INTERNET OF THINGS IN SMART GARDENING

Project Report submitted in partial fulfillment of the requirement for the degree of

Bachelor of Technology

in

Computer Science & Engineering

Under the Supervision of

Dr. VIVEK SEHGAL

By

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to

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Candidate's Declaration

I hereby declare that the work presented in this report entitled **"IOT in Smart Farming"** in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **Computer Science and Engineering** submitted in the department of Computer Science & Engineering and Information Technology**,** Jaypee University of Information Technology Waknaghat is an authentic record of my own work carried out over a period from August 2015 to May 2016 under the supervision of **Dr. Vivek Sehgal** (Associate Professor, Information Technology).

The matter embodied in the report has not been submitted for the award of any other degree or diploma.

Aakashdeep Madaan - 121239

This is to certify that the above statement made by the candidate is true to the best of my knowledge.

Dr. Vivek Sehgal
Associate Professor
Computer Science and Engineering
Dated:

Acknowledgement

We take this opportunity to express are profound sense of gratitude and respect to all those who helped us throughout the duration of our project.

This report acknowledges the intense driving and technical competence of all the individuals who have contributed to it. It would have been almost impossible to produce fruitful results during the working of the project without the support of those people. We extend our thanks and gratitude to our project guide **Dr. Vivek Sehgal** who has helped us at every step. He spent his valuable time from his busy schedule to train us and provided his active and sincere support for our daily activities.

I would like to express my heartfelt thanks to Brig. (Mr.) S.P. Ghrera, H.O.D., Computer Science and Engineering Department, Jaypee University of Information Technology, for his astute guidance, his constant encouragement and support throughout.

This report has been compiled by the sincere and active support from our guide who provided us proper guidance and direction regarding various problems. We have tried our best to summarize this report.

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Abstract

In the Internet of Things (IoT), devices gather and share information directly with each other and the cloud, making it possible to collect, record and analyze new data streams faster and more accurately. The rapid development of Internet of things (IoT) technology makes it possible for connecting various smart objects together through the Internet and providing more data interoperability methods for application purpose. In this project, We present an IoT-based system for Smart Farming services to demonstrate how to collect, integrate, and interoperate IoT data flexibly in order to provide support for Farming and Gardening. The IoT has already brought in significant changes in many areas of Farming. It is rapidly changing the Farming and Gardening scenarios by focusing on the way people, devices and apps are connected and interact with each other. Moreover, as the widespread adoption of IoT grows, many of the inefficiencies in Farming will be reduced. For example, sensors embedded in farms and gardening kits (such as Moisture Sensor, Temperature Sensor, Light Sensor) will perform data collections, measurements, and conduct tests digitally in no time which are currently administered and recorded automatically.

The idea of this project came so to reduce the headache of people as they fail to grow plants effectively. According to many studies, the number one reason why people fail to grow plants is the irregular, over/under watering. People are also busy and tend to forget about their plants, this is where our project comes in handy. With the help of our project we are hoping to save the time of both farmers and normal people interested in growing plants but fail due to their busy lifestyle. In this generation where fully automatic systems are used almost in every life purpose, we have designed this project to serve the purpose of human need. This project is an application of the microcontroller that we use in our daily life. Normally, as we see that in today’s world everyone is busy and has to go here and there for work so they don’t care about their plants and don’t put attention to small gardening problems like improper watering and not efficient sunlight. The project can be used to avoid the above problem. Basically we are developing this application to help people interested in growing plants in their gardens.

Chapter1: Introduction

1.1 Introduction : Internet of Things

IoT is a network of devices that connect directly with each other to capture and share vital data through a secure service layer (SSL) that connects to a central command and control server in the cloud. Let's begin with a closer look at what that entails and what it suggests for the way people collect, record and analyze data—not just in healthcare, but in virtually every industry today. The idea of devices connecting directly with each other is, as the man who coined the term Internet of Things puts it, "a big deal."1 As Kevin Ashton explained a decade after first using the phrase at a business presentation in 1999, "Today computers—and therefore, the Internet—are almost wholly dependent on human beings for information. The problem is, people have limited, time, attention and accuracy—all of which means they are not very good at capturing data about things in the real world."1 The solution, he has always believed, is empowering devices to gather information on their own, without human intervention.

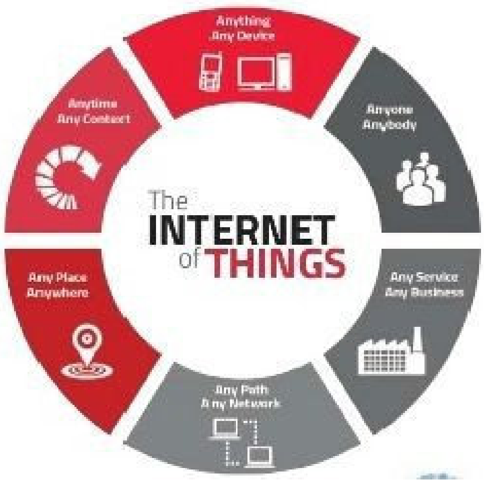


Figure 1: Internet of Things

The Internet of Things, also called The Internet of Objects, refers to a wireless network between objects, usually the network will be wireless and self configuring. Internet of Things (IoT) is one of the major component advances in present time that links the internet with everyday sensors and working devices Smart" objects play a key role in the Internet of Things vision, since embedded communication and information technology would have the potential to revolutionize the utility of these objects. Using sensors, they are able to perceive their context, and via built-in networking capabilities they would be able to communicate with each other, access Internet services and interact with people. "Digitally upgrading" conventional object in this way enhances

