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INTELLIGENT DOMOTICS USING PROGRAMMABLE OBJECT INTERFACE

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ABSTRACT:

This paper presents the recent advancements in affordable open-source hardware platforms that enable the development of low-cost architectures for Intelligent Domotics using programmable object interface or Internet-of-Things (IoT)-enabled home automation and security systems. These systems usually consist of sensing and actuating layer that is made up of sensors such as passive infrared sensors, also known as motion sensors, temperature sensors, smoke sensors and other sensors. These sensors, smart electrical appliances, and other IoT devices connect to the Internet through a home gateway. This project lays out architecture for a cost-effective smart door sensor that will inform a user through an Android application, of door open events in a house or office environment. The proposed architecture uses an Arduino-Mega board along with the API. Several programming languages are used in the implementation and further applications of the door sensor and other applications of intelligent domotics are discussed.

Keywords— *IoT, Arduino Mega, Domotics, API*

I. INTRODUCTION

Programmable object interface or IoT refers to the collection of different types of daily life appliances and gadgets used in different sectors that are broadening the aspect of the internet. The connectivity with the internet enables these devices to share and receive data with different objects. Internet of things simply means the network of devices that are able to share and receive data and information with other devices via using the internet. The things or objects in the Internet of Things above are well equipped with sensors, software, and machine learning techniques. The use of such objects reduces human interference in doing any of the work. The advent of IoT has totally changed the life of human beings by reducing their workload and time. The advancing technology day by day is giving rise to different smart objects thereby improving the standard of living of human beings. The developments of a range of technologies have enhanced the lifestyle of human beings. Digitalization is taking place in India and the world at a very fast pace. Thus in order to be in the pace with the digital world, the network of smart devices is very essential. It is a technology that helps in establishing a good interaction between the different devices among themselves and also with human beings. Moreover, the emergence of devices embedded with sensors and advanced technologies reduces the workload of human beings. It helps in finishing different tasks in less time along with developing coordination with the activities taking place in the surroundings. The development of the network of these smart devices is not only useful in household works but also aid in commercial sector tasks. Thus, IoT in the 21st century has become an essential requirement in different sectors all around the world. The Internet of Things is a concept that has completely changed the way the world works by allowing a greater level of connection between inanimate objects. Things like home appliances, thermostats, and even vehicles can be included in this network and the ramifications of this change are far reaching.

II. BASIC CONCEPTS

In this section basic concepts like programmable object interface, smart home, outline of the project, area monitoring, characteristics and applications are discussed.

A. PROGRAMMABLE OBJECT INTERFACE

Programmable object interface or Internet of Things (IoT) is the networking of physical objects that contain electronics embedded within their architecture in order to communicate and sense interactions amongst each other or with respect to the external environment. In the upcoming years, IoT-based technology will offer advanced levels of services and practically change the way people lead their daily lives. Advancements in medicine, power, gene therapies, agriculture, smart cities, and smart homes are just a very few of the categorical examples where IoT is strongly established.

IoT is network of interconnected computing devices which are embedded in everyday objects, enabling them to send and receive data. Over 9 billion 'Things' (physical objects) are currently connected to the Internet, as of now. In the near future, this number is expected to rise to a whopping 20 billion.

Main components used in Programmable object interface:

- **Low-power embedded systems:** Less battery consumption, high performance are the inverse factors that play a significant role during the design of electronic systems.
- **Sensors:** Sensors are the major part of any IoT applications. It is a physical device that measures and detect certain physical quantity and convert it into signal which can be provide as an input to processing or control unit for analysis purpose.

There are two ways of building IoT**:**

1. Form a separate internetwork including only physical objects.
2. Make the Internet ever more expansive, but this requires hard-core technologies such as rigorous cloud computing and rapid big data storage (expensive).

B. SMART DOMOTICS

Smart Domotics or smart home system can be something that makes our life quite easy. Starting from energy management where the power controls system in the AC appliances where we use the thermostat, all this is managed to cut down the power consumption that's taking place. A door management system, security management system, water management system are the part of this as well. Still, these are vital things that stand out in the smart home system. The limitation of IoT in smart home application stops where our imagination stops. Anything that we wish to automate or want to make our life easier can be a part of smart home, a smartphone system as well.

