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Smart home and security system with intelligent monitoring

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ABSTRACT

Automation is all about technology in one go, and one of such technology is IoT (Internet of Things). By this paper, we provide a dependable, affordable, and secure Smart Home and Home Automation solution to society. Through IoT, one can easily connect any device with anything, anywhere in the world for any view over the internet. Internet of Things, Internet of Everything, Internet of Humans, and it is a network between "Things with Things" and "Things with Human." "Internet of Things (IoT) is a platform where anything, can be inspected, supervised, and executed, from anywhere over the internet." We are connecting a simple device (Home or Commercial) to sensors, actuators, and microcontrollers and further those to the internet to have better living standards, active management also ease of life with customized applications. We have connected all devices and appliances to NodeMCU, which is an ESP8266 firmware-based microcontroller consisting of onboard Wi-Fi capabilities to serve as a gateway for our devices over the internet. It is designed to control and monitor appliances via smartphone using Wi-Fi as a communication protocol. The solution aids in the problems faced by Indians and other personnel in daily life. It additionally helps in Energy Management, Home Security and Power Saving as it is a Smart Home Automation System. Coordination of our gadgets with a few different gadgets, for example, entryway lock so when nobody is inside a home the, it wisely switches the apparatuses, gadgets, water, and gas network off and furnishes the client with a warning, bringing about a sheltered and secure home. It is an intuitive and productive framework for any house.

Keywords— *Internet of Things, NodeMCU, MIT App Inventor, Home Automation*

1. INTRODUCTION

From time to time, the definition of the Internet of Things (IoT) has been evolving spontaneously like its application in the real world. IoT is connecting machines to humans (connecting anything to another thing or connecting anything to human). IoT is what we get when we join "Things" which are not operated by humans, to the Internet. Increasing the interaction between the devices and the humans by the introduction of Internet technology as a medium between these two heterogeneous models(i.e., machines and humans) to achieve the goal of automation, increased efficiency, interoperability, increased and quality production and many more goals on the way. Unlike human beings, the machine is not that much susceptible to errors and laziness, so to have error-free work, sound production, accurate data collection, improved quality with increased quantity, and increased efficiency we need IoT. This has led the vision of ''anytime, anywhere, anyway, anything" communications. Practically in true sense. Significant applications of IoT in the present are in the following sectors-

- For Security
- For Home Automation
- For Industry Automation
- For Governance
- For Health Management (Monitoring) and Disease Detection
- For Agriculture Production and Management

An open and comprehensive network of smart objects that can auto-organize, share information, data, and resources, reacting and acting in the face of situations and changes in the environment. With the help of communication technologies such as Wireless Sensor Networks (WSN) and Radiofrequency Identification (RFID), sharing of information takes place.

The motivation behind IoT is to create, Smart city, to optimize the use of public resources, increase the quality of services offered to people, and decrease the operational costs of the services. The ultimate goal is to create „a better world for human beings, " where objects around us know what we like, what we want, and what we need and act accordingly without explicit instructions.

The IoT depends upon three building blocks, based on the ability of smart objects to (i) be identifiable (anything identifies itself), (ii) to communicate (anything communicates) and (iii) to interact (anything interacts). The focus of IoT is on the data and information, rather than point-to-point communication. The advancing scope of IoT and how it can be used to interconnect various disparate networks is shown below:

Fig. 1: Applications of IoT over time [2]

Comparing from previous years, IoT has proved to be a game-changer over the past two decades. IoT connection and communication procedure is shown below.

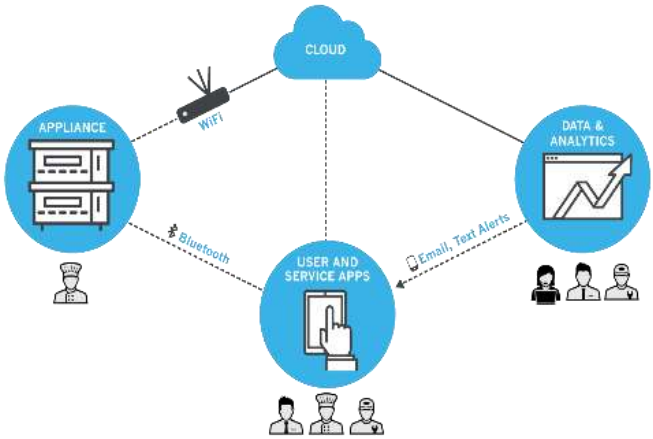

Fig. 2: IoT connection and communication procedure

IoT works over a range of protocols and supports almost every device. Some major protocols are shown below with their respective function and domains.

