Home automation enabled with Augmented Reality and Internet of Things (AR and IoT) using Sinric Pro

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Abstract **Augmented reality(AR) is a vast field which enlarges the capabilities of various technological areas. Even though AR has proven to be advantageous in various areas, mainly by eliminating cognitive overload and providing a visual experience, it has a major drawback of requiring internet connectivity in most applications. Internet of Things(IoT) is associated with AR to upgrade existing IoT technology to another level. Considering home automation(which incorporates IoT), when coerced with AR provides remote access to the network, contactless switching(simply, by hovering over virtual buttons) and includes additional features like temperature, humidity detection, etc. AR is an emerging technology which is rapidly developing. This, when used with novel cloud platforms like Sinric Pro, Blynk, ThinkSpeak, etc. results in the exploration of a lot of new features. This paper describes the concept of AR integrated with home automation which uses IoT and Sinric Pro. Using these technologies in the existing system enhances human capabilities, creates unique customer experiences and provides real time analysis. It discusses an approach to inculcate AR in IoT to increase the applications.**

Keywords: **Augmented Reality, Home Automation, Internet of Things, Sinric Pro, AR and IoT, Temperature detection**

I.   INTRODUCTION

Augmented reality is the science of enhancing user experience via connecting the physical world with the computer generated inputs ranging from images, videos to graphic overlays which respond to real time variations in the present environment. Virtual objects are brought to the real world with the significance of easy operation.

Internet of Things or IoT on the other hand, is a wirework of objects ("things") that can be fused with various sensors, softwares and a vast range of technologies for the sole purpose of exchanging data over the internet. Some projects are based on home automation using smart phones and computers using the principle of multiple cloud servers controlled by a single admin[3].

The emerging AR technology has evolved for the automation of electrical appliances. AR and IoT when integrated together results in operating general Home appliances (eg. Tube lights, fans) to sophisticated level machines in various industries leading to ease of operability of devices by giving remote access to the user. People have presented the idea of ARIoT in realizing in home appliances which include object centered illustrations[4].

The advancement in technologies are leading to high expectations of living standards. Home automation is one of the fillers of these expectations. Home automation using AR and IoT is a technology interfaced between computers and mobile phones to operate the appliances automatically through the internet with the help of apps and virtual buttons generated using platforms like Unity Hub and Sinric Pro.Though with every enhancement comes a challenge. In case of Home Automation one needs constant internet access and is required to install the related apps [5].

Previous research conducted in the augmented reality field and IoT has suggested that the cost of implementing these technologies is not cost effective and heavy on the servers but the recent researches and emergence of future centric technologies in cloud services and handy gadgets had made it feasible to achieve scalability of the connected devices and information sharing capabilities[6]. AR has been massively established as a clearly scientific discipline [9].

The implementation starts with integrating Unity 3D with the Vuforia engine followed by generation of a target image. The results and then linked with the hardware components through the cloud platform. Eventually, an app is generated by the Unity Hub which gives access to the virtual buttons for the users to operate the devices by just hovering through the virtual buttons.

This paper presents a smart automation technique which uses AR and IoT technology implemented using Esp32 , Unity 3D and cloud platform Sinric Pro to control the devices in the most efficient manner. It will discuss a cost effective way to implement AR and IoT incorporated in Home Automation along with the description of the various technologies used.

This paper introduces the topic of home automation using AR and IoT followed by the existing technologies in this field. Then, it conceptualizes the procedure of implementing this technology along with stating the hardware and software specifications. Finally, it concludes and discusses the results.

II. RELATED WORK

Through some previous papers, certain knowledge was acquired which helped in the study of the subject in a better way. It helped build understanding related to the concept.

Choonsung Shin et al.[1] have shown context-awareness of mobile augmented reality. Mobile mashup allows users to interact with mashups in real life. They have illustrated, General Framework, General Framework,implementation, evaluation & showed up the performance accuracy. Dongsik Jo et al.[2] proposed the concept of AR framework with extensible IOT technology. The demonstration was done through performance testing, surveys and prototyping. They also showed possible configuration and the interfacing and tracking information of the AR and IoT based devices.

Dey et al.[3] have focused on automation of home appliances with the help of smartphones and computers. They have connected multiple cloud servers managed by a single admin which aids a number of users to which sensors and control nodes are connected. Dongsik Jo et al.[4] presented the idea of ARIoT for home appliances in comprehending in-situ AR manuals which often require object centered illustrations. Verification of ARIoT concept of TV with operational manual illustrations is presented. A generalized overview is shown but lags with a detailed explanation.

