IoT-based Home Appliances Control System

Under the guidance of

Ms. Sumani Mukherjee

Submitted in partial fulfillment of the requirement for the Degree of Bachelor of Technology of Maulana Abul Kalam Azad University of Technology (formerly West Bengal University of Technology), Kolkata.

Department of Electronics and Communication Engineering

MAY,2018

Electronics and Communication Engineering Department

Vision:

- To build a strong teaching and research environment to cater to the manpower needs in Industrial and Academic domains of the rapidly growing Electronics and Communication Engineering.

Mission:

- To produce certified industry-ready professional in Electronics and Communication Engineering, though innovative educational programs incorporating laboratory practices and project based teaching-learning processes, in a modern environment.
- To create knowledge base of advanced technologies through research in the area of Electronics and Communication, for competitive and sustainable development of the country.
- To groom the department as a learning centre to inculcate advancement of technology in Electronics and Communication Engineering with social values and environmental awareness.

Program Educational Objectives (PEOs):

Graduates of Electronics and Communication Engineering program shall

- **PEO1:** Have design-skills and proficiency in core areas of Electronics & Communication Engineering so that they are employed in the industries related to Electronics & Communication Engineering field.
- **PEO2:** Have in-depth knowledge in core and advanced areas of Electronics & Communication Engineering so that they are prepared to take up higher studies.
- **PEO3:** Have quality of leadership, values, and social commitment so that they can become successful contributors in industry and/or entrepreneurship keeping in view of the global and national status of technology.

Program Specific Outcomes (PSOs):

- **PSO1:** An ability to apply the knowledge in Electronics and Communication Engineering in various areas, like Communications, Signal processing, VLSI, Embedded Systems, Instrumentation.
- **PSO2:** An ability to solve complex Electronic and Communication Engineering problems using hardware and software tools, along with analytical approach towards the appropriate solutions.

PROJECT OUTCOME

Our project deals with the control of home appliances using IoT. The different sensors are controlled simultaneously using an application. The cost of the project is quite low and since smart phones are available nowadays with greater ease, this is a user friendly work and can be used for benefitting the mass.

PROJECT OBJECTIVES

1: Designing a modern, user-friendly tool for welfare and benefit for the people.

2: Applying the theoretical knowledge of various subjects like Embedded Systems, Analog Circuits, Microcontrollers for designing of a practical tool.

3: Applying modern tools like Arduino, NodeMCU, Blynk App and other recent trending tools for designing of the project

4: Planning and Interacting among team members as well as co-ordinating as a team to work as a unit for solving engineering problems.

5: Understanding the different environmental problems and applying ethical principles and commit to professional ethics and norms of engineering practices.

6: Preparing and having ability to engage independent and life-long learning in the broadest content of technological change

PROJECT OUTCOME VERSUS PROGRAM OUTCOME (PO) MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Outcome 1						3								
Outcome 2	3	2	2	2									3	
Outcome 3				2	3									2
Outcome 4									3	2				
Outcome 5							2	3						
Outcome 6												3		
Outcome 7											2			

PROJECT PLANNING

The planning of this project progressed through the following steps:

1.The project was broadly divided into 3 modules each consisting of sensor and actuator circuits to control 3 home appliances namely fan, light and pump .

2.For each appliance input data from its corresponding sensor was displayed in the mobile application by programming the nodeMCU.

3.Actuator circuits were designed and implemented for all the appliances and these circuits were controlled from the app via nodeMCU (output signals) .

4.For testing proper functioning of each module, app was used to monitor data from each sensor and control each appliance accordingly.

5.All the modules were assembled (all the inputs were read together from sensors and appliances were controlled simultaneously).

6.Finally app has 3 separate tabs for 3 separate modules and they can be used at the time of controlling the 3 respective appliances.

CERTIFICATE

Department of Electronics and Communication Engineering

St. Thomas' College of Engineering and Technology

This is to certify that the project entitled "**IoT-based home appliances control system**", has been carried out by

Rudrendu Mahindar	12200314035(32)
Sananda Ghosh	12200314040(26),
Madhav Prakash	12200314023(47),
Gazala Parween	12200315064(45),

under my guidance during the year July, 2017 to June, 2018 and accepted for partial fulfillment of the requirement for the Degree of Bachelor of Technology of Maulana Abul Kalam Azad University of Technology (formerly West Bengal University of Technology), Kolkata.

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Ms. Sumani Mukherjee
(Project guide)

Acknowledgement

We wish to express our deep sense of gratitude and indebtedness to Ms. Sumani Mukherjee, Mr. Rabindranath Ghosh and Mr. Prasun Chowdhury, Department of Electronics and Communication Engineering, St. Thomas' College of Engineering & Technology, for introducing the present topic and for their inspiring guidance, constructive criticism and valuable suggestion throughout this project work.

We take this opportunity to thank all our lecturers who have directly or indirectly helped our project. We pay our respects and love to our parents and all other family members and friends for their love and encouragement throughout our career. Last but not the least we express our thanks to our friends for their cooperation and support.

RUDRENDU MAHINDAR SANANDA GHOSH MADHAV PRAKASH GAZALA PARWEEN

Date:

St. Thomas' College of Engineering and Technology

4, Diamond Harbour Road,

Kolkata-700023,

West Bengal, India.

CONTENTS

INTRODUCTION

In the advancement of technologies controlling and monitoring electrical appliances using laptop, computer with the help of internet connection is possible. So it gives a more space at a home, university and industrial controlling electrical appliances anywhere in the world. By using Internet of Things we can control many devices such as light, water pump, Fan, computer, opening and closing of door etc. It reduces human efforts and power efficiency. The main objective of internet of things is used to help specially challenged people and old age people to control electrical appliances and security purpose. IoT is very useful for these people in crucial situations. There are two ways to access these processes WIFI connectivity (or) it is connected to a router. This process is done in low cost & controlling many devices in a simple circuit. IOT or internet of things is an upcoming technology that allows us to control hardware devices through the internet. This system is used to control the appliances of home such as fan, light ,water pump. Our user friendly interface allows a user to easily control these home appliances through the internet. For this system we use an arduino as a microcontroller. This microcontroller is interfaced with a wi-fi modem to get user commands over the internet. Also we have an LCD display to display system status. Relays are used to switch loads. The entire system is powered by a 12 V transformer. After receiving user commands over the internet, microcontroller processes these instructions to operate these loads accordingly and display the system status on an LCD display. Thus this system allows for efficient home automation over the internet.

Objective

The IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit, when IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which encompasses technologies such as controlling of different home appliances like light, fan and control over doors, water pumps and many more. Technologies for Internet of Things (IoT) such as sensor, network and data processing are advancing rapidly. Thanks to the evolution, many potential applications have been developed in the fields of analysis and automation. We have designed a platform to connect sensor data with users daily life. There are also many smartphone oriented remote controller products. However current products always have platform compatibility problems, additionally, user interaction in such systems are becoming more and more complex. This work proposes an approach to enhance old appliances and the controlling experience through an IoT based Home Appliance Controlling System. With sensors the appliances can be controlled environment condition trigger. The sensor data are processed by single-board computer and delivered to mobile applications through wireless connection. The results of implementation and experimentation has shown the proposed system and platform can provide more IoT application possibilities daily life.

BACKGROUND OF THE PROJECT

A Project's Background is a formal document containing a common description of what is expected to be done within the project, what prerequisites for the project are, and how to produce the expected amount of work.

- A SMART HOME INFORMATION SYSTEM

To manage all appliances in a smart home, it is necessary to develop a smart home information system (SHIS), which can be running in a management sever or the owner's computer. We designed and developed a SHIS with web technologies. The SHIS comprises user login authority, home appliance control, appliance management, contextual mode control, security system, energy management, data processing and graphical display, etc.. With the function of user login authority, a household authorized can monitor and control his appliances via the internet. Appliance control of a SHIS has two ways to achieve the control aim. One is control and regulate an appliance independently. Another way is to control different appliances together with a contextual mode. An independent control example is shown in Fig. 2.By using the SHIS, a person can select an appliance for controlling in his home. If he do not like to control so many appliances one by one, he can use a contextual mode. In a contextual mode, people just set a contextual mode. Then the SHIS will transmit the selection to a smart central controller through a wireless router. There are four ordinary including at-home, going out, sleeping, getting up. Beyond of these modes, the SHIS provides another choice, which is a user definition mode. A user can determine which appliance should be embraced in a user contextual mode. This user definition mode function has greatly facilitated user's operations. A security system is very important for an intelligent building in that it is to provide safety for all the occupancies and visitors. In the security system of the SHIS, as shown in Fig. 3, there are options at the front of each security sensor. Hence, a house holder can configure these security sensors and make various protection zones for different goals. For a given home, the householder can organize a defence or withdraw a defence. When a person is at home, a at-home security mode can be set up; While there is no one in a house, a outgoing security mode should be start. Each security zone has a time schedule so that the householder can set an appropriate protection time conveniently.

- RELATED WORK

Many researches about Appliances Controlling System have been conducted, there are also some related products have been developed. In the following

part of this chapter, several works are introduced. After understanding each work's point of view, advantage and disadvantage, the issues and expected solutions are discussed. A. Researches about Appliances Controlling System started from early on. It can be discussed from various angles.

1) Previous Research: This is a previous study of this work. The system tries to build a Universal Appliances Controlling System which can control different appliances together based on tasks. It provide a web interface for user to manage their appliances, and make it possible to control appliances through infrared signal with Arduino platform.