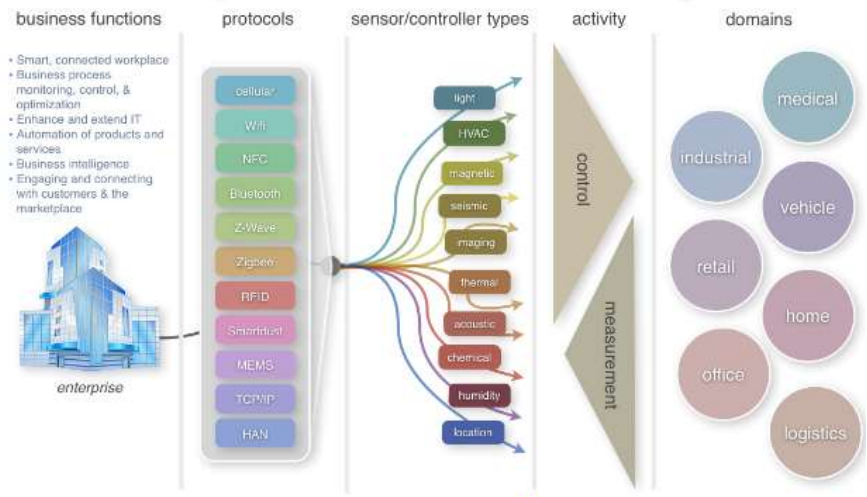

Fig. 3: IoT functional areas with recommended protocols

The Objects like electronic devices, software, sensors, actuators, home appliances, and vehicles connected to a wireless network, Internet of Things considered as a wireless network of these objects, and they can exchange data through lightweight protocols like MQTT, and CoAP. There are many types of radio modules out of which GSM, 3G, Wi-Fi, Bluetooth, and ZigBee are standard. As comparing from other protocols, which are used for large scale industries, for Home Automation we have used Wi-Fi here because it's more feasible and readily available in every house and moreover it does not have any specific range specification, also aids to in the ability of stability to the device (Smart Home Unit) during power-cuts. Interfacing NodeMCU in with the personalized server with a unique authentication code which will define the partition on the server. This authentication code is to be written in the program script to connect the mobile platform and the IoT platform (i.e., NodeMCU). The NodeMCU interacts with the relays with M2M (Machine-2-Machine) protocol, and further, the relay works according to the instruction for the connected device or

appliance. Understanding Goals for the IoT systems is crucial to the system developers. IoT is mainly an automated decision-making systems comprises of feedback mechanism where the system influenced by environmental (external), internal, user factors [1].

2. RELATED WORK

The IoT enables information collecting, transmitting, and putting away be available for gadgets in various circumstances, which makes or stimulates a few applications, for instance, mechanical control systems, the retailing industry, social protection, sustenance, and in industry, key industry, travel and the travel industry, library applications, etc. It can in like manner envision that the IoT would fundamentally add to address the basic issues for instance: strategy, restorative administrations checking systems, step by step living checking, and traffic control [3].

- **Smart cities:** These cities are urban areas that use various kinds of sensors to get and supply data and information for efficient management of community assets and resources. Examples of smart city IoT applications include smart surveillance, smart management systems, etc.
- **Smart offices:** A smart office uses several IoT devices (notepads, printers, smart lighting, etc.) that are connected (they talk to each other). Ideally, in a smart office, everything from the furniture to the copier is connected through IoT.
- **Smart agriculture:** The agricultural sector requires highly scalable technology solutions that can be provided by IoT applications.
- **Smart healthcare:** IoT is considerably contributing to medicine and healthcare. The core IoT healthcare applications include automated data gathering, moving objects‟ tracking, etc.
- **Smart Factory:** Smart Factory is a disruptive development to the existing factory system, and as such the findings first assist to identify the ‘advanced knowledge in science and technology’ that is needed for success (sensors, IoT, storing and processing a huge amount of data and data analytics). It then identifies various possible technologies that can constitute to specific smart factory implementations and guide with the design principles. The value of this research is the proposed methodology, which can guide anyone planning to move forward in the smart factory path [4].

2.1 IoT Architecture

When we design IoT Systems, the first question to ask is “what is the goal that we are going to achieve by using the system?” The goal is the application of the IoT system. It can be a Smart Home, Smart Car or *Smart – Whatever*. The smartness of a system is that the intelligence of the system [1].Internet of Things or Internet for everything is broadly consisting of three layers-viz Application Layer, Network Layer, and Perception Layer.