Khanna et al.[5] Presented a methodology of combining the features of AR and IOT. The user can immerse themselves with the virtual experience and the ability to control multiple devices and objects. Two important contributions are presented in this project: A mobile application to control IOT devices and implementing AR application using Unity 3D.
Dongsik Jo et al.[6] shows the users experience with better usability and satisfaction in the fields of interactive AR shopping and hence reflecting its potential. Wherein they have used GPS-equipped smartphones and augmented reality markup language (ARML) to have location-based geographical and AR services to be developed for shopping purposes.They have demonstrated it using Raspberry pi as microcontroller.

Andrade et al.[7] included envisioning IoT data in Virtual Reality, visualization of smart buildings and cities in 3D or network management of devices used in IoT and Augmented Reality. Here they have demonstrated detailed relationships between Extended Reality, Mixed Reality, Virtual Reality and Augmented Reality. Monica Aiswarya Ankireddy et al.[8] presented an approach to control devices using AR and Image processing. In the first part of the procedure application of AR is developed for mobile devices where changes made in the AR environment are reflected in the real world. The second part consists of a budget friendly smart glass which is portable and is drafted with the control features of the devices.

Manuel Alonso-Rosa et al.[9] have come up with a conclusion of mobile augmented reality (MAR) with IoT technologies. They have tracked energy systems related to augmented reality in order to picture the real-time PQ parameters and the energy consumption in home appliances. It is shown in a simple and convenient way letting the end users focus with their phones directly on the home appliances.

Sivagami.P et al.[10] have shown an IoT concept of incorporating IoT in health care, home and industry automation. They have also shown alternative ways to save energy. Sureshkumar S et al.[11] presented the idea related to the integration of Augmented Reality with Industry(AR-IoT)4.0 and tracking things with the help of sensors. They have given a general overview of how AR is being used in Manufacturing , Service and Maintenance, Industry, and how sensors are being utilized in various domains.
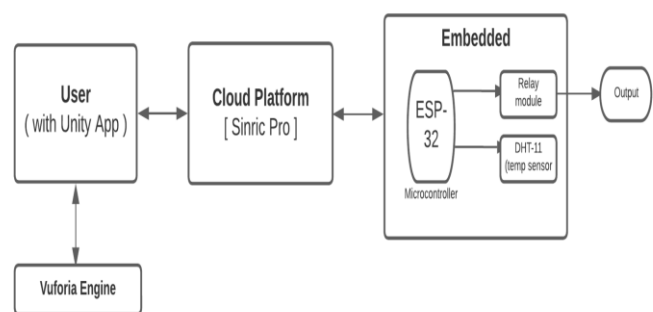
III. PROPOSED SYSTEM

Fig. 1. BASIC BLOCK DIAGRAM

The basic circuit is made by connecting the main components of home automation, here, ESP32, Relay Module, temperature sensor(DHT11) and uploading the code for home automation.This circuit is connected to

electric appliances which need to be controlled as seen in (Fig. 1). Cloud is a major part of Iot. Sinric Pro API helps in this domain. It allows the user to control the buttons by mobile or by using platforms like Google Assistant, Amazon Alexa, etc. Hence, letting the electrical applications be controlled by voice assistance too. Furthermore, it also acts as a cloud in aspects of data. AR app is generated by Unity3D by importing Vuforia Engine. The C# script is uploaded in the software itself. Virtual buttons(ON/OFF) are created which would recognise the target image and hence, display them. This enables the users to just hover over the virtual buttons to switch the application on and off, in short to control the appliances as seen in (Fig 2.) UnityHub gives the flexibility to position with respect to various angles and planes the virtual buttons as per the user's requirement in the desired space.

The DHT11 sensor enables the users to detect the real time temperature and humidity[1]. Moreover, AR enhances the display of this information by just tapping on the virtual button. This can be a separate virtual button created in order to display this information.

Therefore, this technology helps develop ubiquitous and hands-free/ contactless applications.

(Fig.3) shows the installation of the embedded system. An important part of this installation is ESP32. ESP32 is a microcontroller which has integrated Wifi. It's towards the inexpensive side of microcontrollers. Along with this, it also has a dual mode Bluetooth. ESP32 is used as the main component in the embedded part of the home automation project. It comprises various pins which are either UART, I2C, or SPI. The relay module is also used which is a switch. A relay module helps to make the system safe and reliable in terms of power control. Pins like Relay Trigger, Ground, VCC, Normally Open, Common, Normally Closed, etc. are used in the relay modules. There are different channel types in the relay modules depending on the requirement. The temperature sensor used in (Fig.3) is used to monitor temperature fluctuations. In a temperature sensor, the increase in temperature results in bending of the two dissimilar metals making a resistance difference.

