Cost Effective Home Automation using IOT and Smartphone

Bagyaveereswaran V, Shivam Kumar, N. Ruban, R. Anitha

Abstract: ***In this paper, a Home Automation system based on IoT that employs the integration of cloud networking, microcontroller, smartphone and wireless communication, to provide the user with remote control of various lights, fans, and appliances within their home using their smartphone and store data onto the cloud is presented. It also has safety and security features. This system is designed to be low cost, easy to install, compatible with existing home appliances and expandable allowing a variety of devices to be controlled. We tackle the problem of high cost, use of proprietary wireless technology by various companies which are incompatible with each other, incompatibility with existing home system and difficulty of use by designing an IoT system which is based on low-cost open source technology.***

Keywords **: *Automation, IoT, cloud networking, Wireless, MQTT, smartphone..***

I. INTRODUCTION

Home Automation system(HAS) using Internet of Things (IoT) is a project that uses a smartphone to control and monitor basic home appliances and access information about the status of the house using internet from anywhere around the world [3]. It utilizes a cloud-based IoT platform which helps to connect to the things around us so that we can access anything at any time and any place in a user-friendly manner using applications on a smartphone [1].

The IoT is the network of physical objects or things embedded with electronics, software, sensors and connectivity to enable it to achieve greater value and service by exchanging data with the manufacturer, operator and/or other connected devices [1]. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. The motivation behind this proposed work came from the need to save power and make life free of worries. In hustle and bustle of everyday life in the modern world, people need to be more relaxed to lead a healthy life. One may forget to put out lights or forget to lock the door of a house or have doubts after leaving for morning office which would lead him/her to worry till he/she gets back. So, checking the status of house appliances, security of house and taking actions from office or while on a holiday tour would reduce tension and electricity bill in case of forgetfulness [4]. One keeps all valuables, documents that need to be safe in their houses, so security is a real big concern. Also, if some mishap, like house fire possibilities or theft, takes place, the owner needs to know about it and some automated actions if saves the house would be beneficial. This shows the real need for a smart home [5]. But building a new smart home or upgrading to one burns a hole in individual's savings. This motivated us to come up with a solution of building a low-cost smart home that could be used with existing home architecture with minimal modifications. Raspberry pi is used to interface the software and hardware of the system. The entire system can be connected to the peripherals using USB/HDMI/GPIO to the internet by using either Wi-Fi or Ethernet [6-7]. Jayavardhana GubbiA discussed the cloud-centric vision for worldwide implementation of IoT and the key enabling technologies and application domains that are likely to drive IoT research [8]. An effective implementation for Internet of Things used for monitoring regular domestic conditions by means of the low-cost universal sensing system is presented in [9].

The rest of the paper is organized as follows. The detail about the cloud and microcontroller technology used in home automation is discussed in section II. In section III system description is given. Section IV belongs to control algorithm and in section V hardware implementation is presented. Finally, in section VI the conclusion is drawn.

II. BACKGROUND

Microcontroller technology has been fully understood and the conclusion was established that controllers with built-in Wi-Fi module needed to be used to connect the microcontroller to the cloud over the internet using Wi-Fi technology, which is fast, efficient and provides good range and bandwidth [2-3],[14]. The protocol for the communication of cloud platform with a smartphone was decided according to need and use of the communication system. MQTT protocol is used as it is an extremely lightweight publish/subscribe messaging transport [15].

Revised Manuscript Received on October 15, 2019.

Bagyaveereswaran V, School of Electrical Engineering, Vellore Institute of Technology , Vellore, Tamil Nadu, India, Email: vbagyaveereswaran@vit.ac.in

Shivam Kumar, School of Electrical Engineering, Vellore Institute of Technology , Vellore, Tamil Nadu, India, Email: shivamkumar.2016@vitstudent.ac.in

N. Ruban, School of Electrical Engineering, Vellore Institute of Technology , Vellore, Tamil Nadu, India, Email: nruban@vit.ac.in

R. Anitha, School of Electronics Engineering, Vellore Institute of Technology, Vellore, Tamil Nadu, India. Email: ranitha@vit.ac.in

It is useful for connections with remote locations where a small code footprint is required and/or network bandwidth is at a premium. Cloud MQTT platform is used for interaction between smartphone and cloud as it lets us focus on the application instead of spending time on scaling the broker or patching the platform. It also provided an established android app that could be personified as per requirement. Hence, a smartphone user controls a home.