2.1.1 Application Layer: This layer manages all the services related to cloud and data. It collects the data from the devices and the sensors for different purposes, such as data analysis and proceeding. It states the purpose of the use of IoT, like Smart Home, Smart Industry, etc. In this layer, many of the known and user required task take place, and these operations may vary from System Management to Graph analysis, Flow charts to Business model. Moreover, these tasks in an industry take up a new layer called as Business Layer.

2.1.2 Network Layer: This layer is an intermediate layer and works between different set of protocols (Bluetooth, Wi-Fi, HAN, cellular, etc.) to facilitate the connectivity between the device and the user. This layer consists of Gateways which allow the flow of information and data exchange between the user and the machine. This layer also aids in Decision making, Information processing, computing, and Service Management like tasks. Moreover, if all these tasks performed separately, then it is also known as Middleware layer (between Application Layer and Network Layer).

2.1.3 Perception Layer: Perception Layer is the ground floor where all the work is being performed by the devices, actuators, and sensors. On this floor, all the work and instruction execution takes place. Machines connected to different controllers and microcontrollers which do instruct them and take data from them for the user to increase the communication between the Machine and the user (M2U).

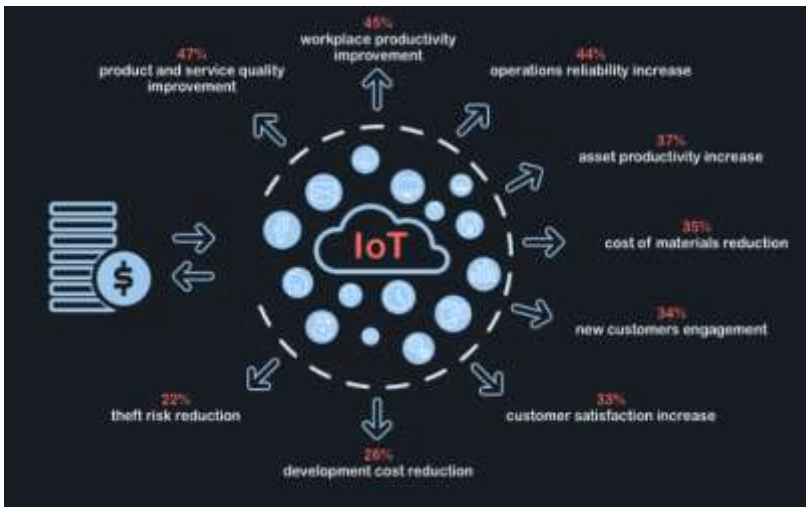

Fig. 4: Advantages of IoT implementation

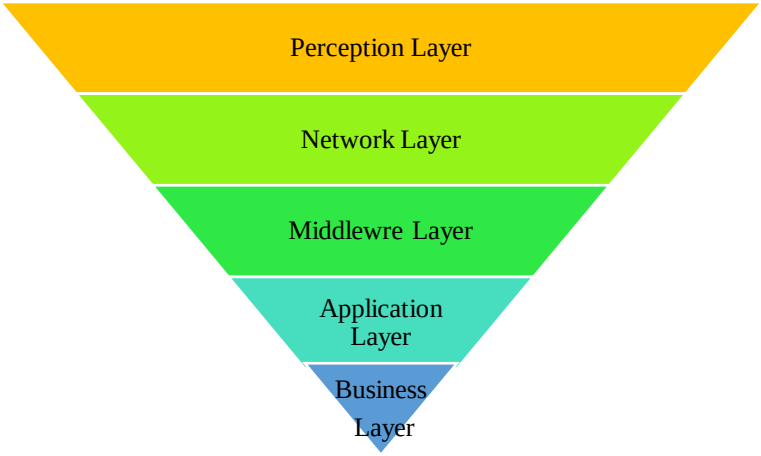

Fig. 5: IoT Layer chart

As IoT evolves, these networks and many others will be connected with added security, analytics, and management capabilities (see Figure 4). This will allow IoT to become even more powerful in what it can help people achieve [2]. In our prototype, we are using:

- Google Firebase
- MIT App Inventor
- Wi-Fi protocol

As a platform for our devices to have interaction with the user for controlling the devices and governing the house through the app as well as defining a security lock which enables keyless entry to the user and ensures the safety of his house and also aids in saving energy as the user locks his door.

3. REQUIREMENTS

3.1 Hardware Requirements

3.1.1 NodeMCU: NodeMCU (NODE MicroController Unit) is an IoT platform which is open source. NodeMCU works on LUA (Lua is a lightweight, cross-platform, multi-paradigm programming language) based firmware. The NodeMCU (Node MicroController Unit) is an open-source software, and hardware development environment that built around a very inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains all crucial elements of the modern computer: CPU, RAM, networking (Wi-Fi), and even a modern operating system and SDK.