2) Wireless Sensor Network Based Smart Home: Wire-less sensors have been widely used in home appliances controlling. Most of the sensors are used for detect the environment change and user's activity. With those information the system can learn and define human behaviors. In those works there are some similar implementation. Many unobtrusive sensor are installed throughout user's house. Using ZigBee or other wireless connection, the system can collect all the sensors data to monitor the house environment.

3) Controlling User Experience: As discussed above, nor-mal appliances controlling processes have focused on de-vices functions. This process could be more user cantered improve the User Interface and Experience. Smartphone application or web page have already become easily accessible for normal users. Many implementation are trying to integrate the remote control into web interface. It can improve the controlling experience by combining functions and appliance into grouped tasks based on the user's activity.

- Existing Products

1) Universal Controller Application: Universal remote control with no wires or power cables. The Beacon device is regarded as a bridge, smartphones can communicate with it through Bluetooth, through the smart-phone application, and users can send IR signals from Beacon to control their appliances. In addition, broad link e-Remote2is providing similar functions. But Broad link e-Remote needs Wi-Fi environment. Another product L5 Remote3 is different from above, in that it is an accessory universal IR controller that can be plugged into iPhone or iPad.

2) Sensor Based: As the sensor technology develops, we have also seen the advent of various ranges of sensor- controller and applications in our lives. We MO Switch +Motion4 can turn appliances, which plugged in the switch, on or off when the sensor detects movement.

3) Self-learning: Another two products are kind of different from those above. Nest5 and Tado6 are both a portable thermostat and appliance controller device with pretty and tidy design. They can detect the user's existence and switch the appliances automatically. They are also equipped with learning mechanism that can provide proper service based on

- Limitations in Appliances Controlling Services

Many works and products were intruded above. The methodologies, features of those work are not identical with each other, nevertheless they all have some certain limitation on compatibility and usability. These limitations come from the diversity of controlling technologies, such as different Infrared protocols, and as a result many old appliances cannot be integrated into those systems. The controlling process and interface of the works above are basically structured based on the appliances' functions and the normal remote control. Therefore these systems will be limited by the appliances actually used. Because of the diver's usage requirements and environments, it is difficult to make a common platform for Appliances Controlling. But the roles of appliances in a user's activities are similar, that is to support and provide required functions and information. Thus the technology of appliances controlling should be constructed based on users 'activity. The approach proposed in this work focuses on help users concentrate on their activities in daily life rather than what appliances to use to support these activities. With an add-on module, most of the families should enjoy new controlling experience with their old appliances.

- SYSTEM DESCRIPTION

A. Objectives

The proposed system Any Control tries to provide User-centered experience for home appliances controlling. The concept is that users should not be concerned about the appliances, but their activities themselves. With this system, users do not need to look for the specific function of appliance on the remote control. For instance, a target user who issued to watch TV after coming back home in the evening. In normal circumstances, A need to turn on the light, air conditioner, and the TV in his living room. To simplify the controlling process could improve the user experience. The more transparent the operation are, the more enjoyable inexperience it creates for the user. Therefore, objectives were set based on Compatibility and Usability needs.

1) Enhance Old Appliances: Every new generation of appliances will bring many new functions that the old appliances are lack of. The proposed system should

able to deploy in normal home environment. So that normal user could apply it to the existing appliances easily. Instead of changing the appliances, an add-on module will be more convenient and fast. IOT technologies using sensors, network connection, -board computer can be applied as add-on modules to the old ones, they can be enhanced and even have more functions than the new models. Although many new remote control technologies have been used such as Bluetooth, ZigBee. Infrared is still most widely used in normal homes. To provide economic solution, the first implementation will be conducted with Infrared.

2) Task based and Sensor Triggered Automation: Control-ling process should be organized based on tasks, and these tasks will be defined by users according to their activities. History record of the operations based on different activities, could support a self-learning and prediction service. Through organization based on tasks, the existence of appliances will become secondary to their collective function. Only the functions that related to the current activity will be added into the operation list of the very task. To trigger each task, not only can the applications interface used, but also sensors and other web APIs. To detect and serve users' activities, environment sensor could be helpful. After uses defined tasks for different activities, they can setup the trigger for each task. As a result, the controlling process will be executed automatically while users' activities are proceeding. Environment condition information would be very useful in other cases. Users can monitor their house condition with the data in a remote place. Or the computer can analyse the data to make advises and provide the information in proper moment for users. Or the data could be used not only inside family, it can be used in a range of community, to provide more helpful result in different fields.

B. Systems Architecture and Component

The system consists of three main components.

Environment Sensor

As an input source to serve user activity, multi-sensory of different environment conditions are required. The sensor data will be retrieved and transferred inside the system.

Universal Controller

With single-board computer platform, it can pro-vide infrared learning function and internet connection ability. This will enable the processing of sensor data, and also the task output which can interact with appliances.

User Interface

Web view based smartphone application will be applied to this system, so that it can be used in different mobile platforms even PC browsers. With clear designed interface and functions, users can manage their task and appliances easily through the application.

COMPONENTS:

1. LDR

- resistance : 400ohm to 400Kohm
- normal resistance variation: 1Kohm to 10Kohm
- sensitivity: about 3msec
- Voltage ratings: I used it on 3V,5V and 12V

2. ULTRASONIC SENSOR

- Working Voltage DC 5 V
- Working Current 15mA
- Working Frequency 40Hz Max Range 4m Min Range 2cm
- Measuring Angle 15 degree Trigger Input Signal 10uS TTL pulse
- Echo Output Signal Input TTL lever signal

3. ARDUINO ATMEGA

- Advanced RISC Architecture – 131
- Execution – 32 x 8 General Purpose Working Registers
- Fully Static Operation – Up to 20 MIPS Throughput at 20MHz
- Non-volatile Memory Segments – 32KBytes of In-System Self-Programmable Flash program

4. NODE MCU

- USB-TTL included, plug & play

5. DHT 11

- Operating Voltage: 3.5V to 5.5V.
- Operating current: 0.3mA (measuring) 60uA (standby)
- Output: Serial data.
- Temperature Range: 0°C to 50°C.

- Humidity Range: 20% to 90%
- Resolution: Temperature and Humidity both are 16-bit.
- Accuracy: ±1°C and ±1%

DC MOTOR

A **DC motor** is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.

DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances.

The very basic construction of a DC motor contains a current carrying armature which is connected to the supply end through commutator segments and brushes. The armature is placed in between north south poles of a permanent or an electromagnet as shown in the diagram above. As soon as we supply direct current in the armature, a mechanical force acts on it due to the electromagnetic effect of the magnet. Now to go into the details of the **operating principle of DC motor** it's important that we have a clear understanding of Fleming's left-hand rule to determine the direction of the force acting on the armature conductors of DC motor.If a current carrying conductor is placed in a magnetic field perpendicularly, then the conductor experiences a force in the direction mutually perpendicular to both the direction of field and the current carrying conductor. Fleming's left hand rule says that if we extend the index finger, middle finger and thumb of our left-

hand perpendicular to each other, in such a way that the middle finger is in the direction of current in the conductor, and index finger is along the direction of magnetic field, i.e. north to south pole, then thumb indicates the direction of created mechanical force.

RELAY

A **relay** is an electromagnetically operated switch.

Pin Number	Pin Name	Description
1	Coil End 1	Used to trigger(On/Off) the Relay, Normally one end is connected to 5V and the other end to ground
2	Coil End 2	Used to trigger(On/Off) the Relay, Normally one end is connected to 5V and the other end to ground
3	Common (COM)	Common is connected to one End of the Load that is to be controlled
4	Normally Close (NC)	The other end of the load is either connected to NO or NC. If connected to NC the load remains connected before trigger
5	Normally Open (NO)	The other end of the load is either connected to NO or NC. If connected to NO the load remains disconnected before trigger

Arduino Uno

Arduino Uno [8] is a microcontroller board based on the ATmega328P. It consists of a circuit board, which can be programed (referred to as a microcontroller) and a ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board.

The key features are:

- Arduino boards are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor, turning LED on/off, connect to the cloud and many other actions.

- The board functions can be controlled by sending a set of instructions to the microcontroller on the board via Arduino IDE (referred to as uploading software).

- Unlike most previous programmable circuit boards, Arduino does not need an extra piece of hardware (called a programmer) in order to load a new code onto the board.

- Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program.

- Finally, Arduino provides a standard form factor that breaks the functions of the microcontroller into a more accessible package.

The ATmega328/P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328/P achieves throughputs close to 1MIPS per MHz. This empowers system designer to optimize the device for power consumption versus processing speed.

