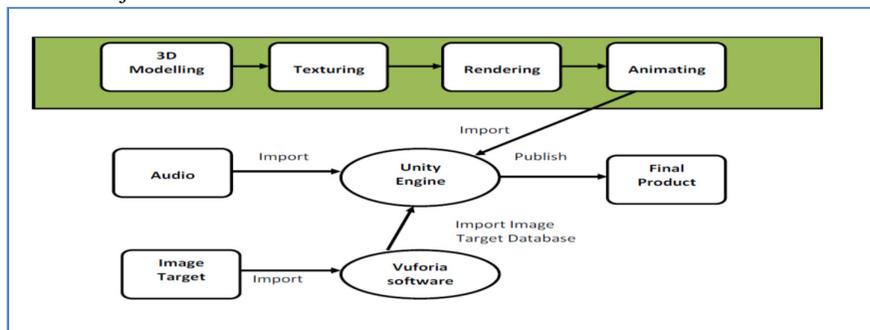


Fig. 2 Components of an AR app.

With the help of blender software the image of object is created and imported to unity which assigns proper sound and lighting effect with the image. The target mage of the object is taken and inserted into the image target database which is created using vuforia software. This database is interfaced with unity and thus the final product of the object is created using AR app[9]. This AR app is installed in any of the android mobile device, which also has some special sensors to identify each device. Separate sensors are used for independent devices, which sense the signals for that particular device. The android mobile device has images for each home appliance. When any one device or any electrical switch is to be operated, its image is selected from the app and instruction for that device is given via the software. The signal to that device is sensed by its sensor, which allows operation of that device.

An arduino microcontroller is used at the actual device which senses the input from AR app software and turns it into an output, which is input to actuator. The interface of arduino and linear actuator is as shown in Fig 3. Once actuators get their input from microcontroller in terms of instructions; they generate their output that performs actual operation



Fig. 3 Controlling Linear Actuator using Arduino

IV. CONCLUSION AND FUTURE SCOPE

The proposed system is used to assist physically disabled as well as elderly people. The idea behind this system is, such people can easily manage and control various home appliances without moving from their position even though they are alone at home. The proposed system uses AR app software along with the microcontroller and interfaced with sensors which are used to sense any household device. The models of the common household devices are created and loaded in AR app using combination of blender, unity and vuforia software. Sensors mounted on the devices activate the devices and microcontroller controls the operation of the device. The proposed system is a cost efficient and beneficial as the software used is open source. Thus the proposed system is feasible to use.

In future we can reduce the software and hardware interfaces by reducing number of components involved in this system. One of the major issues with proposed system is the models of the home appliances need to be created using combinations of different types of software applications which is time consuming task. Once the designs are created they will remain in target image database permanently, but modification in their design is again complicated. The main focus should be made to overcome from this drawback in future.

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