Table 1: NodeMCU ESP8266 Specifications

Specifications	Values
MCU	32 bitTenSilica L 106
RAM	36Kb
Clock Speed	80MHz/160MHz
Opearating Coltage	3.0V 3.6V
Operating Current	80mA(Average)
Available GPIO Pins	10

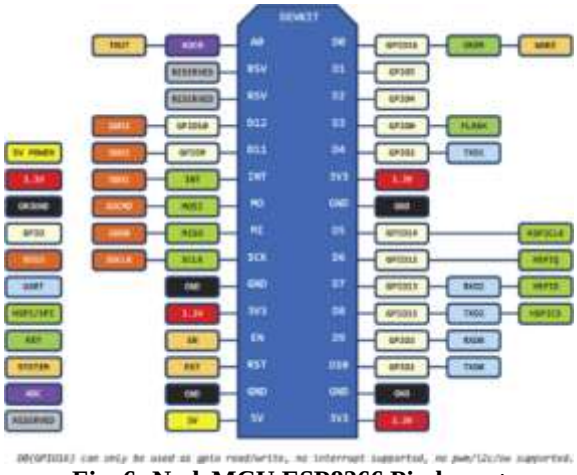

Fig. 6: NodeMCU ESP8266 Pin layout

3.1.2 Relay: These are the electromechanical gadgets, otherwise called electrical switches, which play out their separate capacity (exchanging ON/OFF) as indicated by directions (can be manual or machine activated). Transfer deal with the standard of electromagnetic fascination (i.e., It makes a transitory attractive field to draw in the attractive strip, so the circuit gets finished, and the gadget begins working). We have utilized eight-channel hand-off.

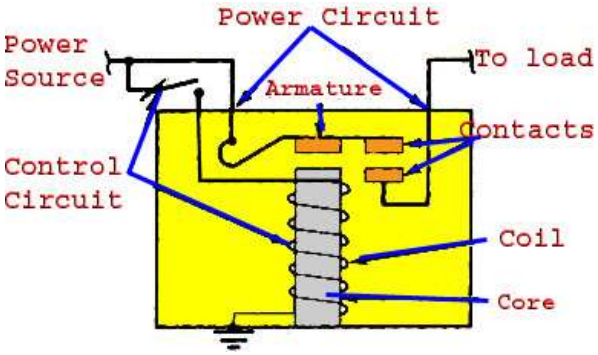

Fig. 7: General Relay Circuit

Fig. 8: General Relay

3.1.3 Sensors: A sensor is a gadget which is utilized to recognize changes in the local environment. Of course, the sensor does not have any job until and except if it has been coordinated with an electronic gadget to play out a specific undertaking. There are numerous sorts of sensors in the market; some of them are IR sensor, Motion Sensor, Proximity Sensor, Humidity Sensor, Temperature Sensor, and LDR Sensor. Here we have utilized LDR Sensor to recognize the light change in the room so that if its diminish than the lights gets turned ON.

Fig. 9: LDR Sensor

3.1.4 Lock: We have utilized an electronic solenoid entryway lock to bolt and open the house and encouraging keyless passage in the house. In this lock, when then-current streams, the attractive field is created which pulls in the axle, and the lock gets opened and closes when the present quits streaming because of demagnetization.

Fig. 10: Electronic Lock

- **Wire:** These are utilized to lead power and information to build up a way and a solid circuit between the gadgets and parts.
- **Power Supply:** It is required to provide power to the setup for execution; Power source may be of 3.3 volts for the NodeMCU and respective for the attached appliances.
- **Load:** These are the device or electric home appliance which do operate on electricity. These may be any home appliance like a fan, AC, TV, and Fridge.
- **Wi-Fi/Net Connection:** This act as a medium and is needed to connect our smart device to the internet for data collection and further operation the router required with SSID and Password for accessing the network.
- **Smart Android Phone:** It required for running a user interface to monitor and control the home appliances.

3.2 Software Requirements

3.2.1 Arduino IDE: It's an Integrated Development Environment developed by Arduino (Microcontroller firm which offers both hardware and software application for IoT). Through this software we are doing microcontrollers programming in high-level language and then burning it to the respective microcontroller (here NodeMCU). It provides a platform to combine hardware-level programming with high-level programming.

Fig. 11: Arduino IDE interface

3.2.2 Google Firebase: An online database platform, used for the collection of data from the devices provided by Google and acts as Back-end. Both, the microcontroller and the User Interface will have an auth token which will point to this database for storing data and acting as an intermediate between both.