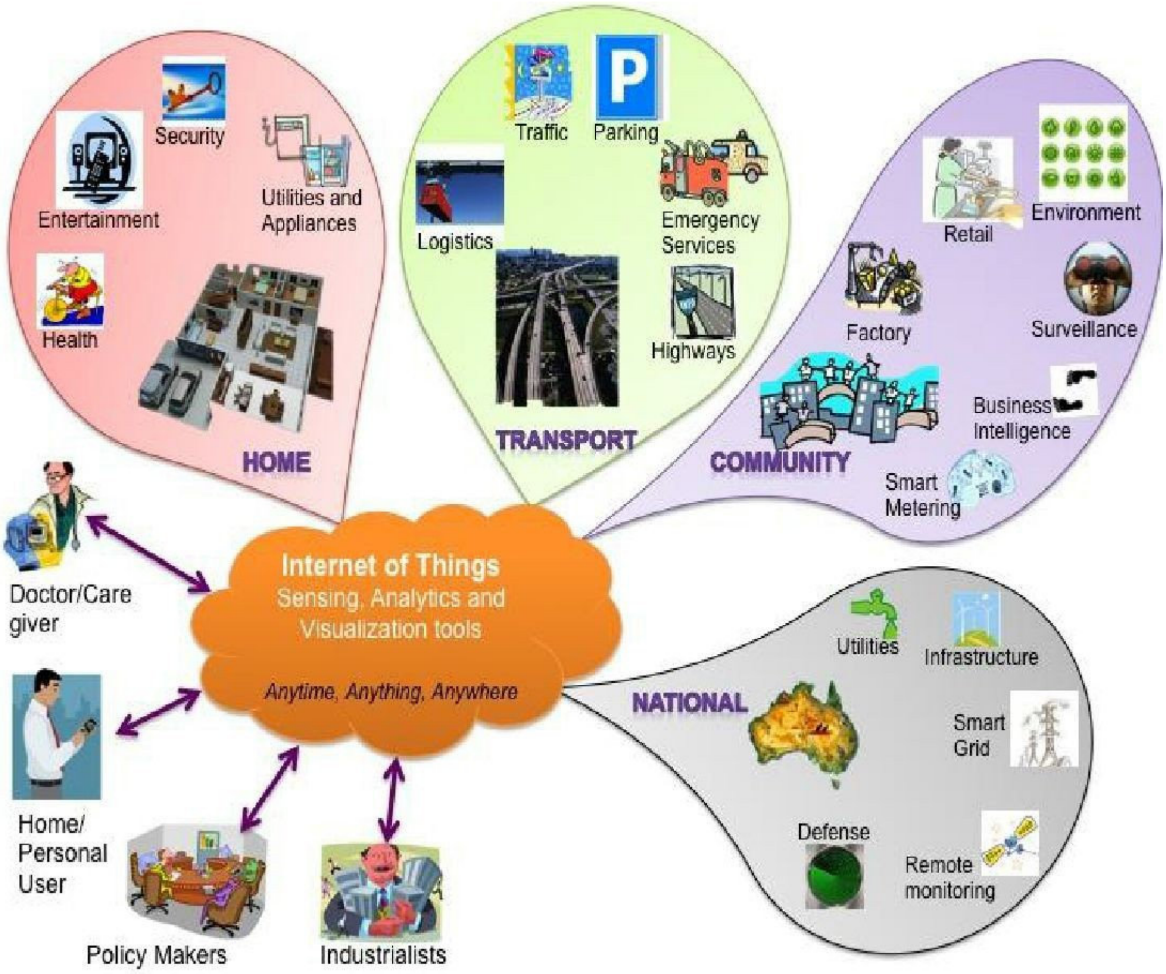


Figure 2: Internet of Things in our daily lives

their physical function by adding the capabilities of digital objects, thus generating substantial added value. Forerunners of this development are already apparent today – more and more devices such as sewing machines, exercise bikes, electric toothbrushes, washing machines, electricity meters and photocopiers are being “computerized” and equipped with network interfaces.From anytime, anyplace connectivity for anyone, we will now have connectivity for anything!

In other application domains, Internet connectivity of everyday objects can be used to remotely determine their state so that information systems can collect up-to-date information on physical objects and processes. This enables many aspects of the real world to be “observed” at a previously unattained level of detail and at negligible cost. This would not only allow for a better understanding of the underlying processes, but also for more efficient control and management The ability to react to events in the physical world in an automatic, rapid and informed. manner not only opens up new opportunities for dealing with complex or critical situations, but also enables a wide variety of business processes to be optimized. The real-time interpretation of data from the physical world will most likely lead to the introduction of various novel business services and may deliver substantial economic and social benefits.

The use of the word “Internet” in the catchy term “Internet of Things” which stands for the vision outlined above can be seen as either simply a metaphor – in the same way that people use the Web today, things will soon also communicate with each other, use services, provide data and thus generate added value – or it can be interpreted in a stricter technical sense, postulating that an IP protocol stack will be used by smart things.

From a technical point of view, the Internet of Things is not the result of a single novel technology; instead, several complementary technical developments provide capabilities that taken together help to bridge the gap between the virtual and physical world. These capabilities include:

– **Communication and cooperation:** Objects have the ability to network with Internet resources or even with each other, to make use of data and services and update their state.

Wireless technologies such as GSM and UMTS, Wi-Fi, Bluetooth, ZigBee and various other wireless networking standards currently under development, particularly those relating to Wireless Personal Area Networks (WPANs), are of primary relevance here.

– **Addressability:** Within an Internet of Things, objects can be located and addressed via discovery, look-up or name services, and hence remotely interrogated orconfigured.

– **Sensing:** Objects collect information about their surroundings with sensors, record it, forward it or react directly to it.

– **Actuation:** Objects contain actuators to manipulate their environment (for example by converting electrical signals into mechanical movement). Such actuators can be used toremotely control real-world processes via the Internet.

– **Embedded information processing:** Smart objects feature a processor ormicrocontroller, plus storage capacity. These resources can be used, for example, to process and interpret sensor information, or to give products a "memory" of how they have been used.

– **Localization:** Smart things are aware of their physical location, or can be located. GPS or the mobile phone network are suitable technologies to achieve this, as well as ultrasound time measurements, UWB (Ultra-Wide Band), radio beacons (e.g. neighboring WLAN base stations or RFID readers with known coordinates) and optical technologies.

– **User interfaces:** Smart objects can communicate with people in an appropriate manner (either directly or indirectly, for example via a Smartphone). Innovative interaction paradigms are relevant here, such as tangible user interfaces, flexible polymer-based displays and voice, image or gesture recognition methods.

1.1.1 Emergence of Internet of Things

The emergence of the IoT, in which devices connect directly to data and to each other, is important for two reasons:

1. Advances in sensor and connectivity technology are allowing devices to collect , record and analyze data that was not accessible before. In healthcare, this means being able to collect patient data over time that can be used to help enable preventive care, allow prompt diagnosis of acute complications and promote understanding of how a therapy (usually pharmacological) is helping improve a patient's parameters.

2. The ability of devices to gather data on their own removes the limitations of human-entered data—automatically obtaining the data doctors need, at the time and in the way they need it. The automation reduces the risk of error. Fewer errors can mean increased efficiency, lower costs and improvements in quality in just about any industry. But it's of particular interest need in healthcare, where human error can literally be the difference between life and death.

1.1.2 IoT Building Blocks Emerging Everywhere

Even though only "1 percent of things are connected today,"2 according to Joseph Bradley, general manager of Cisco Consulting Services, businesses across a variety of industries are establishing the building blocks of the IoT infrastructure. Here are a few examples:

- **Home and building automation:** Digital marketer Lauren Fisher points to the Nest Learning Thermostat, which takes data about the home environment and owners' temperature preferences and programs itself to operate efficiently within the context of that information. This technical framework provides energy providers with the connectivity to better manage the energy grid.

- **Automotive design and manufacturing:** Mobile virtual network operator Alex Brisbourne describes how the automotive industry is increasingly designing automated applications into vehicles to provide maintenance monitoring, fuel and mileage management, driver security and other capabilities that cost little to integrate but have significant earning potential. The addition of a cloud-based server to analyze the data and automatically act on it— automatically scheduling a maintenance appointment at the appropriate time, for example— would move this further in the direction of the IoT.

- **Public transportation/smart cities:** Technology writer Martyn Casserly cites the London iBus system, which "…works with information from over 8,000 buses that are fitted with GPS capabilities alongside various other sensors which relay data about the vehicle's location and current progress,"5 so bus stop signposts can display details of a bus's impending arrival.

IoT concepts have already been adopted in areas such as energy (e.g., smart lighting, smart grid) and industrial automation. According to a report in eWeek2 about a Cisco conference call with journalists, "…as more connections are made, the value to businesses and the global economy will only go up." The eWeek story describes a Cisco vision that goes beyond the IoT to IoE, or the Internet of Everything. This is what Cisco sees as a system of connections that includes not only devices, but also people, data and processes—"…essentially whatever is connected to or crosses over the Internet." Cisco expects the IoE to be worth $14.4 trillion to the global economy by 2020.

1.2 Introduction : Internet of Things in SmartGardening

The Internet of things in farming and gardening encompasses heterogeneous computing and wireless communication systems, apps and devices that help farmers and people alike to monitor, track and store their plant's vital statistics or health information. Examples of such systems are smart solar irrigation systems, connected farms, integrated farms and informed farming. Also, smartphones, intelligent vehicles, and robotics are considered to be the part of IoT.