III. SYSTEM DESCRIPTION

The proposed system consists of a microcontroller with a built-in Wi-Fi capability, PIR motion sensor (HC-SR501), and temperature and humidity sensor (DHT 11), relay module with optoisolation, sensitive Hall Effect switches (A1344), regular bulb, piezo-buzzer, LEDs, a cloud platform, and a smartphone [11-13].

This system incorporates an embedded systems microcontroller (ESP8266 Node MCU) with built-in Wi-Fi module that would help for two-way data communication, i.e. sensor outputs can be viewed or monitored on a digital system (Smartphone with IoT manager application connected to CloudMQTT(cloud service) and control signals can be actuated using the same communication line [10]. The system incorporates such multiple nodes, making the inter-communication among them possible, which is actually the basis of IoT. The cloud has the algorithm that lets the action communicated and also analyses and sends commands for taking suitable actions. The cloud service enables the user to review the status of sensors and appliances and also overwrite the automated decisions. This helps in providing security features to the system. The protocol being followed is very safe and therefore owner stays the only authoritative personnel to have access to his personal belongings. The house shall also alert the owner in case of wanted break-in by putting on the alarm and push notifications to the owner's smartphone. The technology used being open source reduces the cost significantly and also user-friendly.

The goal was designing a smart product which would have the following features:

- It can retrofit in the existing switchboard which is the access point for all devices i.e. no need to change the existing system or devices/appliances.
- It will control all appliances by controlling the current rather than communicating with the device and can control any electrical device.
- It will connect to Wi-Fi router and can be accessed by an Android app installed on a smartphone.
- It can also connect to the internet and send data to the cloud using the Internet and can be accessed from any place in the world.
- It will use open source technology to reduce both product and development cost.

Fig. 1 illustrates the flow of data in the system which is bidirectional and uses the internet. A bottom-up approach was used to build this project where each subsystem was tested and then assembled together to function together.

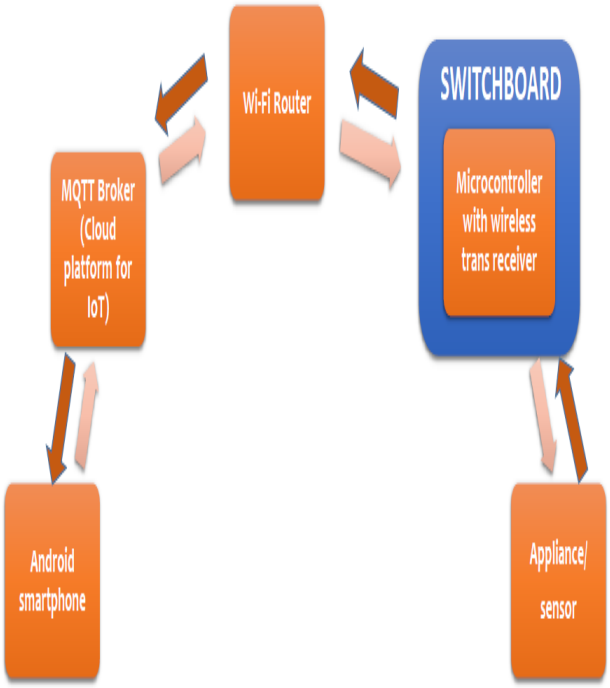

Fig. 1. Block diagram showing flow of data in the system

Fig. 2 illustrates the three main components of the proposed system all of which communicate each other using MQTT protocol [15]. On the client side we have NodeMCU (microcontroller with built-in Wi-Fi capability, the CloudMQTT broker is online hosted broker service which acts as a mediator between client and application and then we have IoT manager android app which has a user interface with many widgets to control the client and display the data from the client [10][16]. Some topics (in the context of MQTT) are decided and then data or payload in a specific format like JSON is published to topics and whoever is subscribed to the topic gets the data [18]. This is why MQTT is known as Pub-Sub protocol [17].

IV. CONTROL ALGORITHM

Fig. 3 shows the complete procedure how the smartphone app (IoT manager) interacts with the broker/server and broker/server communicates with the client i.e. NodeMCU by publishing and subscribing to topics and transferring data in JSON format. One topic is used for displaying the widgets and another topic is used for sending control commands.