Key Features of Atmega 328P are

High Performance, Low Power AVR 8-Bit Microcontroller Family

- Advanced RISC Architecture

– 131 Powerful Instructions

– Most Single Clock Cycle Execution

– 32 x 8 General Purpose Working Registers

– 32KBytes of In-System Self-Programmable Flash program

– 1KBytes EEPROM

– 2KBytes Internal SRAM

– Two 8-bit Timer/Counters

– One 16-bit Timer/Counter

– Real Time Counter with Separate Oscillator

– Six PWM Channels

– 8-channel 10-bit ADC

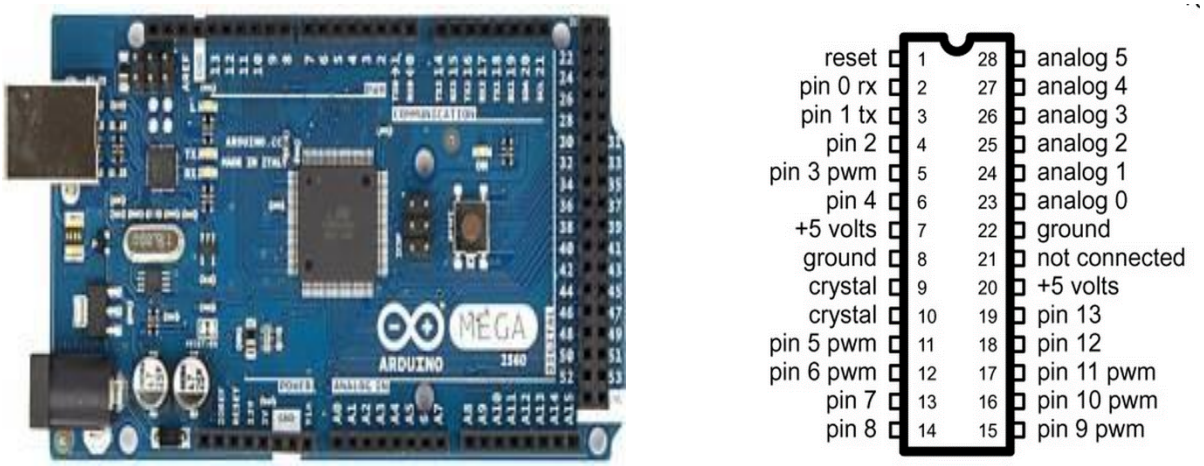

Fig.1

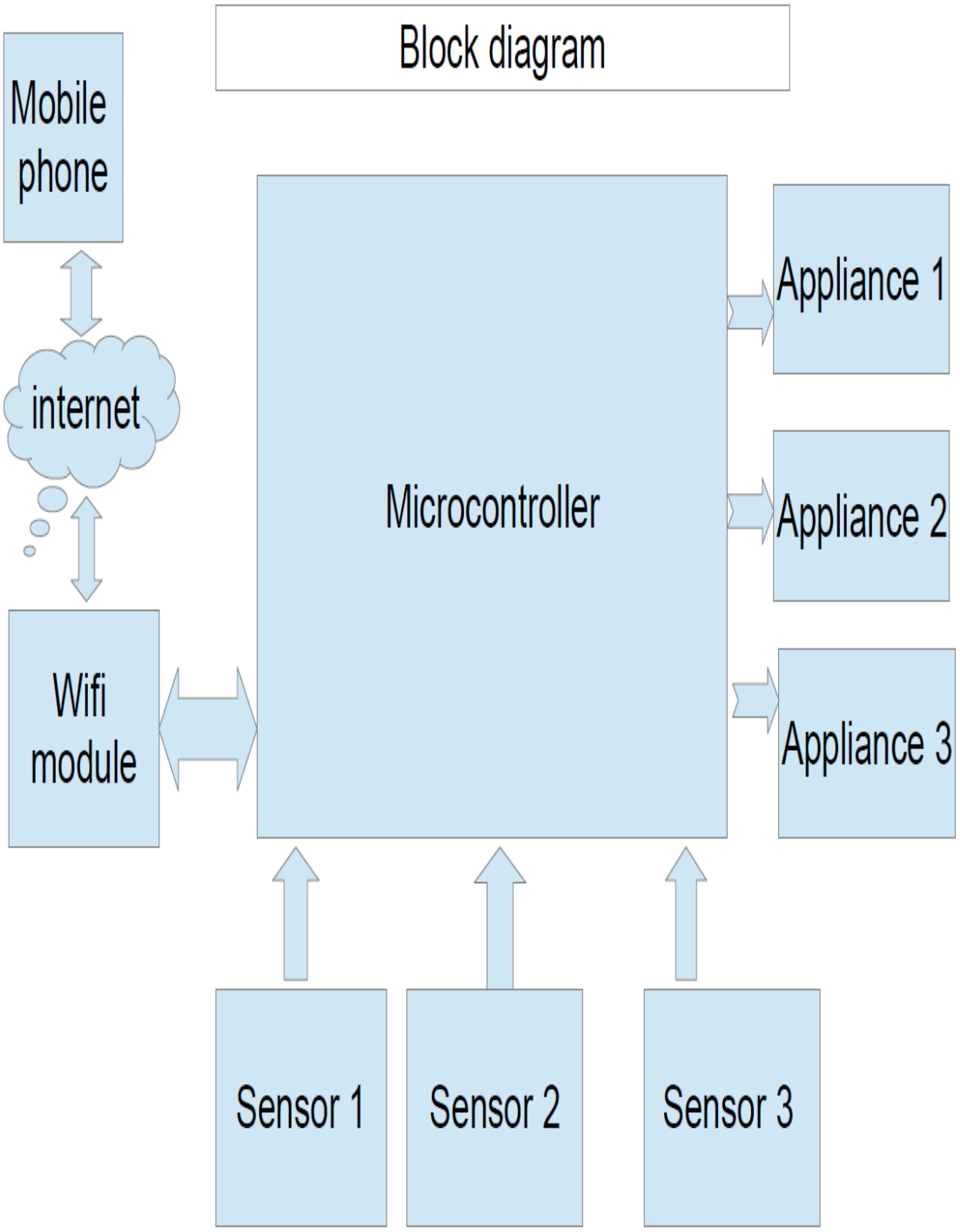
Block diagram
Mobile phone
internet
Wifi module
Microcontroller
Appliance 1
Appliance 2
Appliance 3
Sensor 1
Sensor 2
Sensor 3

Fig.2

Appliance control using sensors

Water level control of pump:

Conservation of resources is yet another important issue that we deal in our lives. For instance if we switch on the water pump and we forget to turn it off, there will be huge amount of water wasted. To avoid this unnecessary flow of water, we can fix an Ultrasonic sensor in the pump itself and when the water height will reach its desired level, sensor will detect it and the application will be notified. From the options valid in the application, we will the able to turn the pump off even if there is nobody at the site physically.

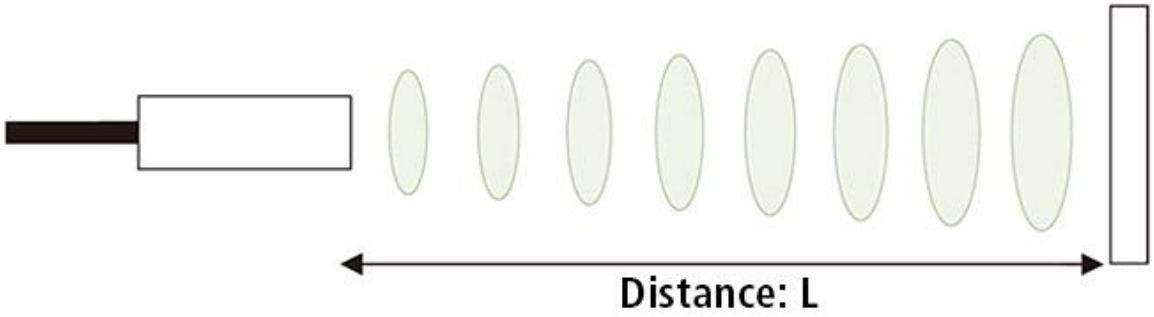

Fig.3

An optical sensor has a transmitter and receiver, whereas an ultrasonic sensor uses a single ultrasonic element for both emission and reception. In a reflective model ultrasonic sensor, a single oscillator emits and receives ultrasonic waves alternately.

This enables

miniaturization of the sensor head.

Pin Number	Pin Name	Description
1	Vcc	The Vcc pin powers the sensor, typically with +5V
2	Trigger	Trigger pin is an Input pin. This pin has to be kept high for 10us to initialize measurement by sending US wave.
3	Echo	Echo pin is an Output pin. This pin goes high for a period of time which will be equal to the time taken for the US wave to return back to the sensor.
4	Ground	This pin is connected to the Ground of the system.

Ultrasonic sensors emit short, high-frequency sound pulses at regular intervals. These propagate in the air at the velocity of sound. If they strike an object, then they are reflected back as echo signals to the sensor, which itself computes the distance to the target based on the time-span between emitting the signal and receiving the echo.

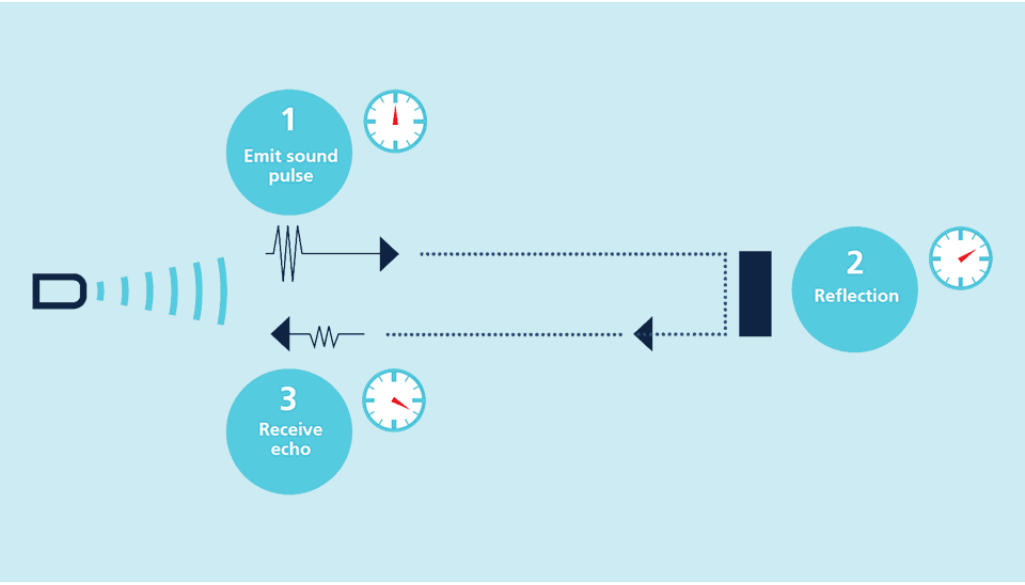

Fig.4

Ultrasonic principle

As the distance to an object is determined by measuring the time of flight and not by the intensity of the sound, ultrasonic sensors are excellent at suppressing background interference.