These IoT devices produce enormous amounts of data which becomes a challenge for providers to deal with efficiently. To harness this huge data in a technological way and make sense of it, the Internet of Things Analytics (IoTA) is implemented. Data mining, data management and data analytics techniques are used to make this deluge of data useful and medically relevant. In fact, it has been predicted that by 2017, more than 50 percent of analytics techniques will make a better use of this influx of data which is generated from instrumented machines and applications.

1.2.1 Enabling Technologies: Making the IoT in Farming Possible

The successful use of the IoT in the preceding farming examples relies on several enabling technologies. Without these, it would be impossible to achieve the usability, connectivity and capabilities required for applications in areas such as farming and gardening.

Smart sensors, which combine a sensor and a microcontroller, make it possible to harness the power of the IoT for farming and gardening by accurately measuring, monitoring and analyzing a variety of health status indicators. These can include basic vital signs such as temperature of the soil and moisture of the soil as well as the amount of sunlight the plant is getting. These Smart sensors can even be incorporated into garden pots and connected to the network to indicate whether a plant is in need for your immediate attention. For smart sensors to work effectively, the microcontroller components must incorporate several essential capabilities:

• **Low-power operation** is essential to keeping device footprint small and extending battery life, characteristics that help make IoT devices as usable as possible. Freescale, which has long offered low-power processing, is working now to enable completely battery-free devices that utilize energy harvesting techniques through the use of ultra-low-power DC-DC converters.

• **Integrated precision-analog capabilities** make it possible for sensors to achieve high accuracy at a low cost. Freescale offers this enabling technology within microcontrollers which contain analog components, such as high-resolution analog-to-digital converters (ADCs) and low-power op-amps.

• **Graphical user interfaces (GUIs)** improve usability by enabling display devices to deliver a great deal of information in vivid detail and by making it easy to access that information. Freescale's i.MX applications processors with high graphics-processing performance support advanced GUI development.

1.2.2 Transforming Farming with the Internet of Things

In the US farming industry, the small and big farming organizations are using the Internet of Things tools and devices which are revolutionizing smart farming in unique ways. From sensors that measure temperature of the soil to the moisture of the soil and even the amount of sunlight getting by the plant,. According to ABI Research, by 2016, the sale of wearable wireless medical device will bloom and reach more than 100 million devices annually. Another report by IMS Research, the research partner of Wearable Technologies, states that the devices which are wearable or are close to the body produce more realistic results. There has been evidence that the physiological data received from wireless devices has been a valuable contributor for managing or preventing crop failures and the degradation of crop during storage. As a result, a growing number of farming devices are becoming popular nowadays, including Temperature Sensors, Moisture Sensors, Light Sensors and so on. The market for Sensing technologies in farming is expected to reach to $4.55 billion by 2020. The Internet of Things enables farming organizations to achieve superior technology interoperability, lift critical data from multiple sources in real-time, and a better decision-making capability. This trend is transforming farming and gardening sector, increasing its efficiency, lowering costs and providing avenues for better plant care.

1.2.3 IoT- A Farming Game Changer

The IoT has already brought in significant changes in many areas of farming. It is rapidly changing the farming scenario by focusing on the way people, devices and apps are connected and interact with each other. IoT is coming out as the most promising information communications technology (ICT) solution which enables providers to improve farming outcomes and reduce farming costs by collecting, recording, analyzing and sharing myriads of new data streams in real time and flawlessly. Moreover, as the widespread adoption of IoT grows, many of the inefficiencies in farming will be reduced. For example, sensors embedded in gardening pots such as temperature equipment, water dispensing systems, moisture sensing systems, light sensing systems, etc., will perform data collections, measurements, and conduct tests digitally in no time which are currently administered and recorded manually.This is extremely important for gaining new insights and knowledge on various issues in farming. For example, to study a plant's response to a specific set of soil and temperature conditions, farming providers study different samples taken from the plants. These samples sometimes are not up to the required standard to give clearer results. But, IoT has made it possible for the first time to collect real-time data from unlimited number of plants for a definite period of time through connecting devices. It is anticipated that it will also improve farming services for people in remote locations as monitoring systems provide a continuous stream of data that enable farming and gardening providers to make better decisions. IoT is gaining momentum among farming providers and farming IT and is emerging as a major technology trend for improved farming.

1.3 Introduction : 2nd generation Intel Galileo Board

The 2nd generation Intel Galileo board provides a single board controller for maker community, students and professional developers. Based on the Intel Quark SoCX1000, a 32-bit Intel Pentium processor- class system on a chip (SoC), the genuine board provides a full featured offering for a wide range of applications. Arduino certificated and designed to be hardware, software, and pin compatible with large range of Arduino Uno R3 shields, the board also provides a simple and more cost effective development environment compared to the Intel Atom processor and Intel Core processor based designs. Based on a new micro-architecture, the processor is designed for a two-chip platform consisting of a processor and Platform Controller Hub (PCH). The platform enables higher performance, lower cost, easier validation, and improved x-y footprint. The processor includes Integrated Display Engine, Processor Graphics, PCI Express ports, and Integrated Memory Controller. The processor is designed for desktop platforms. It supports up to 12 Processor Graphics execution units (EUs).