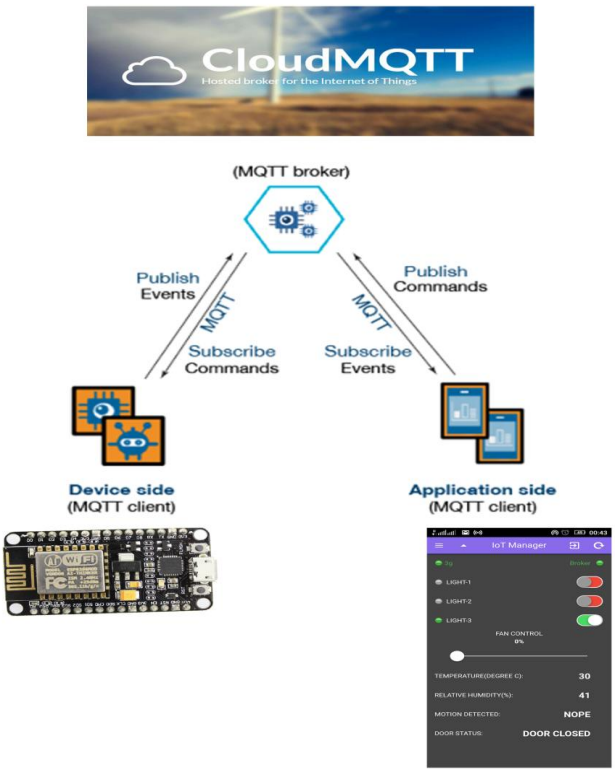

Fig. 2. Main Components of the Proposed System

The app interface and the setup used in real time environment are shown in fig. 4and fig. 5. The working of the system on Arduino IDE serial monitor is illustrated in Fig. 6

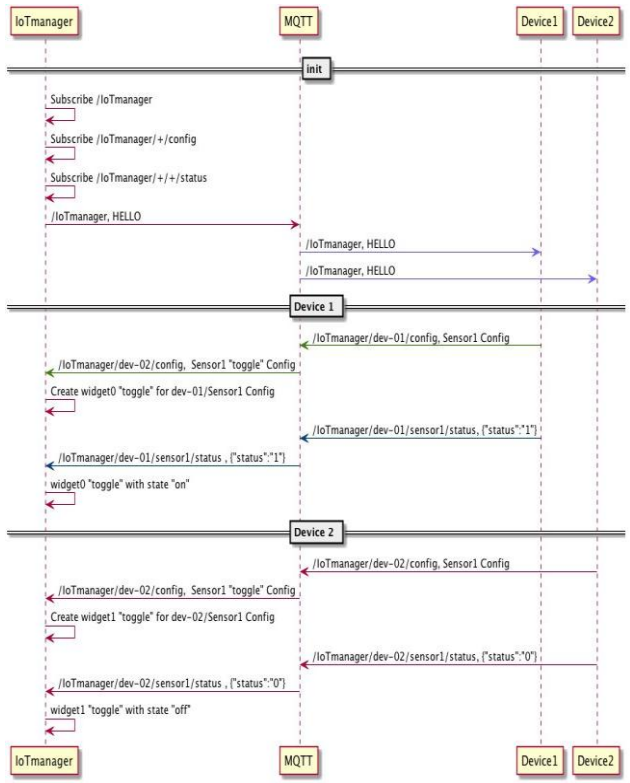

Fig. 3. Complete interaction procedure between the components

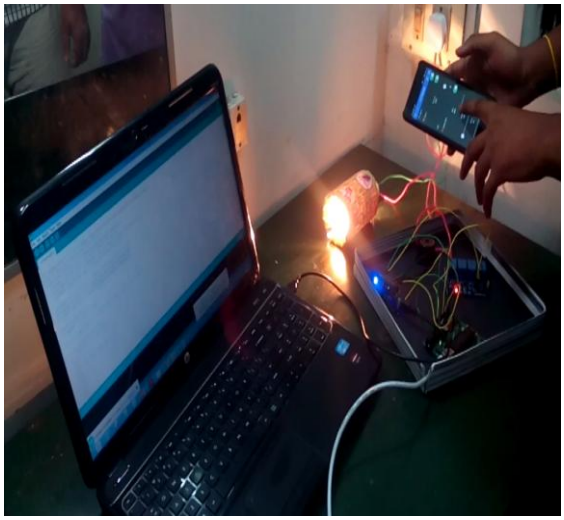

Fig. 4 Setup in real time environment

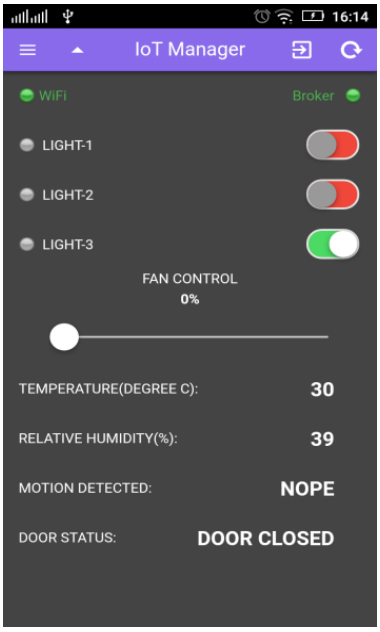

Fig. 5. Developed mobile App

V. CONCLUSION

It is evident from this project work that a home automation system using IoT can be economically feasible using low-cost components. This system can be used to control multifarious home appliances ranging from lights, fans, and security systems. Also, this project shows that it is viable to convert an ordinary home to a smart home without replacing existing components with new high-cost smart appliances.