Virtually all materials which reflect sound can be detected, regardless of their colour. Even transparent materials or thin foils represent no problem for an ultrasonic sensor.

Microscopic ultrasonic sensors are suitable for target distances from 20 mm to 10 m and as they measure the time of flight they can ascertain a measurement with pinpoint accuracy. Some of our sensors can even resolve the signal to an accuracy of 0.025 mm. Ultrasonic sensors can see through dust-laden air and ink mists. Even thin deposits on the sensor membrane do not impair its function. Sensors with a blind zone of only 20 mm and an extremely thin beam spread are making entirely new applications possible today: Fill level measurement in wells of microliter plates and test tubes, as well as the detection of small bottles in the packaging industry, can be implemented with ease. Even thin wires are reliably detected.

Light Switch Control Using LDR

Conservation of energy also deals with the conservation of light. Unnecessary lights during daytime is a waste of resource. So by using LDR or Light Dependent Resistor, we can well design a circuit which will only turn on the lights when there is darkness and turn off the light when there is enough light sources. The control will be done using the application which will have the ON/OFF options.

Working Principle:

The **Light Dependent Resistor** (LDR) is made from a piece of exposed semiconductor material such as cadmium sulphide that changes its electrical resistance from several thousand Ohms in the dark to only a few hundred Ohms when light falls upon it by creating hole-electron pairs in the material

Fig.5

LDR

The net effect is an improvement in its conductivity with a decrease in resistance for an increase in illumination. Also, photoresistive cells have a long response time requiring many seconds to respond to a change in the light intensity.

Materials used as the semiconductor substrate include, lead sulphide (PbS), lead selenide (PbSe), indium antimonide (InSb) which detect light in the infra-red range with the most commonly used of all photo resistive light sensors being **Cadmium Sulphide** (Cds).

Cadmium sulphide is used in the manufacture of photoconductive cells because its spectral response curve closely matches that of the human eye and can even be controlled using a simple torch as a light source. Typically then, it has a peak sensitivity wavelength (λp) of about 560nm to 600nm in the visible spectral range.

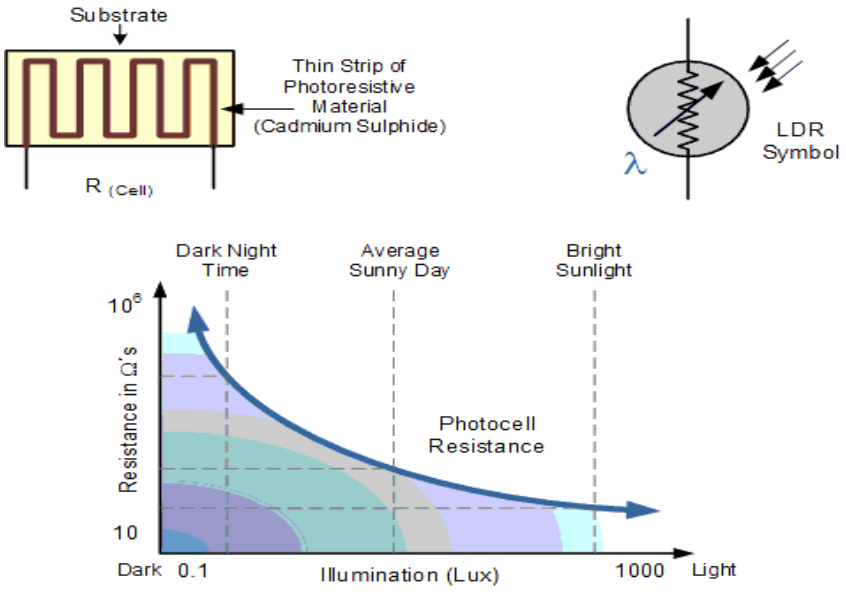

Fig.6

The Light Dependent Resistor Cell

The most commonly used photoresistive light sensor is the **ORP12** Cadmium Sulphide photoconductive cell. This light dependent resistor has a spectral response of about 610nm in the yellow to orange region of light. The resistance of the cell when unilluminated (dark resistance) is very high at about 10MΩ's which falls to about 100Ω's when fully illuminated (lit resistance).

DHT11

A **humidity sensor** senses, measures and regularly reports the relative humidity in the air. It measures both moisture and air temperature. Relative humidity, expressed as a percent, is the ratio of actual moisture in the air to the highest amount of moisture air at that temperature can hold. The warmer

Fig.7

the air is, the more moisture it can hold, so relative humidity changes with fluctuations in temperature. Humidity sensors detect the relative humidity of the immediate environments in which they are placed. They measure both the moisture and temperature in the air and express relative humidity as a percentage of the ratio of moisture in the air to the maximum amount that can be held in the air at the current temperature.

As air becomes hotter, it holds more moisture, so the relative humidity changes with the temperature. Most humidity sensors use capacitive measurement to determine the amount of moisture in the air. This type of measurement relies on two electrical conductors with a non-conductive polymer film laying between them to create an electrical field between them. Moisture from the air collects on the film and causes changes in the voltage levels between the two plates. This change is then converted into a digital

measurement of the air, relative humidity after taking the air temperature into account.

POWER SUPPLY AND ITS COMPONENTS:

A transformer (Tx=Primary 230 Volt, Secondary 12 Volt, 1Amp step down transformer) is used to covert 230V to 12V from mains. Here used a bridge rectifier made by four 1N4007 or 1N4003 diode to convert AC to DC . The filtering capacitor 1000uF, 25V is used to reduce the ripple and get a smooth DC voltage. This circuit is very easy to build. For good performance input voltage should be greater than 12Volt in pin-1 of IC LM7812. Use a heat sink to IC LM7812 for safeguarding it from overheating.

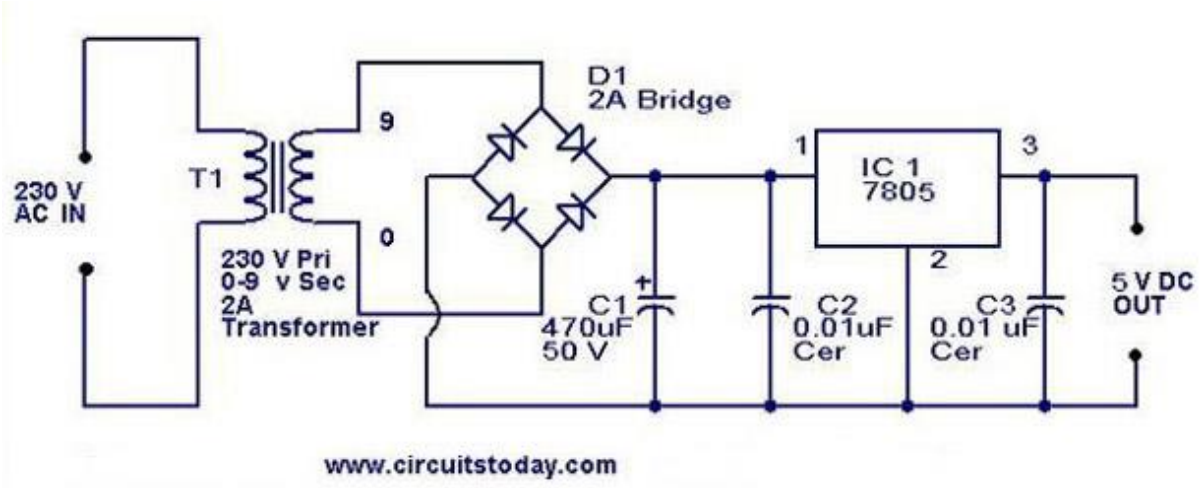

Fig.8

4 Steps to Convert 230V AC to 5V DC

1. Step Down the Voltage Level

The step-down converters are used for converting the high voltage into low voltage. The converter with output voltage less than the input voltage is called as a step-down converter, and the converter with output voltage greater than the input voltage is called as step-up converter. There are step-up and step-down transformers which are used to step up or step down the voltage levels. 230V AC is converted into 12V AC using a step-down transformer. 12V output of stepdown transformer is an RMS value and its peak value is given by the product of square root of two with RMS value, which is approximately 17V.

Step-down transformer consists of two windings, namely primary and secondary windings where primary can be designed using a less-gauge wire with more number of turns as it is used for carrying low-current high-voltage power, and the secondary winding using a high-gauge wire with less number of turns as it is used for carrying high-current low-voltage power. Transformers works on the principle of Faraday's laws of electromagnetic induction.