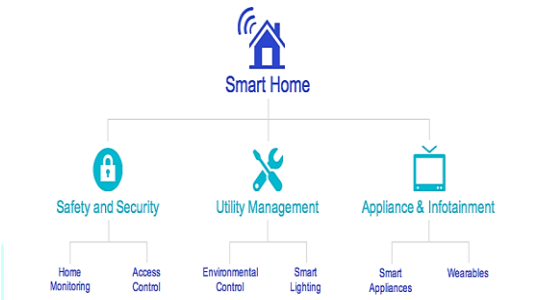

Figure 1: Smart Domotics

Now, a smart home usually is going to be a base of a **smart city**. The smart city is an evolution of a smart home. Here, it is not just the sensors of a single home that is connected, here its correlation or a network or a connection between various organizations, various domains as well as multiple segments of that city as a whole. In the smart city, the life of every single dependent becomes more comfortable and in tune really help to develop that city to greater extends as such. Now, the key factor for a smart city is government support as well, and if the governments are willing to take this step, then we hope we would see a smart city completely build on the Internet of Things. IoT home automation is the process of controlling home appliances automatically using various control system techniques. The electrical and electronic appliances in the home such as windows, refrigerators, fans, lights, fire alarms, kitchen timers, etc. can be controlled using various control techniques.

C. OUTLINE OF THE PROJECT

Classic smart home, internet of things, cloud computing and rule-based event processing, are the building blocks of our proposed advanced smart home integrated compound. Each component contributes its core attributes and technologies to the proposed composition. IoT contributes the internet connection and remote management of mobile appliances, incorporated with a variety of sensors. Sensors may be attached to home related appliances, such as air-conditioning, lights and other environmental devices. And so, it embeds computer intelligence into home devices to provide ways to measure home conditions and monitor home appliances' functionality. Cloud computing provides scalable computing power, storage space and applications, for developing, maintaining, running home services, and accessing home devices anywhere at any time. The rule-based event processing system provides the control and orchestration of the entire advanced smart home composition.

D. AREA MONITORING

Area monitoring is a typical application of Iot. In area monitoring, the programmable object interface is deployed over a region where some phenomenon is to be monitored. As an example, a large quantity of sensor nodes could be deployed over a battlefield to detect enemy intrusion instead of using landmines. When the sensors detect the event being monitored heat, pressure, sound, light, vibration the event needs to be reported to one of the base stations, which can take appropriate action (e.g., send a message or the related information on the internet or to a satellite).

III. EXISTING SYSTEM

In the olden days electrical, electronic and electromechanical devices were supporting all the day to day life activities. Some devices were fully automated and some were semi-automated. Due to the advancement in computer and communication technology, the trend is more towards the automation of most of the activities which are needed in day to day activities with very less human intervention.

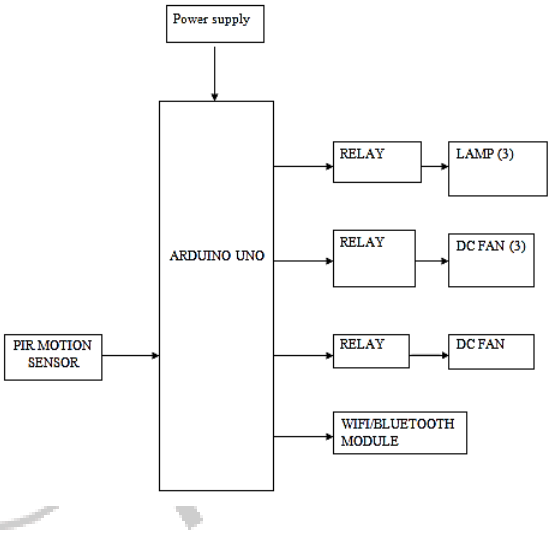

Figure 2: Existing System

This existing system presents a design and prototype implementation of a home automation system that uses Wi-Fi technology as a network infrastructure connecting its parts. The proposed system consists of two main components; the first part is the server (web server), which presents system core that manages, controls, and monitors users' home. Users and system administrator can locally (LAN) and control system code. Second part is hardware interface module, which provides appropriate interface to sensors and actuator of home automation system. Like most of available home automation system in the market the proposed system is scalable that one server can manage many hardware interface modules as long as it exists on Wi-Fi network coverage. System supports a wide range of home automation devices like power management components, and security components.