The successful completion of project showcases the intent of making human living more comfortable and stress-free in complicated and competitive life empowering a user control and monitor his/her home from anywhere around the world by a click on the personal smartphone in real time. Further up gradation and addition of features is possible in the system developed, proving it to be a truly expandable home automation system.

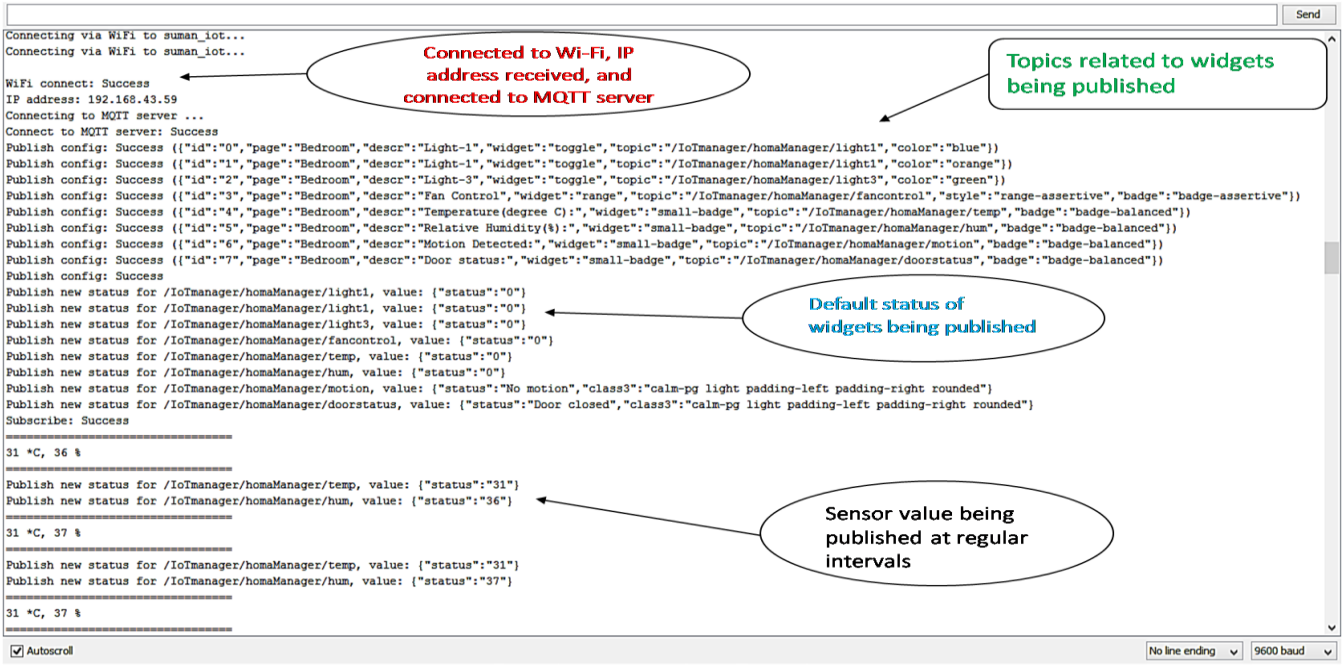

Fig. 6. Arduino serial monitor

REFERENCES

1. Vinay sagar K N 1 ,Kusuma S M2, "Home Automation Using Internet of Things", International Research Journal of Engineering and Technology, Volume: 02 Issue: 03 | June-2015 Page 1965-1970
2. Kumar Mandula, Ramu Parupalli, CH.A.S.Murty, E.Magesh, Rutul Lunagariya, "Mobile based home automation using Internet of Things(IoT)", 2015 International Conference on Control,lnstrumentation , Communication and Computational Technologies (lCCICCT), pp 341-343.
3. Atzori, Luigi, Antonio Iera, and Giacomo Morabito. "The internet of things: A survey." Computer networks 54.15 (2010): 2787-2805.
4. Pavithra.D, Ranjith Balakrishnan, "IoT-based Monitoring and Control System for Home Automation ", Proceedings of 2015 Global Conference on Communication Technologies (GCCT 2015) ,pp 169-173.
5. Kaushik Ghosh, Rushikesh Kalbhor, Disha Tejpal, Sayali Haral, "Wireless Home Automation Technology (WHAT) Using Internet Of Things (IoT)", International Journal of Technical Research and Applications, Volume 3, Issue 6 (November-December, 2015), PP. 161-164.
6. Chirag Atha, Kshitij Baranwal, Varad Desai, Sunil Wankhade, "Review Paper on Home Automation System using Raspberry Pi", International Journal on Recent and Innovation Trends in Computing and Communication, Volume: 4 Issue: 10, pp 168-172.
7. Smita Mahindrakar 1, Ravi K. Biradar, "Internet of Things: Smart Home Automation System using Raspberry Pi", International Journal of Science and Research (IJSR), Volume 6 Issue 1, January 2017, pp 901-905.
8. Gubbi, Jayavardhana, et al. "Internet of Things (IoT): A vision, architectural elements, and future directions", Future Generation Computer Systems 29.7 (2013): 1645-1660.
9. Kelly, Sean Dieter Tebje, Nagender Kumar Suryadevara, and Subhas Chandra Mukhopadhyay. "Towards the implementation of IoT for environmental condition monitoring in homes." Sensors Journal, IEEE 13.10 (2013): 3846-3853.
10. https://en.wikipedia.org/wiki/NodeMCU.
11. Adafruit, https://learn.adafruit.com downloads/pdf/dht.pdf.
12. "HCSR501", https://www.mpja.com/ download/ 31227sc.pdf.
13. Robu, "Four relay module", http://robu.in/product/4-channel-isolated-5V-10A-relay- module-optocoupler-for-Arduino-pic-avr-dsp-arm/.
14. https://en.wikipedia.org/wiki/IEEE_802.11
15. http://mqtt.org/faq.
