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Intelligent Device-To-Device Communication in the Internet of Things

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ABSTRACT

Nowadays the use of smart devices (embedded devices like mobiles, laptops, smart watches, etc.), in the day to day life is increasing. If all these devices are able to communicate with each other and transfer data via some medium (Wi-Fi, Bluetooth, etc.), then all these devices can be controlled and used remotely. Internet of Things (IoT) is being used to connect all these devices wirelessly, where the internet may or may not be used as a medium of communication. We are trying to communicate using the android mobile application in a smartphone and Wi-Fi as a medium to implement DALI (Digital Addressable Lightning Integration) system. DALI is used in Building Automation (BA), where we implement HVAC (heating, ventilation and air conditioning) using DALI protocol. The main purpose of using an android application in building automation is to control HVAC appliances remotely from one single location. The android application controls HVAC system via Wi-Fi (IEEE 802.11b standard) which acts as a medium of communication.

KEYWORDS: *Internet of Things (IoT), Building Automation (BA), Digital Addressable Lightning Integration (DALI), HVAC (heating, ventilation and air conditioning), Wi-Fi, Android Application*

I. INTRODUCTION

With the arrival of the web, folks became more and more interconnected at an -unprecedented scale. However, because of the proliferation of short-range networks and therefore the prevalence of devices connected to those networks, a seamless interconnection between devices is being created. Such short-range networks embody wireless sensor networks (WSNs), wireless fidelity (Wi-Fi), Bluetooth, radio-frequency identification (RFID) networks, and ZigBee. It's envisaged that devices are connected along to form, gather, and share data. The method of sharing, gathering and making data can involve a series of communication between devices with or no intervention. These devices are different forms of objects/things with embedded intelligence and communication capabilities. Examples of such devices are sensors, smartphones, cars, home appliances, healthcare gadgets, or RFID tags. Therefore, not solely humans are being interconnected however devices too are being interconnected. This paradigm shift has pointed to the creation of concept which is Internet of Things (IoT). It's a radical evolution of this web, that has been reworked from providing human interconnection into a network of interconnected devices. These devices move with the physical world by utilizing web protocols and standards so as to gather knowledge from the atmosphere. It'll alter the transformation of perceived or gathered knowledge into intelligent data, hence embedding intelligence into our surroundings. Additionally, the IoT can involve billions of devices that have the flexibility to report their location, identity, and history over wireless

connections. The belief of the IoT is step by step coming back into fruition as a result of many major trends. Advancements within the field of digital physics have vastly contributed to the introduction of miniature devices which will sense, compute, and wirelessly communicate inside short distances. These devices exist as a part of our everyday lives in areas like health care, smart grid, home appliances, retail, etc. Also, the decreasing prices of those devices have conjointly put up a forceful increase in their deployments in recent years.

A building automation system deals with watching and management of building services, like heating, ventilation, air-con (HVAC), lighting, alarms, etc. Not solely is it the system sure to operate in HVAC appliances and lamps, however, HVAC and lighting management also can be obtained by additional natural and economical ways in which, e.g. beginning a motor to open blinds.

BAS were first developed to regulate HVAC systems. Through time we've got more established many forms of controllers, e.g. pneumatics, analog circuits, microprocessors, etc. At the time of its starting, BA's purpose was the comfort of finish shoppers and later on (the early 1970s), energy potency criteria were conjointly thought-about. Despite the fact that different home systems like lighting ought to conjointly use automation, they're sometimes put in during a totally different system than HVAC. This division of the 2 subsystems will increase the top shopper price because of further investment in communication hardware and software system for integration HVAC and lighting during a single management purpose. Because it was antecedently explicit, building services are sometimes controlled individually, creating BA the set of management and communication technologies that link those totally different subsystems and make them work from a centralized watching and management center. The big purpose of getting one management purpose that provides access to all or any building services is that the cost reduction. A wireless monitoring permits the short detection of failing devices with no need long searches and wasting personal time. This continuous watching allows a preventive, or prognostic yet, maintenance, which ends up during a reduction of operational and maintenance prices. Since it's calculable that the operational price of a building is concerning seven times the initial investment, taking into thought the world life-cycle an extra initial price is definitely worth the effort.