- Not cost effective and high latency.
- There is no Autonomous capability for emergency situations.

- Controlling access is limited within the Wi-Fi range.
- Internet disconnection may lead to complete failure of the system.
- Latency due to heavy workload.
- Failure of microcontroller leads to total failure of the system.
- These devices have security flaws and can be hacked.
- Serious batteries drain issues.
- Even inside the home user needed to be connected to Wi-Fi or Bluetooth for controlling the electronic application with User ID and password.
- There is only one Administrator.
- Server must always run under windows system.

IV. MATERIALS AND METHODS

A. *PROPOSED METHOD*

In order to address the mentioned issues of flexibility and functionality in the literature survey, we designed and implemented a flexible and low cost home controlling system using Node MCU Module and Arduino Mega. The system consists of a Web - server based on Arduino Wi-Fi, hardware interface modules and the Android compatible Smart phone app. MQTT protocol is used. The architecture presented in this work can be customized in different ways in order to accommodate different application scenarios with minimum recoding and design i.e. each time a new device is added to the Web-server, a new thread dedicated to the device is has to be created in the Smart phone app. This system allows authorized home owners to remotely control and monitor connected devices at home using any wired portion. The smart phone app provides a graphical user interface (GUI) for accessing and controlling the devices at home through server real IP.

B. *OBJECTIVE*

The system aims to do all the controls and operations manually the construction of the system will enable easy interaction between the home devices and the user within a matter of seconds. Security of these system and the connections is also a top priority in this system. In our system we are going to automate the things and try to reduce the human-machine intervention. In the existing system the user can only control the electrical application by Wi-Fi or Bluetooth control but in our system we can control our electrical applications by conventional switches too.

C. *FLOW CHART*

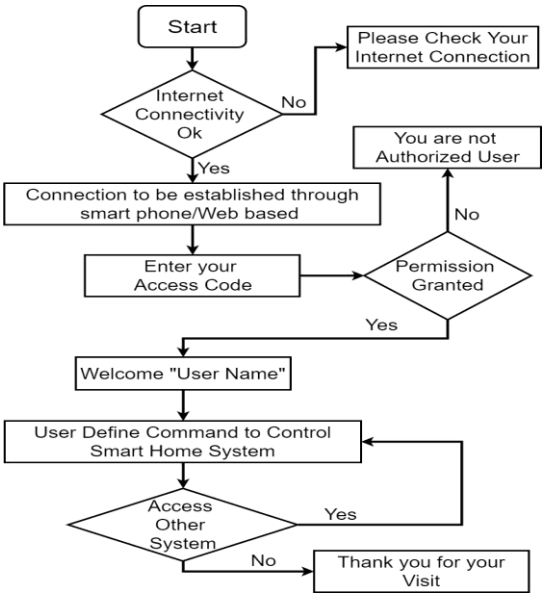

Figure 3: Flowchart

The working of the smart home automation is shown in Figure 3. As shown, initial requirement is the Internet connectivity to access your smart home. One can access their After successful connection, users will be able to access their smart home appliances. It will be accessed through the Adafruit for creating the connectivity between the Google assistant and the Node Mcu which is the main control unit of the smart home automation. The home appliance is connected to the main controller unit with the sets of relay. The functions of these relays are to act as an ON/OFF switch on the main control unit. Finally, with the help of Google assistant, based on the user command the home appliance can be turned ON/OFF with the help of the designed system. Here, we have shown the example of turning the three bulbs. However, any home appliance can be connected through the proposed control unit.