2. Convert AC to DC

230V AC power is converted into 12V AC (12V RMS value wherein the peak value is around 17V), but the required power is 5V DC; for this purpose, 17V AC power must be primarily converted into DC power then it can be stepped down to the 5V DC. But first and foremost, we must know how to convert AC to DC? AC power can be converted into DC using one of the power electronic converters called as Rectifier. There are different types of rectifiers, such as half-wave rectifier, full-wave rectifier and bridge rectifier. Due to the advantages of the bridge rectifier over the half and full wave rectifier, the bridge rectifier is frequently used for converting AC to DC.
Bridge rectifier consists of four diodes which are connected in the form a bridge. We know that the diode is an uncontrolled rectifier which will conduct only forward bias and will not conduct during the reverse bias. If the diode anode voltage is greater than the cathode voltage then the diode is said to be in forward bias. During positive half cycle, diodes D2 and D4 will conduct and during negative half cycle diodes D1 and D3 will conduct. Thus, AC is converted into DC; here the obtained is not a pure DC as it consists of pulses. Hence, it is called as pulsating DC power. But voltage drop across the diodes is (2*0.7V) 1.4V; therefore, the peak voltage at the output of this retifier circuit is 15V (17-1.4) approx.

3. Smoothing the Ripples using Filter

15V DC can be regulated into 5V DC using a step-down converter, but before this, it is required to obtain pure DC power. The output of the diode bridge is a DC consisting of ripples also called as pulsating DC. This pulsating DC can be filtered using an inductor filter or a capacitor filter or a resistor-capacitor-coupled filter for removing the ripples. Consider a capacitor filter which is frequently used in most cases for smoothing.

We know that a capacitor is an energy storing element. In the circuit, capacitor stores energy while the input increases from zero to a peak value and, while the supply voltage decreases from peak value to zero, capacitor starts discharging. This charging and discharging of the capacitor will make the pulsating DC into pure DC, as shown in figure.

4. Regulating 12V DC into 5V DC using Voltage Regulator

15V DC voltage can be stepped down to 5V DC voltage using a DC step-down converter called as voltage regulatorIC7805. The first two digits '78' of IC7805 voltage regulator represent positive series voltage regulators and the last two digits '05' represents the output voltage of the voltage regulator.

IC 7805

Voltage sources in a circuit may have fluctuations resulting in not providing fixed voltage outputs. A voltage regulator IC maintains the output voltage at a constant value. 7805 IC, a member of 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC). The xx in 78xx indicates the output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add a heat sink.

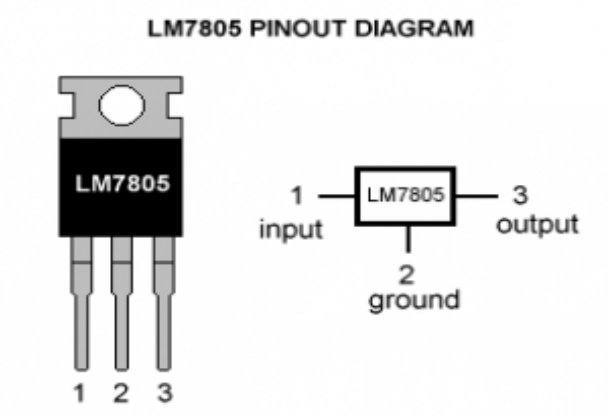

Fig.9

7805 IC Rating

- Input voltage range 7V- 35V
- Current rating Ic = 1A

- Output voltage range V(max)=5.2V, V(min)=4.8V

Pin Details of 7805 IC

Pin No.	Pin	Function	Description
1	INPUT	Input voltage (7V-35V)	In this pin of the IC positive unregulated voltage is given in regulation.
2	GROUND	Ground (0V)	In this pin where the ground is given. This pin is neutral for equally the input and output.
3	OUTPUT	Regulated output; 5V (4.8V-5.2V)	The output of the regulated 5V volt is taken out at this pin of the IC regulator.

IN4007

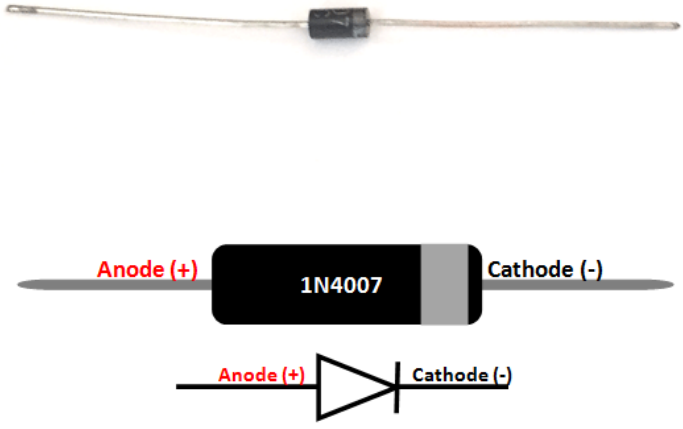

Fig.10

Pin Configuration:

Pin No.	Pin Name	Description
1	Anode	Current always Enters through Anode
2	Cathode	Current always Exits through Cathode

Features:

- Average forward current is 1A
- Non-repetitive Peak current is 30A
- Reverse current is 5uA.
- Peak repetitive Reverse voltage is 1000V
- Power dissipation 3W

Description:

A diode is a device which allows current flow through only one direction. That is the current should always flow from the Anode to cathode. The cathode terminal can be identified by using a grey bar as shown in the picture above.

For **1N4007 Diode**, the maximum current carrying capacity is 1A it withstand peaks up to 30A. Hence we can use this in circuits that are designed for less than 1A. The reverse current is 5Ua which is negligible. The power dissipation of this diode is 3W.

BLYNK application

The application we have used in our project is BLYNK. This interfaces the ESP8266 with the other sensors via an android phone with its hotspot connection and user id, password.

Blynk is a Platform with iOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet.

It's a digital dashboard where we can build a graphic interface for our project by simply dragging and dropping widgets. Blynk is a supporting hardware.

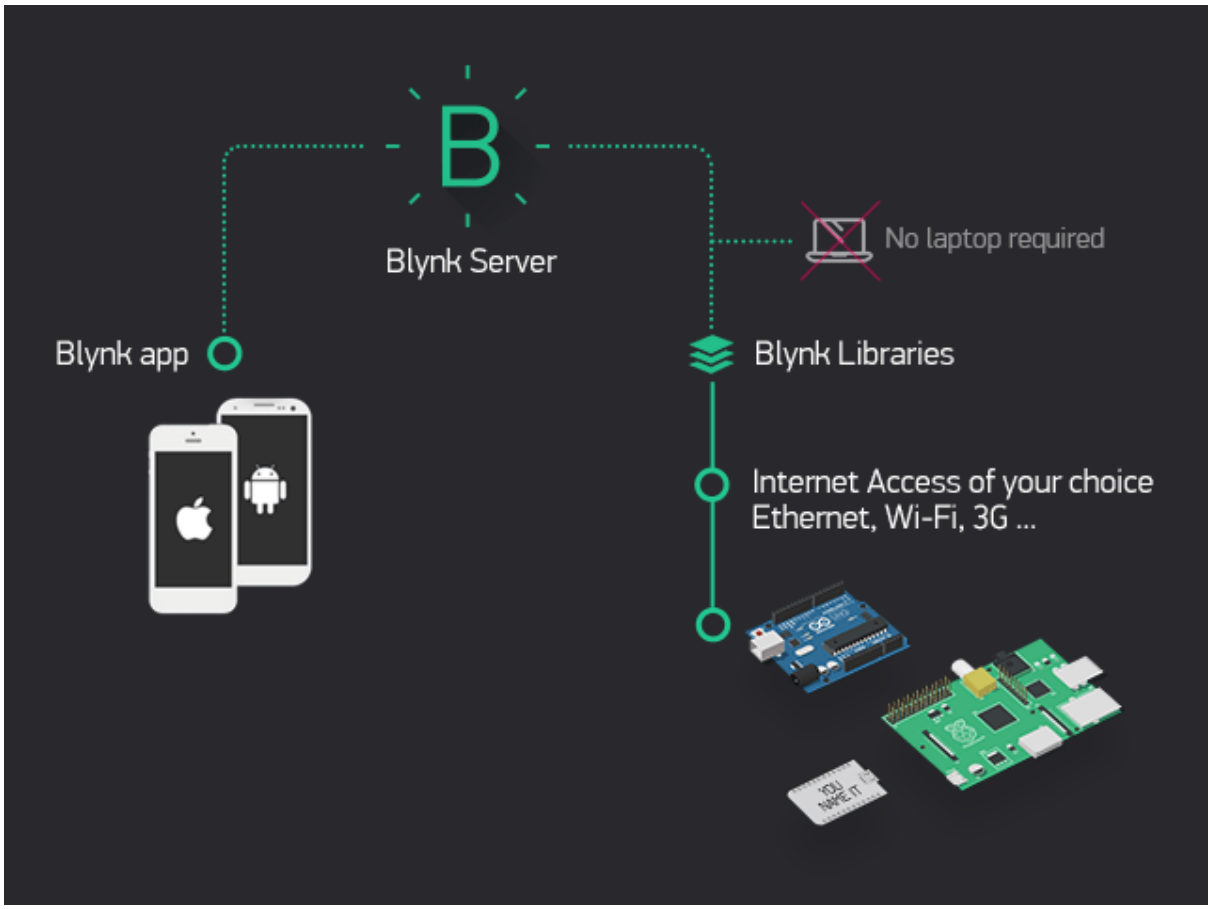

Fig.11

Interfacing of hardware components with software application:

The Ultrasonic sensor is used to measure the distance of the water level and then accordingly the motor is turned on or off. For high distance, the motor will be turned on, and for low distance, the motor is turned off as the water level almost reaches the higher threshold level. All of this is controlled via BLYNK application and the vales of the distance and the status of the motor is displayed.