3.2.3 MIT App Inventor: It is Java and Kawa based application web portal provided by MIT for designing android app by just dragging and dropping the blocks and linking them in sequence to make logic for the application, which offers the user to customize apps accordingly, and here it provides a GUI interface to the user and acts as Front-end.

Fig. 12: MIT App Inventor Interface

4. WORKING DESIGN

The device consists of three isolated systems:

- First, the sensors and actuators
- Second, the Microcontroller or Master Controller
- Third, the GUI platform, i.e., a mobile app and the user interface.

When the user feeds instruction in the app (ON/OFF) it travels through the cellular protocol to the specified database location and checks for the current status of the device and the connecting lock and LDR, if the provided state of operation is established then the instruction is passed to the Microcontroller through an IP protocol through the Wi-Fi, further then the microcontrollers checks for the current status takes the data from the sensors and actuators, if the data and the specified condition evaluates to true then the instruction is processed, and the respective work performed. All this long process takes milliseconds for its execution, and within the blink of an eye, the provided instruction gets executed. This device can work from anywhere in the world, may it be any other state or any country. It is just one go method, need to open the interface and in one click its done.

Table 2: Observation and practically performed on Bulb.

App Switch	Bulb(load)	LDR	Lock
ON	ON	=<200	OPEN
ON	OFF	>=800	OPEN
ON	OFF	=<200	CLOSED
ON	OFF	>=800	CLOSED
OFF	OFF	=<200	OPEN
OFF	OFF	>=800	OPEN

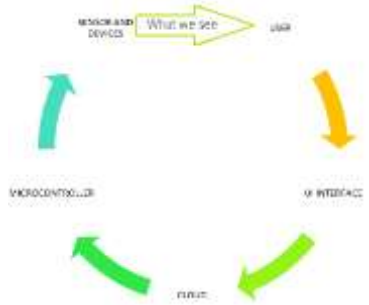

Fig. 13: Background vs Foreground

Table 3: Observation when devices were tested.

App Switch	Lock	Load (HOME APPLIANCES)
OFF	CLOSED	OFF
OFF	OPEN	OFF
ON	CLOSED	OFF
ON	OPEN	ON

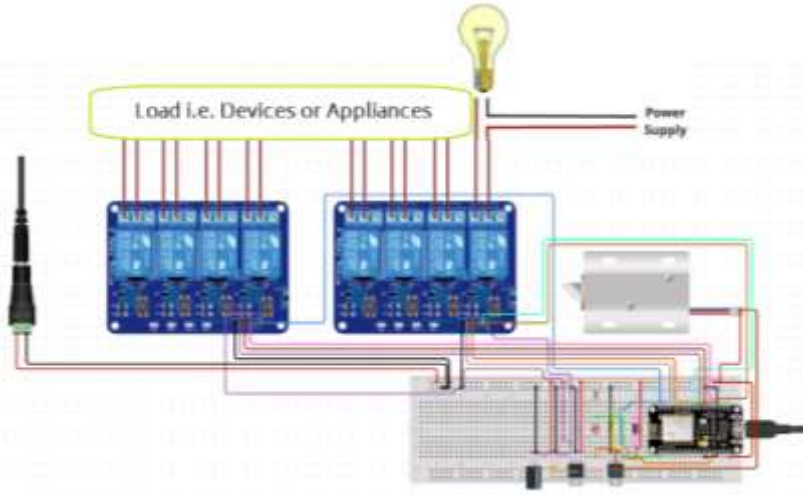

Fig. 14: Circuit Diagram of the System

5. EFFECTS AND SOCIAL CAUSE

Everything in this world has its pros and cons like IoT on one side is making our life easy, whereas on the other side it is working on finishing the privacy of the persons. Moreover, the recently many countries government is working on the laws which will allow the government of that country to get the private information of its peoples (like -Germany). So, it will also have a real effect on the health of persons as it will reduce the work and make the population work freak.

This solution may be a revolution from the manual to the automated world, which started from houses. Moreover, it is also helpful in saving time as well as human effort. One can easily use it without any ambiguity. This solution can help in several ways, some of them listed below:

- Save accidental deaths of people from electric shocks.
- Help the Handicapped people and save their efforts of walking and switching the devices.
- Saves the human effort.
- Saves power and energy, so aids in towards sustainable development.
- Saves cost and energy wastage.
- Help the enterprises to govern and control their homes and firms remotely.

6. CONCLUSION

This paper introduces a home management system. Moreover, it mainly focuses on overcoming everyday problems targeted by people in the world. The real-world appliances are being prepared with intellect and computing capability so that they can configure themselves accordingly. The implementation provides an intelligent, comfortable, and energy efficiency, home automation system. It also assists the old and differently-abled persons to control the appliances in their home in a better and easier way.

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