D. *BLOCKDIAGRAM*

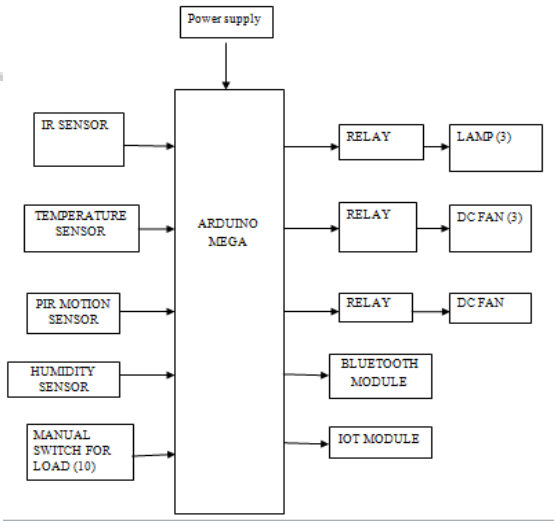

Figure 4: Blockdiagram

In this block diagram Arduino Mega controller is used for controlling the home applications, IoT module or Node MCU connected to the local internet connectivity by which it can get the user input, the user may be at any part of this world, but the user should have internet connectivity. There are 3 ways to accesses the home, by turning ON/OFF with help of switches, with the help of local Bluetooth module (same application will be used for controlling the home with local connectivity) and with the help of Internet connectivity.

An autonomous capability is also given to this Home, fire and theft detection and reporting, automatically temperature controlled rooms and human intervention less water pumping mechanism.

E. ARDUINO MEGA MICROCONTROLLER

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila. The Mega 2560 is an update to the Arduino Mega, which it replaces. ATmega2560 The high Performance, low power AVR 8-bit microcontroller. EEPROM The ATmega2560 features 4kb (4096 bytes) of EEPROM, a memory which is not erased when powered off. Four serial ports Connect to several devices through the 4x hardware serial ports (UARTs).

Special Microcontroller Features – Power-on Reset and Programmable Brown-out Detection – Internal Calibrated Oscillator – External and Internal Interrupt Sources – Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby.

F. NODE MCU

NodeMCU is an open-source LUA based firmware developed for the ESP8266 Wi-Fi chip. By exploring functionality with the ESP8266 chip, NodeMCU firmware comes with the ESP8266 Development board/kit i.e. NodeMCU Development board. Since NodeMCU is an open-source platform, its hardware design is open for edit/modify/build. NodeMCU Dev Kit/board consists of ESP8266 wifi enabled chip. The **ESP8266** is a low-cost Wi-Fi chip developed by Espressif Systems with TCP/IP protocol. There is Version2 (V2) available for NodeMCU Dev Kit i.e. NodeMCU Development Board v1.0 (Version2), which usually comes in black colored PCB. NodeMCU Development board is featured with wifi capability, analog pin, digital pins, and serial communication protocols.

To get started with using NodeMCU for IoT applications first we need to know about how to write/download NodeMCU firmware in NodeMCU Development Boards. And before that where this NodeMCU firmware will get as per our requirement. There are online NodeMCU custom builds available using which we can easily get our custom NodeMCU firmware as per our requirement.

G. PROGRAMMING

Arduino Mega, natively, supports a language that we call as Arduino Programming Language, or Arduino Language. This language is based upon the Wiring development platform, which in turn is based upon Processing, it is based on p5.js. It's a long history of projects building upon other projects, in a very Open Source way. The Arduino IDE is based upon the Processing IDE, and the Wiring IDE which builds on top of it. When we work with Arduino we commonly use the Arduino IDE (Integrated Development Environment), a software available for all the major desktop platforms (macOS, Linux, Windows), which gives us 2 things: a programming editor with integrated libraries support, and a way to easily compile and load our Arduino programs to a board connected to the computer.

The Arduino Programming Language is basically a framework built on top of C++. It's not a real programming language in the traditional term, but this helps avoiding confusion for beginners.A program written in the Arduino Programming Language is called sketch. A sketch is normally saved with the .ino extension (from Arduino). The main difference from "normal" C or C++ is that wrap all the code into 2 main functions. We can have more than 2, of course, but any Arduino program must provide at least those 2. One is called setup(), the other is called loop(). The first is called once, when the program starts, the second is repeatedly called while program is running. We don't have a main() function like you are used to in C/C++ as the entry point for a program. Once compile sketch, the IDE will make sure the end result is a correct C++ program and will basically add the missing glue by preprocessing it. Everything else is normal C++ code, and as C++ is a superset of C, any valid C is also valid Arduino code. One difference that might cause the troubles is that while one can spawn your program over multiple files, those files must all be in the same folder. Might be a deal breaking limitation if the program will grow very large, but at that point it will be easy to move to a native C++ setup, which is possible. Part of the Arduino Programming Language is the built-in libraries that allow to easily integrate with the functionality provided by the Arduino board. First Arduino program will surely involve making a led turn on the light, and then turn off. To do so, user should use the pinMode(), delay() and digitalWrite() functions, along with some constants like HIGH, LOW, OUTPUT.