Interfacing ULTRASONIC SENSOR with BLYNK Application:

```
#define BLYNK_PRINT Serial

#include <ESP8266WiFi.h>

#include <BlynkSimpleEsp8266.h>

#define TRIGGERPIN D1

#define ECHOPIN    D2

char auth[] = "Your auth token";

// Your WiFi credentials.

// Set password to "" for open networks.

char ssid[] = "your wifi SSID";

char pass[] = "your password";

void setup()

{

  Serial.begin(9600);

pinMode(TRIGGERPIN, OUTPUT);

  pinMode(ECHOPIN, INPUT);

  Blynk.begin(auth, ssid, pass);

  // You can also specify server:
```

```
}
void loop()
{
  long duration, distance;
  digitalWrite(TRIGGERPIN, LOW);
  delayMicroseconds(3);
  digitalWrite(TRIGGERPIN, HIGH);
  delayMicroseconds(12);
  digitalWrite(TRIGGERPIN, LOW);
  duration = pulseIn(ECHOPIN, HIGH);
  distance = (duration/2) / 29.1;
  Serial.print(distance);
  Serial.println("Cm");
  Blynk.run();
 Blynk.virtualWrite(V1, distance);
  delay(3500);
}
```

Controlling the speed of the fan:

We have developed a 2-layered control system for a fan.

The first layer of control system consists of the operation, ON/OFF. The fan can only be switched on and off using the Blynk application based on the readings of DHT11. The sensor gives reading of the temperature and humidity via NodeMCU and are displayed in the application.

The second layer of control is the controlling of the speed of the fan. When the temperature is high, the speed of fan will be high. For recorded low temperature, the speed of the fan will also be low, thus making it an effective system for fan control. When both the speed buttons are turned on, a medium level speed is attained.

Interfacing DHT 11 with BLYNK Application:

```
#define BLYNK_PRINT Serial

#include <ESP8266WiFi.h>

#include <BlynkSimpleEsp8266.h>

#include <DHT.h>

char auth[] = "YourAuthToken";

char ssid[] = "YourNetworkName";

char pass[] = "YourPassword";

#define DHTPIN 2

DHT dht(DHTPIN, DHTTYPE);

BlynkTimer timer;

void sendSensor()

{

  float h = dht.readHumidity();  float t = dht.readTemperature();
```

```
  if (isnan(h) || isnan(t)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }
  Blynk.virtualWrite(V5, h);
  Blynk.virtualWrite(V6, t);
}
void setup()
{
  // Debug console
  Serial.begin(9600);
  Blynk.begin(auth, ssid, pass);
  // You can also specify server:
  //Blynk.begin(auth, ssid, pass, "blynk-cloud.com", 8442);
  //Blynk.begin(auth, ssid, pass, IPAddress(192,168,1,100), 8442);
dht.begin();
 timer.setInterval(1000L, sendSensor);
}
void loop()
{
  Blynk.run();
  timer.run();
}
```

Controlling light:

The light is turned ON/OFF using the Blynk application directly and with the help of LDR module. If there is darkness, the light will be turned on, and if there is light, the light will be turned off. We have used a bulb for the demonstration.

Interfacing LDR with BLYNK Application:

```
#define BLYNK_PRINT Serial

#include <ESP8266WiFi.h>

#include <BlynkSimpleEsp8266.h>

#define LDRPIN D0

char auth[] = "YourAuthToken";

char ssid[] = "YourNetworkName";

char pass[] = "YourPassword";

BlynkTimer timer;

void setup()

{

 Serial.begin(9600);

 pinMode(LDRPIN, INPUT);

 Blynk.begin(auth, ssid, pass);

}

void loop()

{    int sensorValue = digitalRead(LDRPIN);  // read the input on digital pin 0

   Blynk.run();

   timer.run();
```

```
if(sensorValue==1)
    Blynk.virtualWrite(V0, "HIGH");
else
    Blynk.virtualWrite(V0, "LOW");
  delay(3500);
}
```

Putting all codes together

```
/* Comment this out to disable prints and save space */
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include <DHT.h>
#include <NewPing.h>
#define LDRPIN D0
#define TRIGGERPIN D1
#define ECHOPIN    D2
#define MAX_DISTANCE 200
#define DHTPIN D3         // What digital pin we're connected to
// Uncomment whatever type you're using!
#define DHTTYPE DHT11     // DHT 11
//#define DHTTYPE DHT22   // DHT 22, AM2302, AM2321
//#define DHTTYPE DHT21   // DHT 21, AM2301
```

```
DHT dht(DHTPIN, DHTTYPE);
BlynkTimer timer;
NewPing sonar(TRIGGER_PIN, ECHO_PIN, MAX_DISTANCE);
// You should get Auth Token in the Blynk App.
// Go to the Project Settings (nut icon).
char auth[] = "YourAuthToken";
// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "YourNetworkName";
char pass[] = "YourPassword";
// This function sends Arduino's up time every second to Virtual Pin (5).
// In the app, Widget's reading frequency should be set to PUSH. This means
// that you define how often to send data to Blynk App.
void sendSensor()
{
  float h = dht.readHumidity();
  float t = dht.readTemperature(); //or dht.readTemperature(true) for
Fahrenheit

  if (isnan(h) || isnan(t)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }
```

```
else{
   Serial.println("Humidity=");
   Serial.print(h);
   Serial.println("Temperature=");
   Serial.print(t);
}
  // You can send any value at any time.
  // Please don't send more that 10 values per second.
  Blynk.virtualWrite(V5, h);
  Blynk.virtualWrite(V6, t);
}

void setup()
{
  // Debug console
  Serial.begin(115200);
  pinMode(LDRPIN, INPUT);
  Blynk.begin(auth, ssid, pass);
  // You can also specify server:
  //Blynk.begin(auth, ssid, pass, "blynk-cloud.com", 8442);
  //Blynk.begin(auth, ssid, pass, IPAddress(192,168,1,100), 8442);

  dht.begin();
```

```
  // Setup a function to be called every second

   timer.setInterval(1000L, sendSensor);
}

void loop()
{
  int distance;
  delay(50);
  Serial.print("Ping: ");
  distance=sonar.ping_cm();
  Serial.print(distance);
  Serial.print("cm");

 if(distance<=6)
  {   //notification and email to turn off pump when water is about to overflow
      Blynk.notify("Hey, water about to overflow");
      Blynk.email("rudrendumahindar@gmail.com", "Subject:water pump", "water will overflow");
}
  int sensorValue = digitalRead(LDRPIN);  // read the input on digital pin 0
  Blynk.run();
  timer.run();
```

```
 Blynk.virtualWrite(V1, distance);
 if(sensorValue==1){
     Serial.println("brightness is high");
     Blynk.virtualWrite(V0, "HIGH");
}
else
  {   Serial.println("brightness is low");
      Blynk.virtualWrite(V0, "LOW");
}

  delay(3500);
}
```

Flow chart for IoT-based home appliances control system

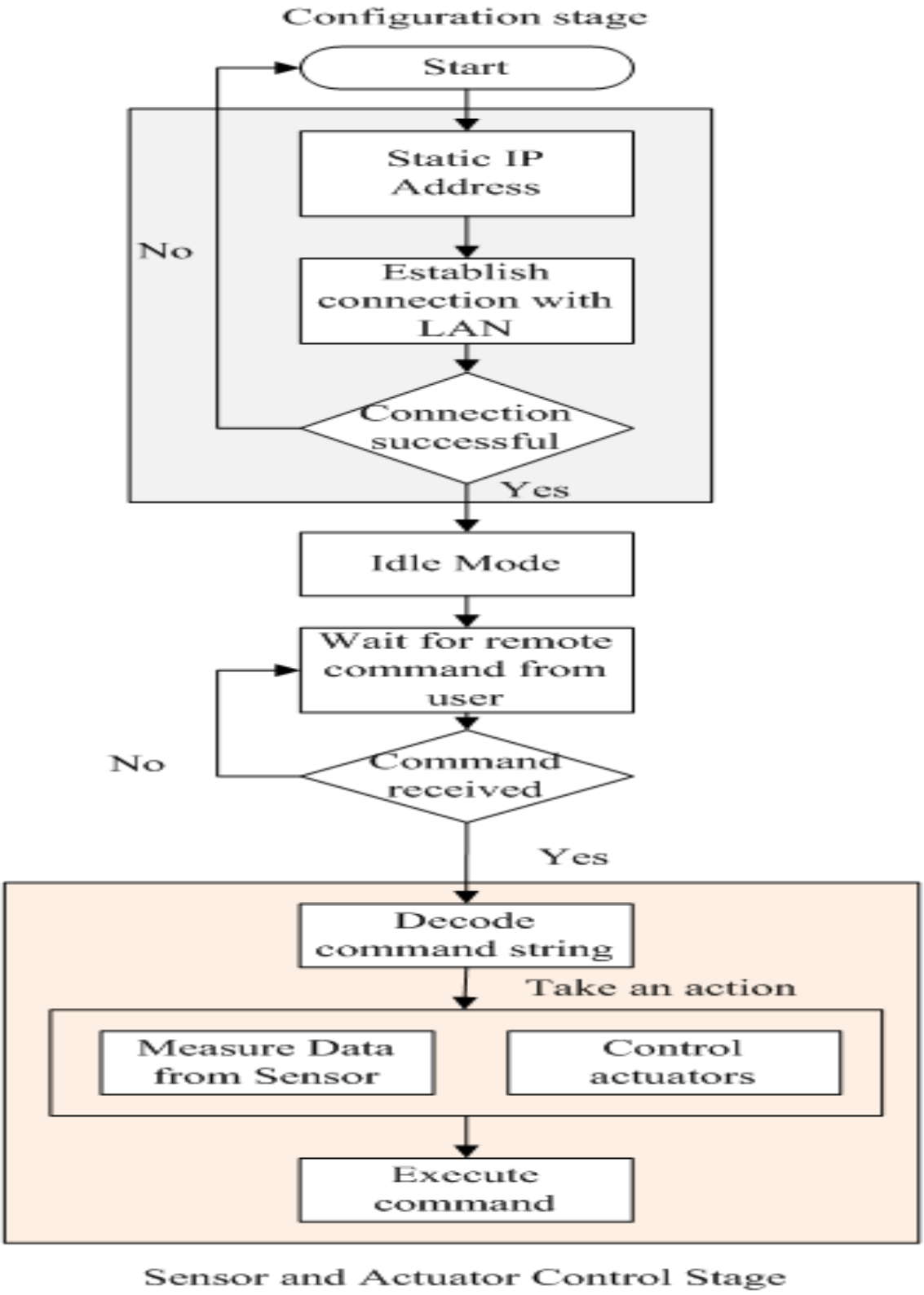

Fig.12

INTERFACING OF LDR WITH ARDUINO:

```
int sensorPin = A0;

int sensorValue = 0;

void setup() {

Serial.begin(9600); //sets serial port for communication

}
void loop() {

sensorValue = analogRead(sensorPin); // read the value from the sensor

Serial.println(sensorValue); //prints the values coming from the sensor on the
screen

delay(100);

}
```