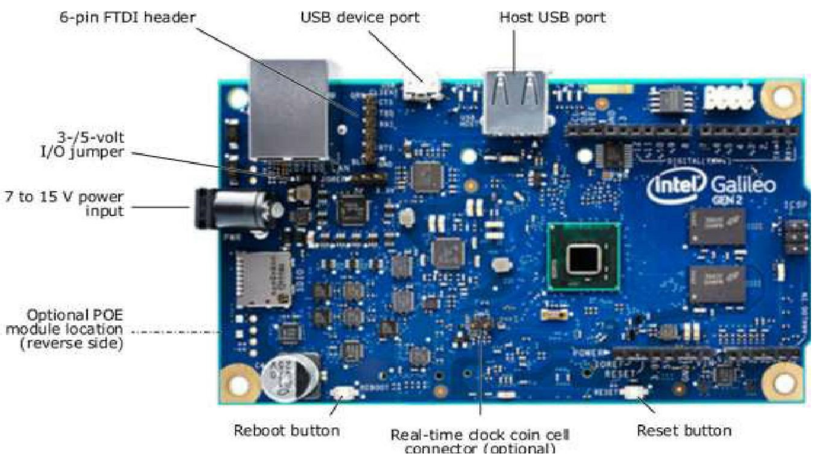


Figure 3: Outer view of 2nd Gen Intel Galileo Board

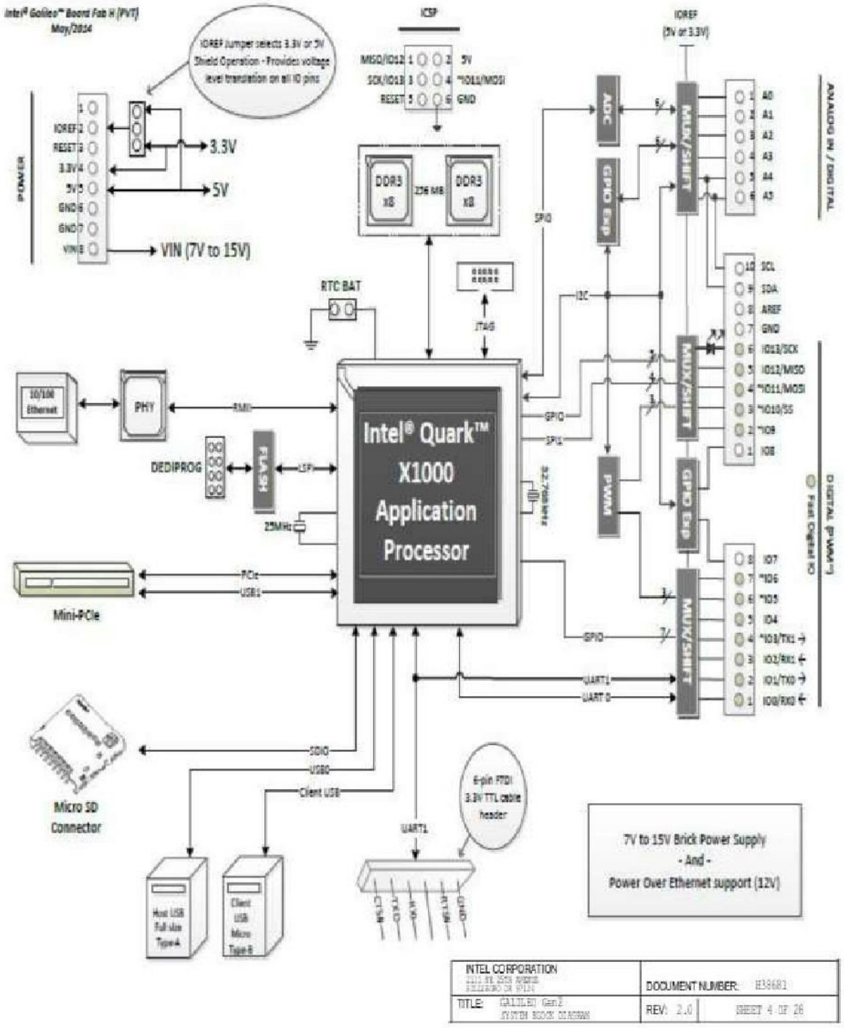


Figure 4: Pin configuration of 2nd Gen Intel Galileo Board

1.3.1 Physical Characteristics

- 10 cm long and 7 cm wide with the USB connectors, UART jack, Ethernet connector, and power jack extending beyond the former dimension
- Four screw holes allow the board to be attached to a surface or case
- Reset button to reset the sketch and any attached shields

1.3.2 Processor Features

- Instruction set architecture (ISA)-compatible 32-bit Intel® Pentium® processor
- 16 Kbytes L1 cache
- 512 Kbytes of on-die embedded SRAM
- Simple to program: single thread, single core, constant speed
- ACPI-compatible CPU sleep states supported
- Integrated real-time clock (RTC) with optional 3V “coin cell” battery for operation between turn on cycles
- 400 MHz clock speed

1.3.3 Storage Options

- 8 Mbyte Legacy SPI Flash to store firmware (bootloader) and the latest sketch
- Between 256 Kbytes and 512 Kbytes dedicated for sketch storage
- 512 Kbytes embedded SRAM
- 256 Mbytes DRAM
- Optional micro SD card offers up to 32 Gbytes of storage
- USB storage works with any USB 2.0 compatible drive
- 11 Kbytes EEPROM programmed via the EEPROM library

1.3.4 Enhancements

The Intel Galileo board (Gen 2) delivers improved features and functionality in following areas:

- 12 GPIOs fully native for greater speed and improved drive strength.
- 12-bit PWM for more precise control of servos and smoother response.
- 12 V Power-over-Ethernet capable.
- Power supplies from 7 V to 15 V are supported.
- Serial console URAT header is compatible with FTDI USB converters.
- Console URAT1 can be redirected to Arduino headers in sketches, which can eliminate the need for soft-serial.

1.3.5 Description of Key Components

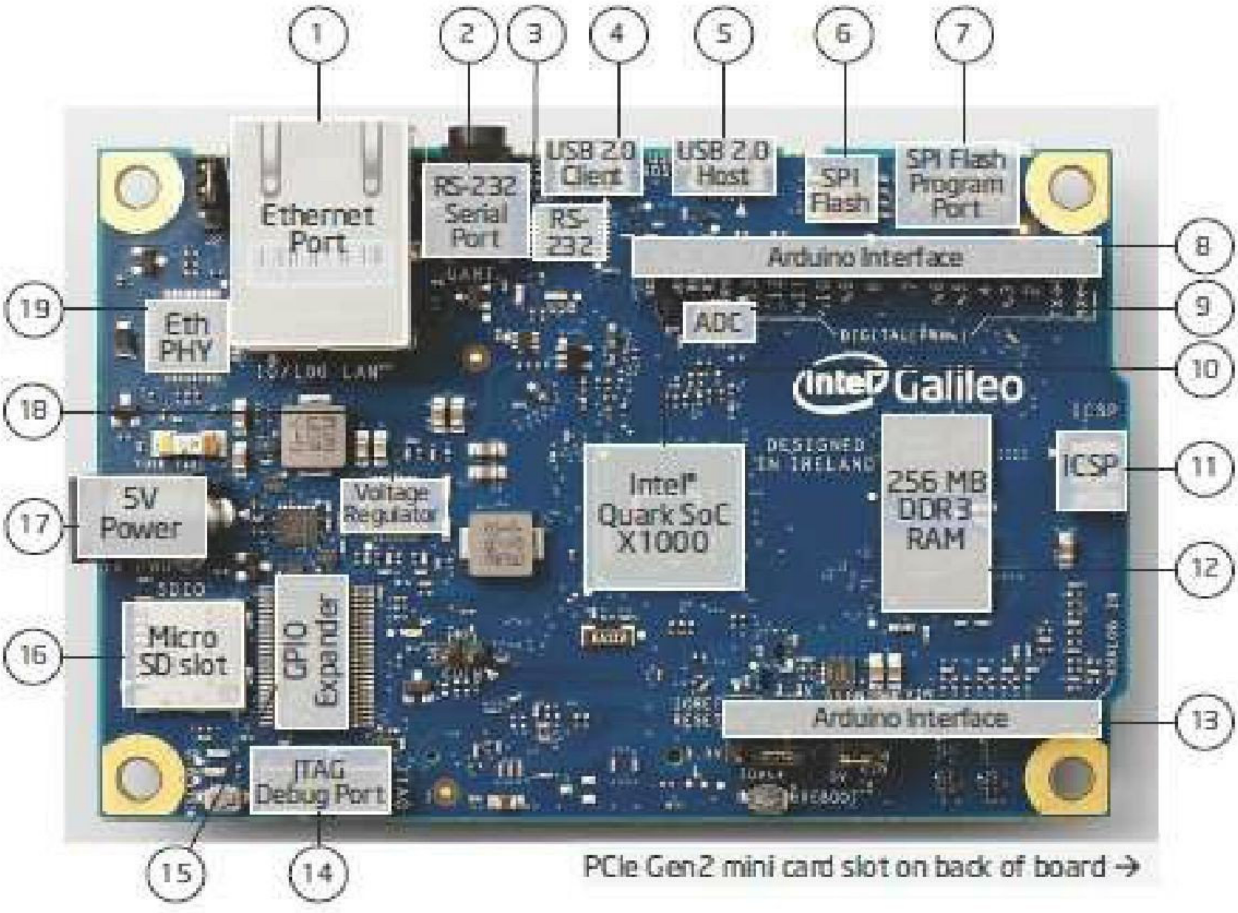


Figure 5: Detailed View of Board

CHAPTER 2 : LITERATURE REVIEW

2.1 Title:

Smart Farm : Extending Automation To The Farm Level

Automation is the use of machines, control systems and information technologies to optimize productivity in the production of goods and delivery of services. Automation is the answer to India's pursuit for being a world-class industrial competitor. The Indian farms are slowly beginning to feel the stimulus for the instrumentation, control and automation industry. Indian automation is advancing at a fast pace, yet it is one area that can never be achieved and admired

– it is something that needs constant innovation and identification of trends in technology, and the innovations that thrust the implementation of automation in other countries. India, as one of the world's fastest growing economies based on agriculture and farming, has not taken to technology at a rather quick pace.