Our work focuses on the making of a prototype which is to be employed in a wireless local area network that conjointly integrates DALI protocol. Since DALI may be a well-established customary and it's been adopted by major electronic ballasts' suppliers it's terribly simple to seek out DALI compliant devices. Despite it's designed for lighting management, it's conjointly been tailored to different applications, like motor or fan controllers, proximity alarms, etc. Hence, it permits watching and management applications for the home user and energy potency in industries.

II. System Design

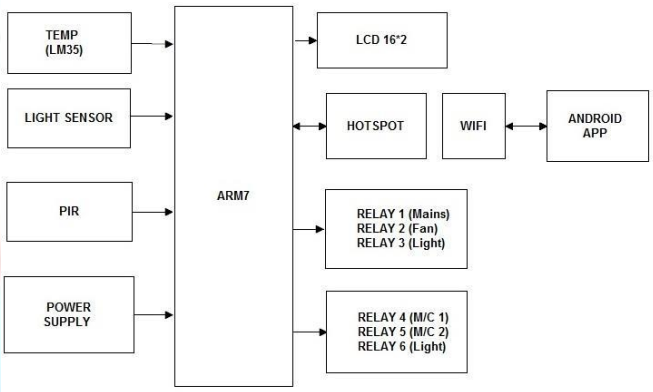

Fig: Block Diagram of Device-to-Device Communication in the Internet of Things

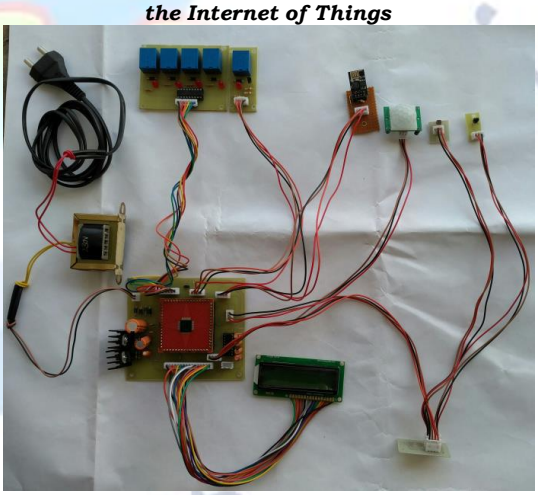

Fig: Hardware Kit

A. ARM 7:

The LPC2138 microcontroller relies on a 32/16 bit ARM7TDMI-S CPU with a period of time emulation and embedded trace support, that mixes the microcontroller with embedded high- speed non-volatile storage starting from 32KB to 512KB. A 128-bit wide memory interface and distinctive accelerator design modify 32-bit code execution at the maximum clock rate. For vital code size

applications, the different choice 16-bit Thumb mode reduces code by quite 30% with the bottom performance penalty.

B. Liquid Crystal Display:

Liquid crystal display (LCD) is employed in any project to envision the output of the application. we've used 16x2 LCD that indicates 16 columns and 2 number of rows. So, we are able to write sixteen characters in every line. So, total thirty-two characters we are able to show on 16x2 liquid crystal display. It also can be utilized in a project to verify the output of various modules interfaced with the microcontroller. Therefore LCD plays an important role in any project to check the output and to correct the system module wise just in case of a system failure so as to rectify the matter.

C. Light Sensor:

Photoresistors modify the resistance consistent with intensity. Commonly the resistance of Photoresistor (LDR) decreases with increasing intensity of sunshine falling thereon. Photomultiplier tube contains a cathode that emits electrons once illuminated; the electrons then get amplified by a sequence of dynodes.