Writing codes for NodeMCU After setting up ESP8266 with Node-MCU firmware, let's see the IDE (Integrated Development Environment) required for the development of NodeMCU. NodeMCU with ESPlorer IDE Lua scripts are generally used to code the NodeMCU.

Lua is an open-source, lightweight, embeddable scripting language built on top of C programming language. NodeMCU with Arduino IDE. Here is another way of developing NodeMCU with a well-known IDE i.e. Arduino IDE. We can also develop applications on NodeMCU using the Arduino development environment. This makes it easy for Arduino developers than learning a new language and IDE for Node MCU.

V. RESULTS

A. HARDWARE CONNECTIONS

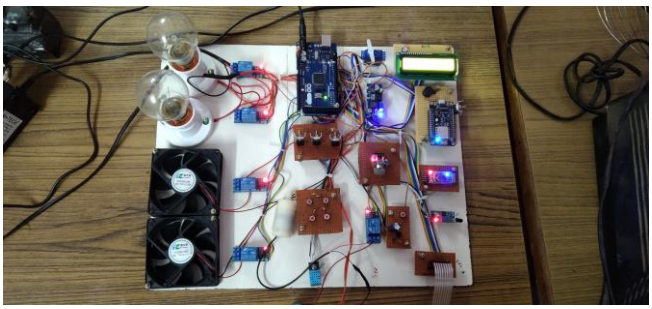

Figure 5: Circuit (Hardware)

Figure 6: Circuit with keypad security(Hardware)

B. *Manipulating with Bluetooth*

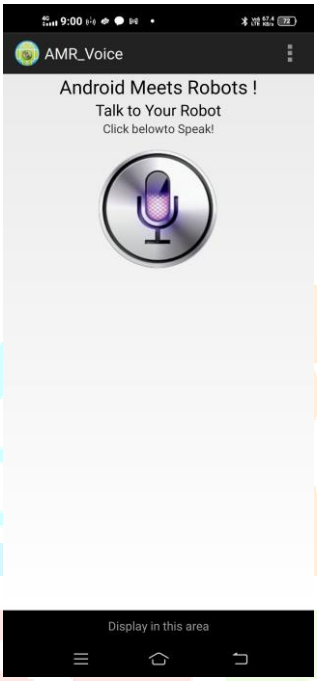

Figure 6: Application UI of AMR_VOICE

With Bluetooth we can control our home with our voice commands.

C. *Manipulating with IoT*

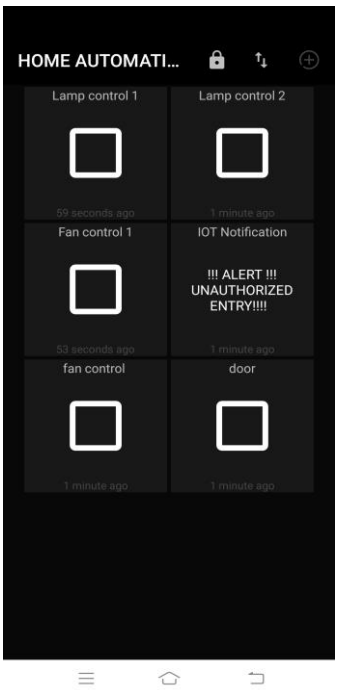

Figure 7: Application UI of MQTT dash

VI. CONCLUSION AND FUTURE IDEAS

In this paper, we have proposed an internet based automated tool using Arduino Mega, Bluetooth module and Node MCU to control the home appliances such as light, fan and washing machine. The system is tested by developing a prototype model and evaluated for its correctness and completeness.

In Future we are planning our project to add artificial intelligence mode, in which all the changeable parameters of the home will be operated autonomously with high accuracy or efficiency.

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