India's growing foreign trade, rising internal consumer demands, infrastructural growth, as well as the revival from the economic slowdown, has only given the entire financial set up a new lease of life. India has now realized the importance of developing its own strength with automation, instead of being the smaller ally of the world. A large number of farmers in India depend on animal husbandry for their livelihood. India has the world's largest dairy herd, composed of cows and buffaloes, at over 304 million. It stands first in milk production, with 112.5 million tons of milk produced in 2009-2010 [2]. India is also the third largest egg-producer in the world, at over 180 million eggs being produced every day or 65.7 billion eggs for the year 2011-12, and the world's sixth largest producer of poultry meat [2]. India is the top global exporter of buffalo meat, and is also the fourth largest exporter of soybean meal, an important ingredient in commercial feed for farmed animals [2]. Present farming practices require a lot of redundant manual labor, which is tedious as well as strenuous. It is time consuming to manually look after the whole farm and livestock.

Automation provides a solution to some of these problems. However, automation is still underdeveloped in Indian farms, which constitute for a vast majority of the Indian economy. Automation is a single solution to achieve quality as well as the environmental balance. Apart from this, the growing interface, optimization, quality control and product tracking are a few advantages, that India has now estimated to receive from higher automation controls. A number of automation has been implemented in farms abroad. For example, automatic milking of cattle has been introduced in Europe. The aim has been to measure the effects of converting from conventional parlor milking to milking all cows by an automated milking system (AMS) [3]. Automatic hatcheries are also in use for incubating eggs and maintaining health of newborn chicks. It also includes counting and boxing of eggs, weighing of chicks and eggs and removal of bad eggs [4]. This paper aims to raise awareness that there are now alternative ways to support farming. Modern farming techniques seek to diminish human involvement, escalate yield, and improve animal health. Economics, quality and consumer safety, all play its role in how animals are raised in the farm.

The paper attempts to extend automation to the farm house level, by incorporating sophisticated home automation techniques, and adjusting them to suit a modern day farm. We describe the proposed system in the next section, followed by a short discussion and conclusion.

2.1.1 Temperature Control System

An exhaust fan or a heater will get switched on automaticallydepending on real time readings from a temperature sensor.An 8-bit ADC is sufficient to provide required accuracy for inhouse temperature readings. Depending on whether cooling down or heating up is required inside the farmhouse; the microcontroller decides to switch on the exhaust fan or the heater respectively. It has different configuration options, like temperature, humidity, auto-door open and close timings, etc. It provides comfortable conditions for livestock without tedious manual monitoring, along with energy conservation. The system can also be used for storage of farm products like milk and eggs, which require ambient temperature conditions to prevent spoilage. In addition, the system can also be used in hatcheries to store eggs at required temperature for artificial hatching to ensure quality control. The temperature output can be preset with a keyboard interface to the microcontroller based system. The system has also a humidity sensor to decide whether to humidify or dehumidify the hatchery.

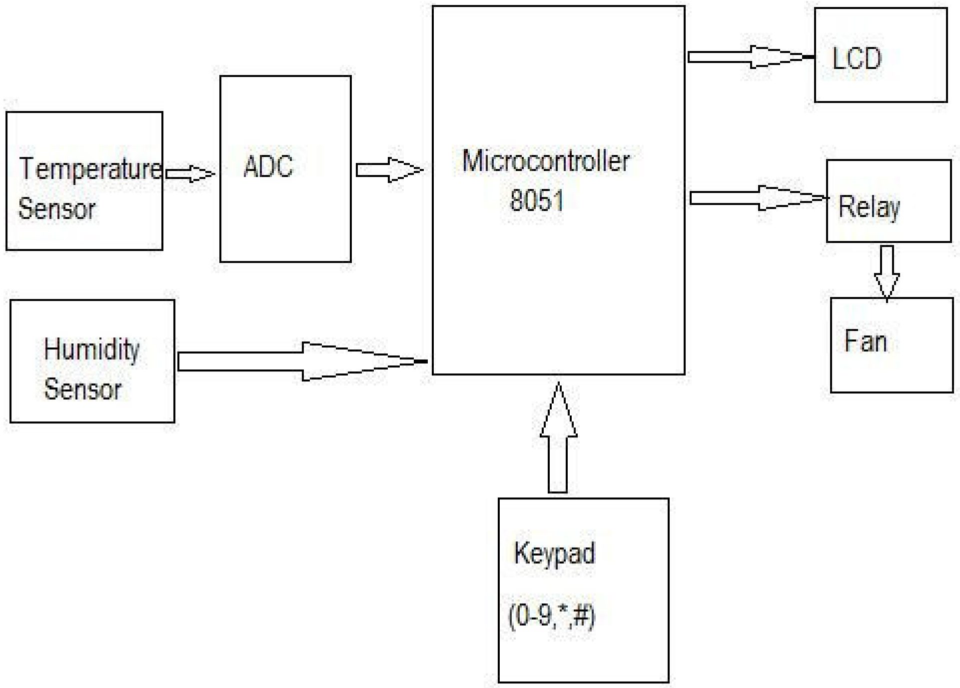


Figure 6: Block diagram for Temperature control

2.1.2 Moisture Control System

An additional humidity sensor circuit is used to detect a change in humidity of the surroundings and generate an interrupt signal to the microcontroller, at which the sprinklers are activated with the help of a digital solenoid valve [6]. In the present scenario of water shortage, this system is an efficient and simple way of conserving water used in the farm. Humidity sensor is also used in hatcheries to maintain ambient temperature for artificial hatching. New born chicks require specific humidity and temperature conditions for their survival and healthier growth.