D. Temperature Sensor:

The Temperature sensor is an associate analog detector and provides the output into a style of an analog signal. This signal is supplied to ADC which is able to convert it into digital type. Once changed into analog type, the microcontroller will convert the digital temperature signal as per the applying.

E. Passive Infrared Sensor:

A device used to detect motion by receiving infrared radiation. Once an individual walks past the detector, it detects fast modification of infrared energy and sends a signal. PIR sensors area unit used for applications like automatically turning on lights once somebody enters a space or inflicting a video camera to start its operation. All objects which show absolute zero temperature also emit heat energy i.e. in radiation form. Typically this radiation is invisible to the human eye as a result of it radiates at infrared wavelengths, however, it will be detected by electronic devices designed for such a purpose. The passive methodology isn't as reliable as “active” motion sensors that either bounce back a radar signal or transmit light to a photodetector in the distance. The term passive in this instance refers to the actual fact that PIR devices don't generate or radiate any energy for detection functions. They work entirely by detecting work the energy given off by different objects. it's vital to notice that PIR sensors do not notice or detect "heat" per se; instead they detect the infrared radiation emitted from associate object that is completely different from however typically associated/correlated with the object's temperature (e.g., a detector of X-rays or gamma rays wouldn't be thought-about as a heat detector, even if high temperatures could cause the emission of X or gamma radiation).

F. Relay :

The Relay is electromagnetic force switch; with a coil, one common terminal, one commonly closed terminal, and one commonly open terminal. Relays enable one circuit to switch a second circuit, which may utterly break free the primary. To Illustrate this consider a low voltage battery circuit will use a relay to modify a 230V AC mains circuit. There's no electrical association within the relay between the 2 circuits; the link is magnetic and mechanical.

G. Relay Driver Circuit:

In our project 2 SPDT Relays (Single Pole Double Throw Relay) are used. The Relay is driven by the small controller as per system necessities. One of them is employed to chop off the facility to provide power supply once balance goes to zero and another relay is used for off hook or on hook notification to MSEB.

H. Wi-Fi Module:

This module comes with AT commands firmware which allows you to get functionality like Arduino Wi-Fi shield, however, you can load different firmware's to make your own application on the modules' memory and processor. It’s a very economic module and has a huge and growing community support. This module has on-board 80MHz low power 32-bit processor which can be used for custom firmware. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existence interfaces; it contains a self-calibrated RF allowing it to work under all operating conditions and requires no external RF parts. ESP8266 is transforming the world with its low cost and high features which make it an ideal module for Internet of Things (IoT). It can be used in any application where you need to connect a device to your local network or internet.