TABLE I SOFTWARE AND HARDWARE REQUIREMENT

Sr. no.	Name of Software /Hardware	Description
1	**Unity3D**	This software enables users to build applications, animate, and design architecture of a project. It helps to build real time projects which can be two dimensional or three dimensional. Unity is executed in C# language. Generation of the application which can be downloaded on mobile phones in order to control home appliances is done using Unity3D. Virtual buttons(ON and OFF) can be made and then set according to the user's requirements.
2	**Vuforia Engine**	Vuforia Engine is a software development kit which is imported into the Unity project.This is used to create AR applications. It tracks the target images which occur due to the image recognition feature provided by the Vuforia Engine. This SDK provides various features to make the application interact with the real world. Vuforia Engine assists the Unity software to display virtual buttons once the target image is recognised from its database.
3	**Cloud Platform**	Sinric Pro is an Application Programming Interface(API) cloud which helps to integrate IoT boards with Amazon Alexa cloud, Google Home, Cloud. Python, C++, NodeJS, etc. libraries are provided by this API.

4	**Microprocessor**	**ESP32** is a wifi based microcontroller having 38 GPIO pins. It has 2.4GHz Dual-Mode WiFi + Bluetooth. It is secure and can be used in a lot of applications
5	**Physical devices**	● All the physical devices like lights, fans, switches, etc. are all connected to the microprocessor through a relay module which allows the software to operate the functionality of the devices. ● **The Relay Module** is used to control many appliances, and other equipment with currents with high magnitude. It consists of 2 status indicator lights (green - ON , red - OFF). AC appliances are controlled by the DC power input used by the relay module. ● **Temperature sensor :** DHT-11 is a low cost temperature and humidity sensor module.Uses 3.3 - 5V as input voltage. Temperature range 0-50°C

IV. RESULTS AND DISCUSSION

We successfully built the application for smartphones (Android and IOS).The camera was able to detect the target image set in the Unity 3D and virtual buttons were displaced with no issue [Fig 2]. The functionality on the virtual buttons were tested which resulted in successful operation (turning ON and OFF) of the appliances [Fig 3] . Additionally the App was able to display the real time temperature and humidity in the surrounding based on the data updated on the cloud as per the changes occurring in the user's environment [Fig 4]. For smooth operation of the automation and Temperature detection system it is required to build the system efficiently. As AR uses real time data it is necessary for the data to be updated within seconds and reflect with accuracy.

To achieve this one should make sure of the following:
1) Set up a target image
2) Recognise the IoT components
3) Upload the data on cloud service
4)Get relevant data
5) Display the results on the App.

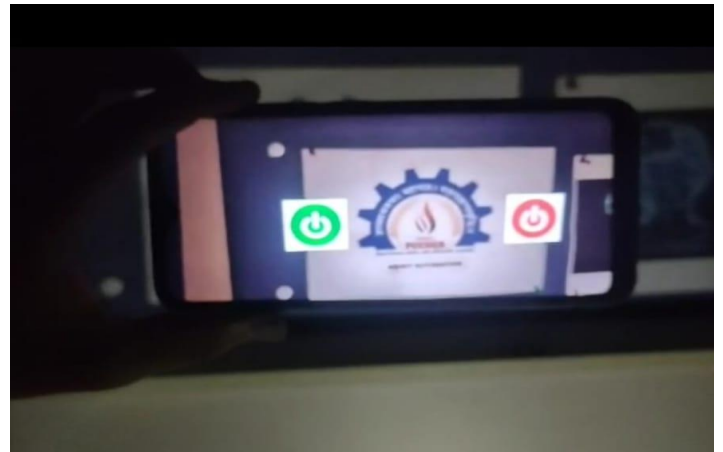The results were as expected and the embedded parts (hardware system/appliances) were interactive with the cloud

Fig 2 . Camera focused on 1st target image (ON/OFF button pop up)

Fig 3. Installation of Embedded system

.Fig 4. Camera focused on 2nd target image(temperature, humidity status pop up)

V.   CONCLUSION

This paper proposed that feature of AR in IOT ie. ARIoT has broadened its capabilities. It is an innovative way to represent a realistic environment. In this paper, an AR framework has been proposed for Home automation which displays the temperature and humidity of the surrounding environment where the hardware is placed. In the olden days, applications had to be operated by physically turning ON / OFF the switch but over time they can be operated by hand gestures movement   with the help unity app. The technology can be scaled to a large extent and can be exposed to a variety of environments. The use of expensive devices like oculus, hololens is eliminated and is replaced by Unity generated mobile apps for AR experience. Henceforth, cutting the cost of AR home automation experience. By blending AR and IOT, more innovative and unimagined ways of interacting with appliances have been created.

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