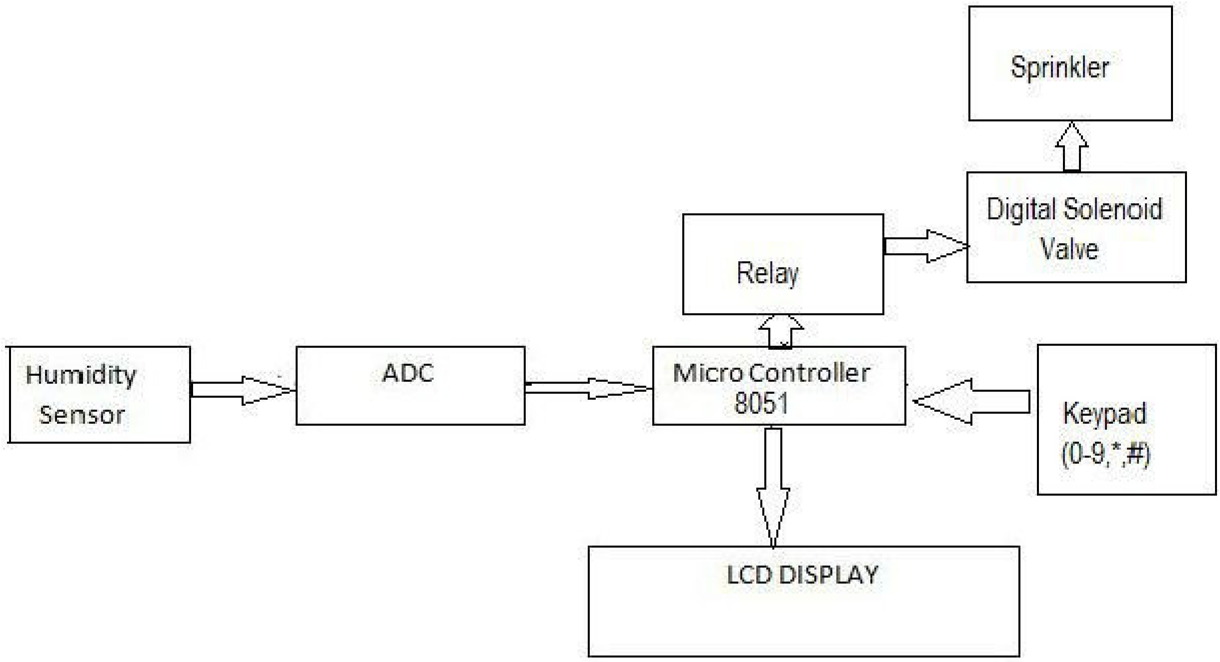


Figure 7: Block diagram for temperature control system

2.1.3 Conclusion

This project has attempted to introduce an efficient smart farm system. It has incorporated automation into various aspects of the farm. It includes an automated light, temperature, and moisture control system. The moisture control mechanism makes sure the plants are having enough moisture in the soil. The system is energy efficient as it helps conserve resources like energy and water. A GSM module is interfaced to connect all aspects of the modern automated farm. The farm owner has easy access to the system and can control it remotely through his mobile phone. This paper demonstrates that with the integration of information technology to the farm environment, systems and appliances will be able to communicate in an integrated manner. This will result in convenience, energy efficiency, and quality and safety benefits.

2.2 Title : A Smart System for Garden Watering using Wireless Sensor Networks

As water supplies become scarce and polluted, there is an urgent need to irrigate more efficiently in order to optimize water use. In this paper, we present a WSN based, smart home irrigation system that consists of heterogeneous motes, special sensors and actuators. The system is fully adaptive not only to environmental conditions but also to the specific water needs that different plants may have. This way, it man ages to perform efficient home irrigation, while it provides an IPv6-capable managing system.

Wireless Sensor Networks consist a crucial part of the Future Internet. Thus, they will play an important role in our everyday life in years to come. The applications of WSNs range from distributed monitoring systems to smart embedded systems. As water supplies become scarce and polluted, there is a dire need to irrigate more efficiently in order to optimize water use. Recent advances in soil water monitoring combined with the growing popularity of Wireless Sensor Networks make the commercial use of such systems applicable not only to agriculture and industry but to homes as well.

Figure 8: The EC-5 soil sensor shouldered on a TelosB mote

Our system architecture includes sensor motes, soil humidity sensors, mote driven electro valves that control the water towards the plants, and a Java application running on a PC, that collects data from the sensor network and stores them in a MySQL database. For the purposes of this study, we abstract a regular home garden with three pots containing different plants with highly diverse watering needs; a geranium that has very limited watering needs (once a week), a lavender that under normal weather conditions has medium watering needs (three times a week) and a mint that requires regular watering (in high temperatures during summertime, even twice a day).

The soil humidity of each pot is monitored by a motor equipped with soil humidity sensor. The watering of each pot is controlled by a corresponding motor driven electro valve independently from the other pots. When the soil of the pot is too dry, then the corresponding mote, monitoring soil humidity, informs the mote that drives the corresponding electro valve to start watering the pot. When the soil humidity returns to normal levels, the soil monitoring motor signals the electro-valve mote to cut of water supply for that pot.

Figure 9: The entire smart gardening system deployed

Throughout the operation of the system, the levels of the soil humidity of each pot are forwarded to the Sink by the corresponding motors. The Sink is a motor connected to a PC on a USB port that acts as a gateway for the rest of the motors. When it receives a soil humidity measurement, it forwards it to the PC where a Java application receives data

In this paper we presented the architecture and the implementation of a smart home irrigation system. The system consists of two types of sensors motes (TelosB and IRIS),special soil humidity sensors, electro valves that are motor driven with the use of relays and a Java application that is used for data collection. Performance evaluation showed that our system manages to maintain soil humidity levels regardless of external factors (i.e. variations at temperature and sunlight). It also proved that the system is aware of the different watering needs of each plant. In future work, we plan to use solar panels along with rechargeable batteries in order to make our system self sustainable in terms of energy consumption. We also plan to incorporate to our system the ability to be managed remotely. This will be done by representing sensor motes as resources in a Restful architecture, thus allowing to access and control the system with the use of web services (e.g. via Android smart phones).

For our implementation we used two more platforms, Telosb and IRIS motes. Both of them are ZigBee compliant, small, light weight and when using energy saving protocols can be powered with two AA batteries for several weeks, even months. These characteristics makes them ideal for our smart garden watering system as they can easily be deployed everywhere while being independent of power installations. Furthermore, IRIS was combined with the MDA100CB sensor and data acquisition board which has a precision thermistor, a light sensor/photocell and general prototyping area. This prototyping area was used in order to connect a relay, through which IRIS motes were able to control the electro-valves.

The EC-5 soil humidity sensor by Decagon was used for soil monitoring. It consists of a cable, which on one end has two prongs and on the other end has 3 wires. The prongs are pushed inside the potting soil and the three wires of the other end are connected to the 10-pin expansion connector of TelosB motes. The bare wire is connected to the ground pin, the red one is connected to the ADC channel pin (programmed as input) and the white wire is connected to the VCC pin. This sensor had to be used along with TelosB motes as it provides 12-bit data, while the IRIS mote has a 10-bit ADC. For successful communication between TelosB and the soil humidity sensors for collecting soil humidity data, we used the component Msp430Adc12 Client C and the corresponding interface. In the source code we set the ADC1 (i.e. pin 5 of the 10-pin TelosB expansion connector) in which we had previously shouldered the red wire (analogue out) of the soil humidity sensor. We, also, used the component Sensirion SHT11 of TelosB to monitor the air temperature.

In order to control the irrigation process we use solenoid valves provided by Irritrol . A solenoid valve is an electromechanical valve that is controlled by an electric current. The electric current runs through a solenoid, which is a wired coil wrapped around a metallic core. The solenoid cre- ates a controlled magnetic field when electrical current is passed through it. This magnetic field affects the state of the solenoid valve, causing the valve to open or close. The electric valves operate with a 9V-32V battery.

In this paper we presented the architecture and the implementation of a smart home irrigation system. The system consists of two types of sensors motes (TelosB and IRIS),special soil humidity sensors, electro-valves that are motor driven with the use of relays and a Java application that is used for data collection. Performance evaluation showed that our system manages to maintain soil humidity levels regardless of external factors (i.e. variations at temperature and sunlight). It also proved that the system is aware of the different watering needs each .In future work, we plan to use solar panels along with rechargeable batteries in order to make our system self sustainable in terms of energy consumption. We also plan to incorporate to our system the ability to be managed remotely.This will be done by representing sensor motes as resources in a RESTful architecture, thus allowing to access and control the system with the use of web-services (e.g. via Android smart-phones).