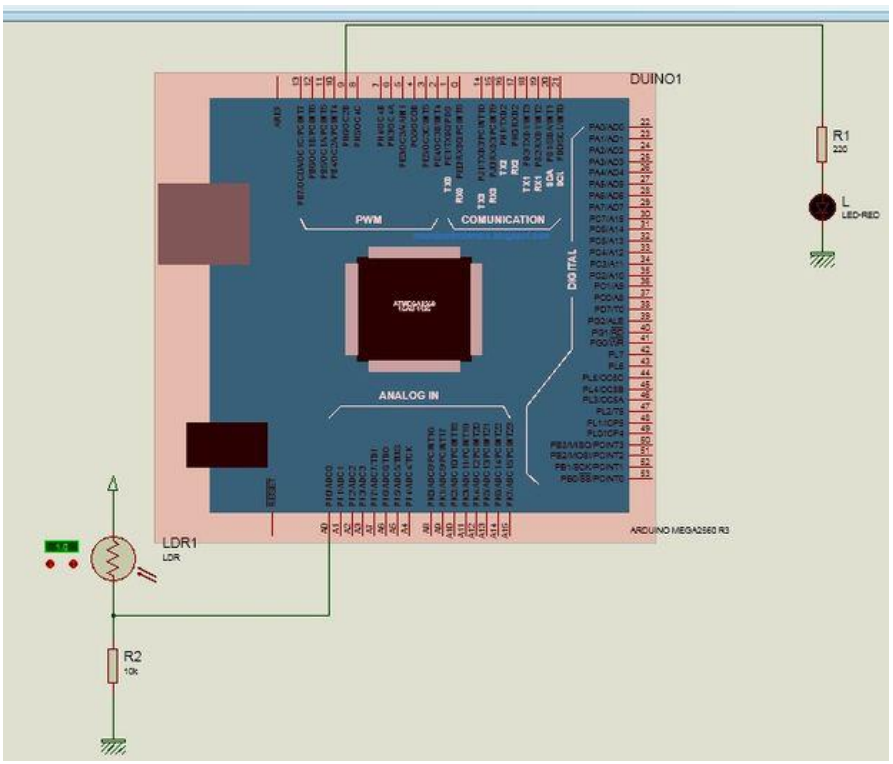

Fig13

INTERFACING OF ULTRASONIC SENSOR WITH ARDUINO:

```
const int trigPin = 9;
const int echoPin = 10; // defines variables
long duration;
int distance;
void setup() {
pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
pinMode(echoPin, INPUT); // Sets the echoPin as an Input
Serial.begin(9600); // Starts the serial communication
}
void loop() { // Clears the trigPin
digitalWrite(trigPin, LOW);
delayMicroseconds(2); // Sets the trigPin on HIGH state for 10 micro seconds
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW); // Reads the echoPin, returns the sound wave travel
time in microseconds
duration = pulseIn(echoPin, HIGH); // Calculating the distance
distance= duration*0.034/2; // Prints the distance on the Serial Monitor
Serial.print("Distance: ");
Serial.println(distance);
}
```

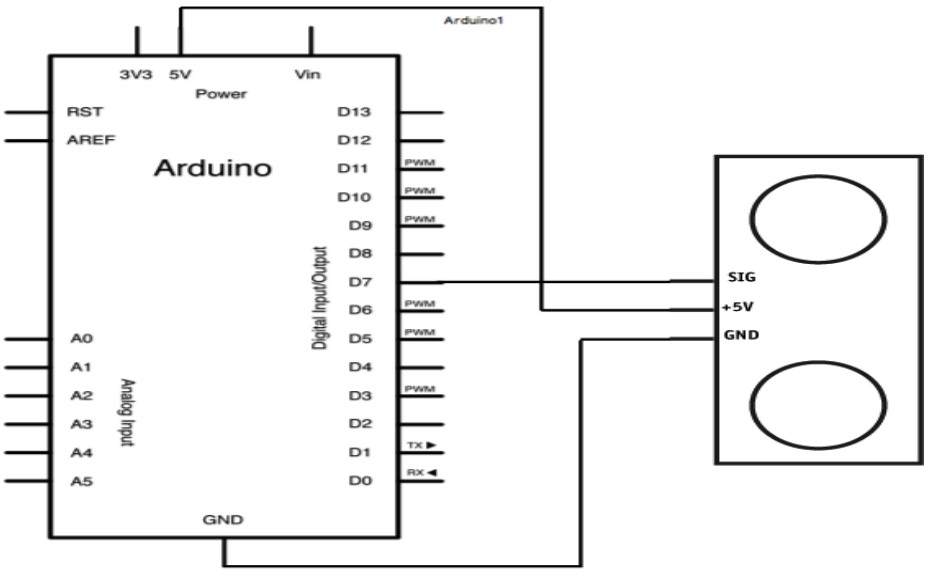

Fig.14

INTERFACING DHT11 WITH ARDUINO

```
#include<dht.h>
dht DHT;

#define DHT11_PIN 3

void setup() {

Serial.begin(9600);

Serial.println("Temperature”)

void loop()

int chk = DHT.read11(DHT11_PIN);

Serial.println(" Humidity " );

Serial.println(DHT.humidity, 1);

Serial.println(" Temparature ");

Serial.println(DHT.temperature, 1);

delay(2000);

}
```

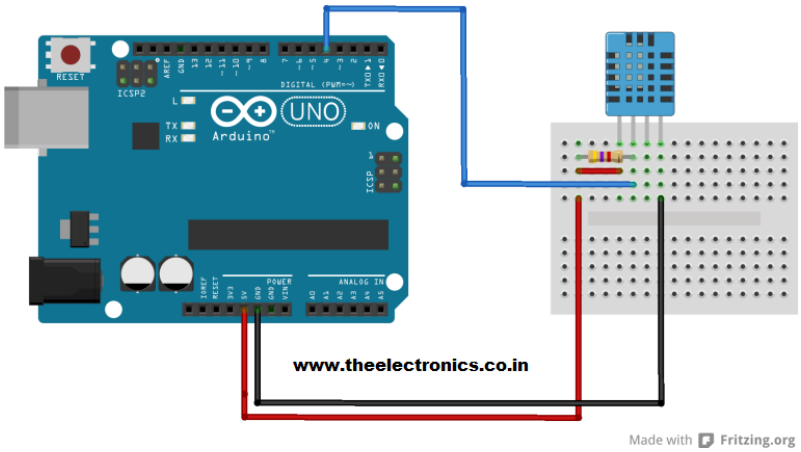

Fig.15

RESULT

Name of the project in Blynk app was DHT11 and while controlling the appliances the display of app in mobile screen was saved as screenshot . 3 tabs were created in the app for 3 appliances (light,motor,fan).

LIGHT CONTROL:

The light is turned ON or OFF using the BLYNK Application. It has an ON/OFF option. The light, we have used a bulb, is controlled using the application directly. The heading denotes the appliance we want to control, in this case "LIGHT". Also, the level of brightness is shown. The screenshot of the application is below.