16. http://www.Allaboutcircuits.com/ Projects/introduction to the MQTT protocol-on-nodemcu/.
17. https://www.cloudmqtt.com/Images/publisher_subscriber.png
18. https://en.wikipedia.org/wiki/JSON.

AUTHORS PROFILE

V.Bagyaveereswaran became a Member (M) of IEEE in 2011.He was born in Madurai, Tamilnadu, India in 1980. He received the B.E degree in Instrumentation and Control Engineering from Madurai Kamaraj university, Madurai in 2002 and M.Tech degree in Control Systems and Instrumentation from SASTRA university, Tanjore, Tamilndau, India in 2004. He was a lecturer with Mookambigai college of Engineering from 2004 to 2007. Since 2008, he has been an Assistant Professor with school of electrical engineering, VIT, Vellore, Tamilnadu, India. He is the author of more than 25 articles. His research interest include optimization applications, controller design for nonlinear processes. Mr. Bagyaveereswaran is also an active member in soft computing research society.

Shivam kumar is a student studying in VIT Vellore , INDIA, TAMIL NADU. He is currently pursuing Btech in EEE field, and has consistently performed well in his academics and published 2 research papers. He is awarded with special achiever's award for presenting paper in Hong Kong . He is also a part of SEDS PTOJECT which is the most renowned project team in VIT , and had gone for many international completions , he represents the team as electrical head. His reserach intrest are in embedded systems and healthcare .

Ruban Nersisson has completed his Bachelor of Engineering in Instrumentation & Control Engineering from University of Madras, India in 2001, Masters in Biomedical Signal Processing & Instrumentation from SASTRA University, Thanjavur, India in 2004 and PhD from VIT University in 2018. He is having 15+ years of teaching experience in various Engineering colleges in and out of India. He currently works as an Academic Faculty member in India's number 1 private university VIT University. His research areas are Bio signal Processing, Speech recognition, Machine learning. He is having number of research articles on the above mentioned fields.

R.Anitha became a Member (M) of IEEE in 2011.SHe was born in Dharmapuri, Tamilnadu, India in 1983. She received the B.E degree in Electronics and Communication Engineering from PGP College of engineering, Namakkal in 2004 and M.E degree in Applied Electronics from K.S.R College of Technology, Tiruchengode, Tamilndau, India in 2006. She was a lecturer with Sona college of Technology from 2006 to 2007. Since 2008, she has been an Assistant Professor with school of electronics engineering, VIT, Vellore, Tamilnadu, India. She is the author of more than 20 articles. Her research interest include multiplier design using Vedic mathematics.