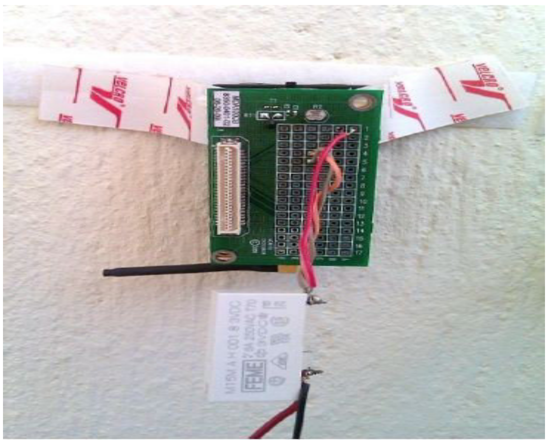


Figure 10:A relay shouldered on the MDA100CB data acquisition board of an IRIS mote

In order for the IRIS motes to be able to drive the valves we used relays that take as input a 3 VDC current and can control circuits of up to 250 VAC. Due to the low current IRIS motes can provide as output, the relay is driven by using two digital outputs of the prototyping area of the MDA100CB board. Then, the relay is connected in series with the electro-valve and an external 9V battery. This way, when the IRIS mote triggers the relay, the circuit is closes,the

electro-valve opens and the irrigation process begins.Finally, in order to have a base of reference, we also installed a common irrigation programmer. This programmer can be set to irrigate at regular time intervals for xed periods of time; i.e. every second day for half an hour.

2.3 Title : An Android Application for Farmers toDisseminate Horticulture Information

Today's the mobile phone is used worldwide. As the price of smart phone is decreasing, its popularity is increasing day by day. Moreover, android is the mobile operating system used in smart phone, most of its applications are freely available. The use of smartphone is increase in every sector of business, education, etc. So in this research paper, using the concept of Horticulture and Android introduces a "Farmer Helping Service" system that will provide the detail information of fruits, vegetables and flowers in audio format to the farmers. This system can provide information using android smartphone from anywhere and anytime without using internet and at free of cost. It is very useful to Gujarat Farmer because they will get information in Gujarati Language just by typing number from the mobile keypad. An illiterate person can also easily operate the system.

2.3.1 INTRODUCTION

In recent days, Android SmartPhone is becoming more popular due to low price and free applications. Smartphone makes all our tasks fast, efficient & accurate. Android Market allows Android Smart Phone users to download application freely. Due to this android features, in our research paper we have combined the concept of Horticulture and Agriculture sector to utilize the maximum benefit of android technology.Horticulture is a one type of arts which is useful in cultivation of fruits, flowers, vegetables or ornamentals plants. Horticulture contains study of fruits, vegetables, flowers etc. Android is an Operating System for mobile device and also a platform to developed key application for the Smart Phone..Java Programming Language is used to developed Android Application by using Android SDK tools and API. Android Architecture: Android provides an open source development platform that offers developers the strength to build extremely powerful applications. Android help Developers to take free advantage of the device hardware, access location information, run background services, divert call and messages, etc. For developing key application developers take the advantages of same framework APIs. Application architecture use reusability features of components. Once the application has been published, its capabilities are reuse by other applications. Thus it allows the one component to replace by others components. Below listed all applications are a set of services and systems use in developing this application, including:

- To build an application consists of buttons and textboxes used rich set of Views..
- The lifecycle of application and navigation back stack is managed by an Activity Manager.
- Used of telephony services on the device to access information is provided by Telephony Manager.
- To Control the volume and ringer mode is managed by an Audio Manager
- To receive intents send by other application into our own application can by managed by Broadcast method of BroadcastReceiver service. Using this method events raised by any application can be handle by our application.

Now in our system,we take the horticulture information for flowers,vegetables and fruits like soil required for their plantation, season in which they grows, which types of fertilizer and how much quantity required to them, which are their different categories and other much more information that are mostly required by the farmer to harvest them. After that all horticulture information is converted into voice data in our system and whenever farmer required that information, they just used the system and retrieved it just used the keypad of their android phone.

2.3.2 Problems

After completing the intensive study of data following problem are identified:-

- Various website provides Horticulture information related to fruit, flowers and vegetables. But all the information is in English Language and in Text form. So illiterate farmers of Gujarat are not able to take advantage of these services.
- If some literate farmer want to access website, but then a laptop or personal computer is mandatory.
- Using mobile phone, some farmer can access website, but then also constant internet services is required.
- There are some agency like IFFCO Kisan Sanchar Limited (IKSL) [] and Reuters Marker Light (RML) that provide agricultural information via SMS or call.

2.3.3 Methodology

To overcome the limitations mentioned in problem statement. We have design a system that will provide the horticulture information to the farmer using Android phone in form of voice data. No cost of pc & laptop is required. No internet services required. All the information is provided in Gujarati Language so the literate farmers of Gujarat State can easily operate the system just by dialing numbers from the mobile keypad. No call or SMS charges, it provides free information anywhere and anytime. As the system gets installed on Android phone, tower problem will not be a problem anymore.

Below Figure show the System Design Architecture flowchart that will take number as input from the mobile keypad and give horticulture information in voice form to the farmers.

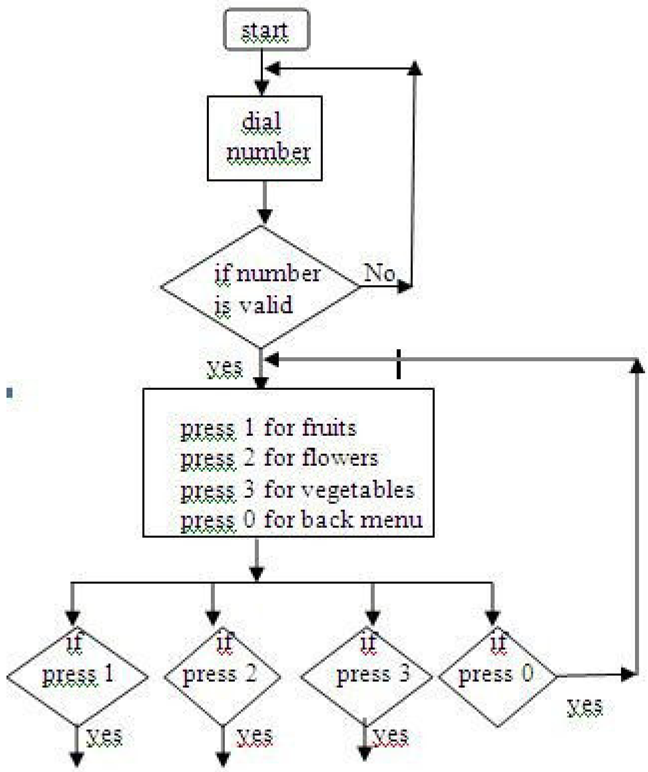


Figure 11: FlowChart for Proposed System

We assume that farmer has press 1 as an input, then further system will check input value and provide information base upon the input provided(system provide information about fruits). And further allow user to select information from fruits category. Example press 1 for tropical zone fruit, press 2 for subtropical zone fruit, press 3 for temperate zone fruit and 0 to return to back menu.

2.3.4 Conclusion

From the above study it is conclude that the “Farmer Helping Services” system provide all the Horticulture information related to fruits, flowers and vegetables in Gujarati Language to the illiterate farmers in voice form without used of internet. No cost is required for this system and also it provides information 24*7 from any location.

Again we assume that farmer has press 2 then system will input value again and base on that input value provide further information. Examples press 1 for jamrukh (guava), press 2 for dedham (pomegranate), press 3 for (draksha) Grapes and 0 to return to back menu.

CHAPTER 3: PROBLEM STATEMENT

The goal of this Project is to build a Smart Gardening Kit and an Android Application which can be used by farmers.According to many studies, the number one reason why people fail to grow plants is the irregular, over/under watering.People are also busy and tend to forget about their plants, this is where the **our project** comes in handy.