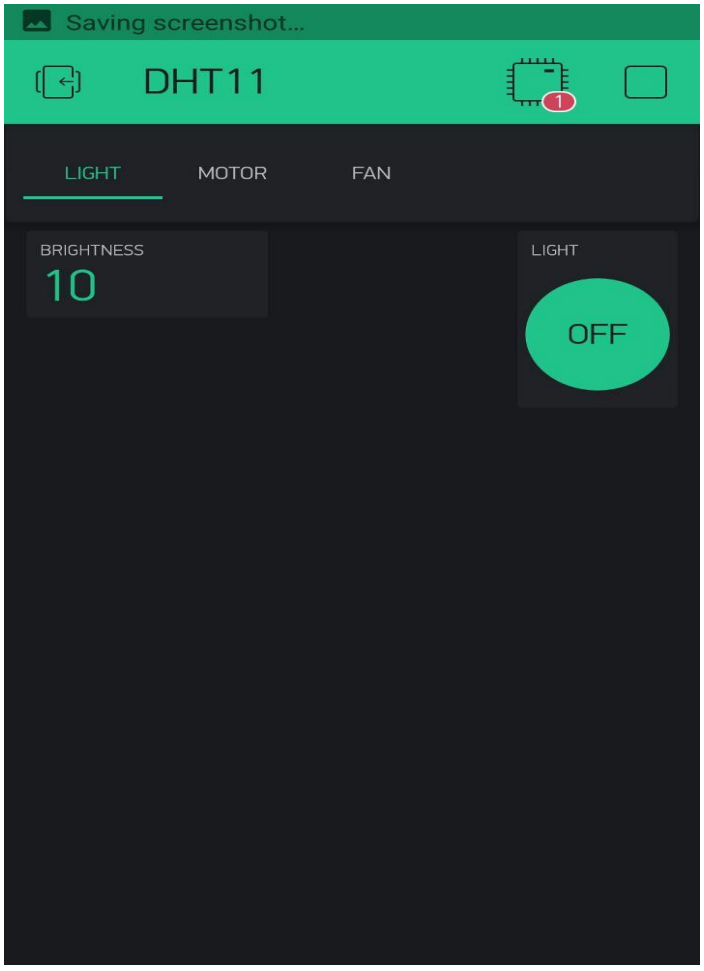

Fig. 16

WATER LEVEL CONTROL:

The motor is turned ON/OFF according to the distance of the sensor from the water level. The ultrasonic sensor is used to measure the distance of water level and accordingly the motor is turned ON/OFF and the distance is also displayed on the screen.

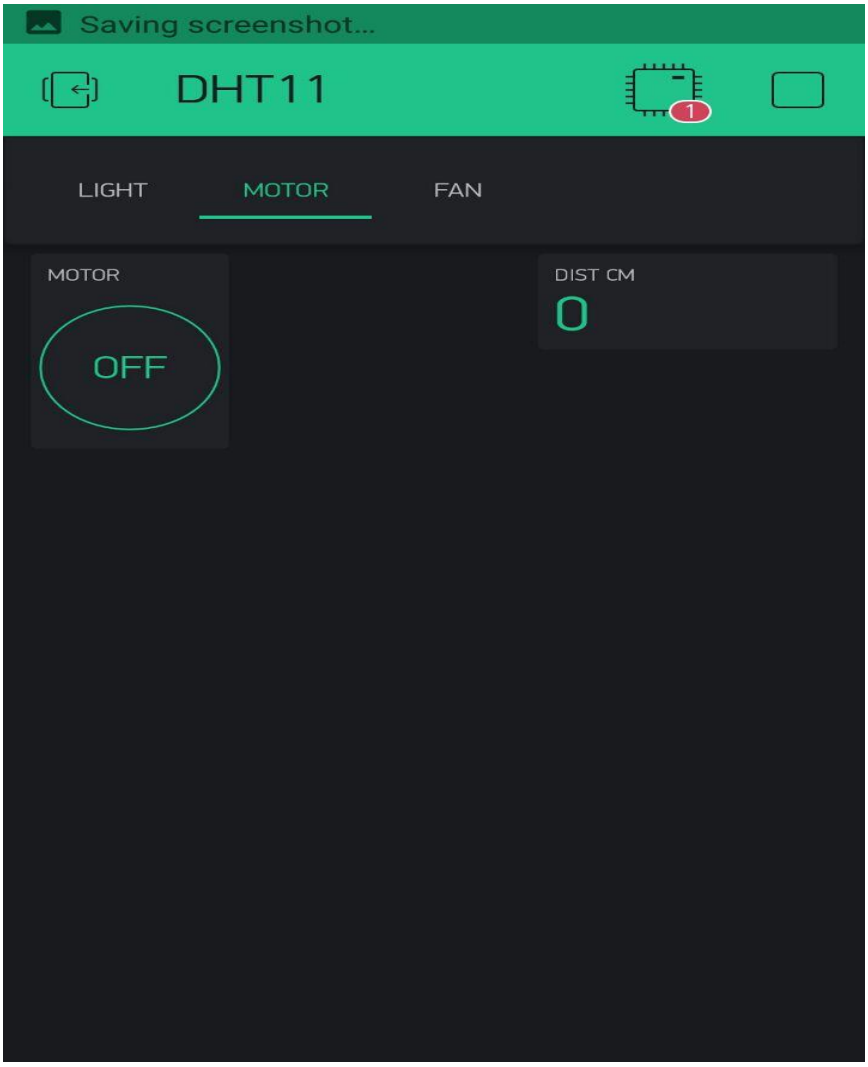

Fig. 17

FAN CONTROL:

Using DHT11 sensor, we have measured the humidity and temperature and displayed it in the application, which is shown. We have offered a 2 level controlling system. The first level is switching ON/OFF the fan. The second level is controlling the speed of the fan as HIGH/LOW. The screenshot of the application is below.

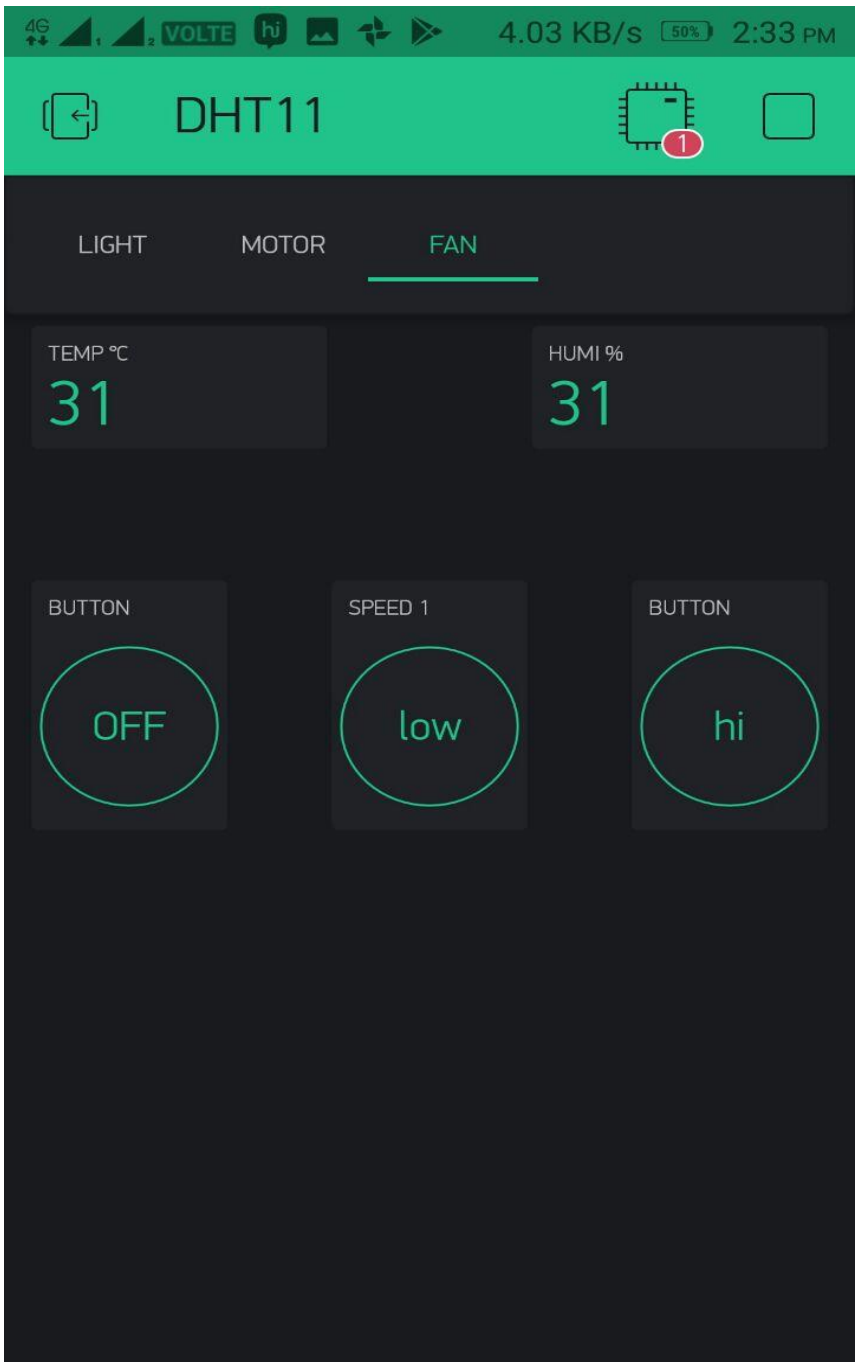

Fig. 18

Conclusion

The project can further be upgraded using different sensors and thus maximizing the application. Since smart phones are available nowadays with greater ease, this is a user friendly work and can be used for benefitting the mass. The cost of the project is also within the reach and incorporating sensors like MQ6(gas sensor), the project can be extended to a security level too.

Mobile application development companies with dedicated teams are working extensively on IoT-based applications that are connected to the cloud. These applications are highly suitable for start-ups who can own the applications without the hassle of software subscriptions and customize them to match their needs entirely. JavaScript-based scalable solutions enable businesses to focus on management and business, without the hassle of hiring in-house software technicians.

As awareness grows, the adoption rate is likely to increase for **IoT-based mobility solutions** that will automate business operations and end-to-end processes.

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APPENDIX

Project Finance:

Serial No.	Name of the Component	Quantity	Cost
1	NodeMCU	1	400
2	Arduino Mega	1	840
3	DHT11 Module	1	150
4	Light sensor module	1	180
5	HC-SR04 ultrasonic sensor module	1	130
6	4 channel relay module	1	240

Total	1940

Thus the total material cost of the project is Rs.1940.