III. WORKING

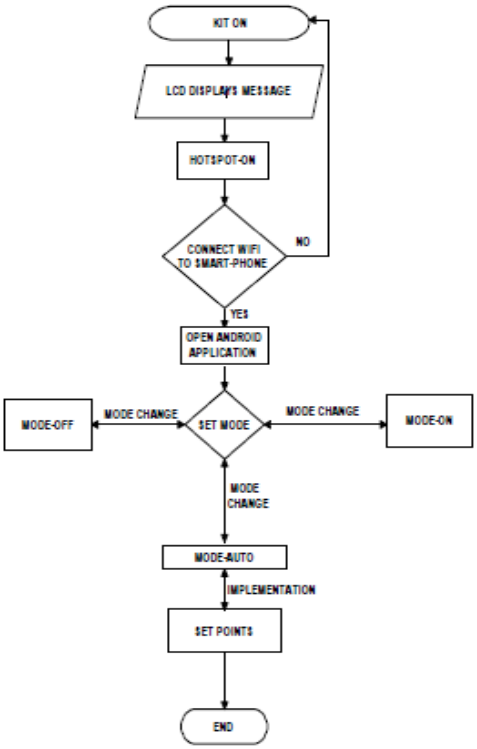

Fig: Flowchart

- First, we switch on the circuit which has ARM7 mounted on it. It is interfaced with other peripherals like the LCD, the Relays and Sensors, and the Wi-Fi module. Here we are using five relays (1N4007), out of which three are connected to PIR (Passive Infrared) sensor, LM35(Temperature Sensor) and LDR(Light Dependent Resistor), and the remaining two relays are connected extra, where one can connect other devices as per requirement. A Wi-Fi module (ESP82XX) is used to create a hotspot of range 2.4 GHz.
- Once we switch ON the circuit, the ARM7 is reset and the Program installed in it initiates and we can see messages displayed on the LCD. The first message on the LCD shows "WELCOME" and then it shows our Project name "INTEL. D-2-D COMM. IN IOT". This confirms that the circuit is working fine. Now we connect the Wi-Fi of our smartphone to the Wi-Fi of the kit. An android application is created, which works on any Android device and is able to connect to the hotspot created by the above Wi-Fi module via android device. With the help of this android application, we are able to pre-set the values of temperature and light. We can remotely turn-on and turn-off devices which are connected to 4th and 5th relay using this application. There are three modes in the application which controls the overall working of the sensors. The Three modes are:
- MODE-ON
- MODE-OFF
- MODE-AUTO

IV. RESULTS

1 Kit ON: When the kit is turned ON the message displayed on LCD as shown is "Welcome" and "Intel. D2D Comm. Using IOT "

2 ConnectTOServer: When this button is pressed on the android application the message displayed on LCD is as "Scanning…"

3 Server Connection: Once the ConnectToServer tab is pressed on the android application the application tries to connect the application with circuit via Wi-Fi module. When the message "Successfully connected" is displayed it indicates a successful connection with Wi-Fi module. Now we can give commands from the android application directly to kit. The blue light on Wi-Fi module indicates that the module is ready to accept commands and perform specific operations.

4 MODE-ON: In this condition, all the relays connected to the sensors will be in working condition and should remain ON.

5 MODE-OFF: In this condition, all the relays connected to sensors will be switched OFF and will not be in working condition.

6 MODE-AUTO: In this condition, the relays will be ON as per the requirement in the surrounding. The sensors sense the requirement according to surrounding i.e. the movement of humans is detected by the PIR sensor and once it detects the movement the other two sensors sense the requirement for light and fan/AC. We can see the reading of the sensors and the movement detection on the LCD. The relay connected to the LM35 shall turn ON if the present reading is more than that of the pre-set value. The relay connected to the LDR sensor will turn off once the present value is less than that of pre-set value. Here at start the PIR sensor detects the movement

7 Device 1 On: When this button is pressed on the android application the message displayed on LCD is as "Data Received Relay 4 on". The relay 4 i.e Device 1 turns on.

8 Device 1 Off: When this button is pressed one the android application the message displayed on LCD is as "Data Received Relay 4 off".

9 Device 2 Off: When this button is pressed on android application the message displayed on LCD is as "Data Received Relay 5 off"

10 Device 2 On: When this button is pressed on the android application the message displayed on LCD is as "Data Received Relay 5 on". The relay 5 i.e. Device 2 turns on

11 Send Set Pts: When this button is pressed on the android application the message displayed on LCD is as "Settings changed 400 300" as it is set in temperature and light block i.e. 40 and 30. New threshold values are set as temperature 40 and light 30.

IV. CONCLUSION

Nowadays, electricity is been used up by companies day and night irrespective of its need. Most of the electricity is wasted when only a certain part of a building/floor, in a company, is functioning, due to which the remaining part of the building/floor is inactive and still consuming electricity. In proposed system, we try to find a solution for operating electronic devices remotely using an Android application, in smartphone and Wi-Fi. The electricity consumption is reduced by controlling a certain part of companies using above application as and when required, irrespective of surrounding conditions. Companies have a department to handle the lighting and ventilation (air conditioners, heaters, etc.); we try to nullify this department by providing this

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