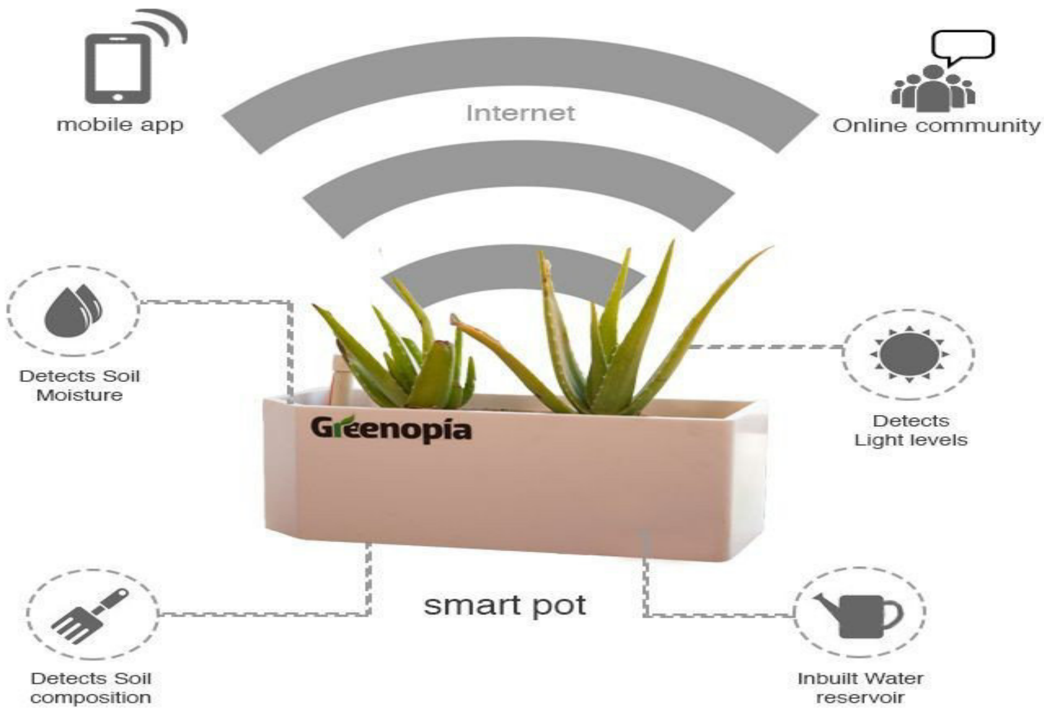


Figure 12 : Smart Gardening Pot

Moreover, in today's world everyone is busy and has to go here and there for work so they don't care about their plants and do not put attention to small planting problems like improper watering, temperature of soil , improper sunlight etc. This project will help to avoid above problems. Our problem statement is to connect and collect data information through plant's status monitors which would include plant's moisture level, temperature of soil and light sensing and sends an emergency alert directly to plant's owner with current status.

CHAPTER 4: PROPOSED MODEL

4.1 Project Introduction

In our day to day activities we are introduced to many intelligent to many intelligent systems and one of them would be this i.e. a system capable enough to monitor the plant automatically using IoT that will accurately collects data information through smart sensor status monitors which would include plant's moisture, temperature of the soil and the amount of light the plant is getting and sends an alert to plant's owner with the current status and full plant's information. It will help the owner to monitor his plant from anywhere.

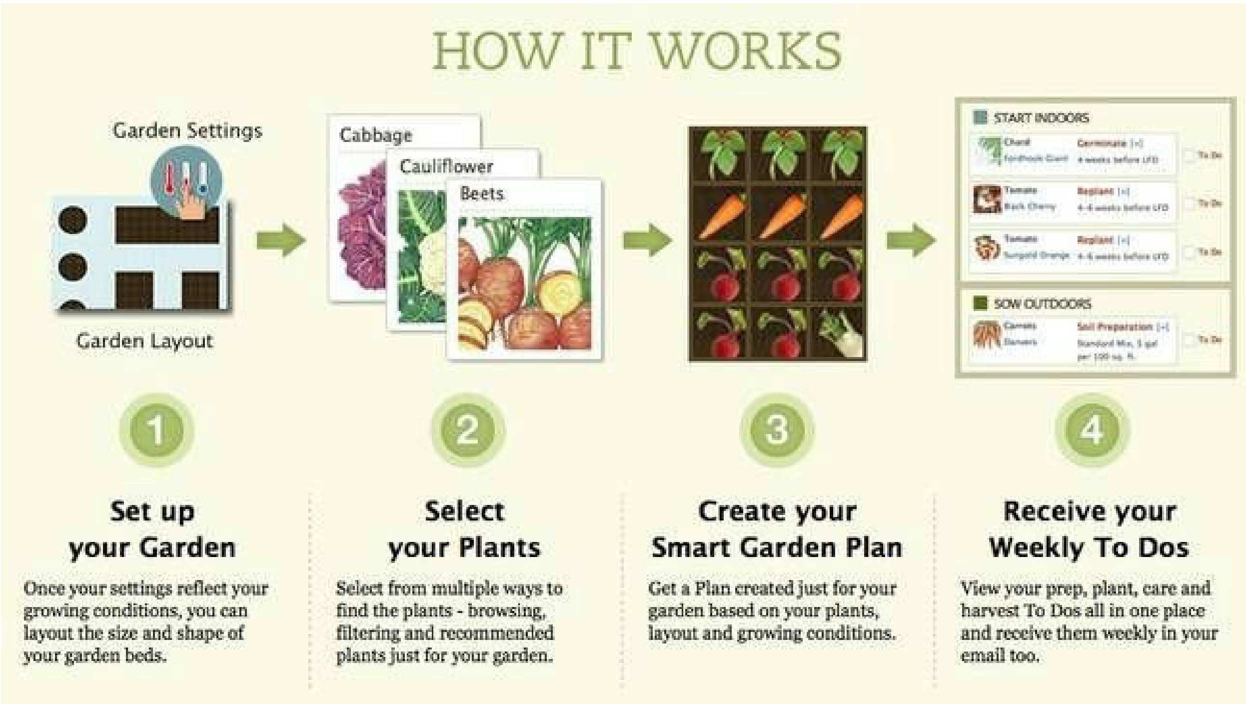


Figure 13 : Proposed Model

4.2 Hardware Requirements

The major hardware requirements required for the project are:

I. Smart Sensors

II. 2nd Gen Intel Galileo Board

III. Water Pump

IV. IR

V. Bread Board

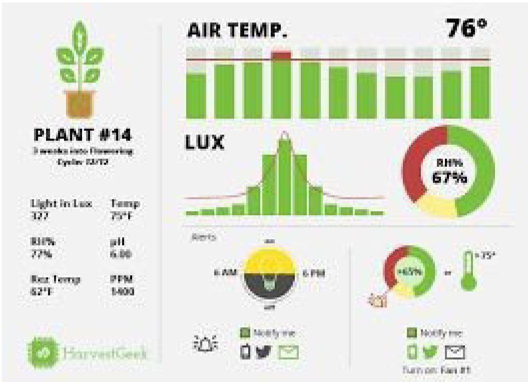


Figure 14 : Components

Smart Sensors : A **sensor** is a device that detects events or changes in quantities and provides a corresponding output, generally as an electrical or optical signal; for example, a thermocouple converts temperature to an output voltage. But a mercury-in-glass thermometer is also a sensor; it converts the measured temperature into expansion and contraction of a liquid which can be read on a calibrated glass tube.

Sensors are used in everyday objects such as touch-sensitive elevator buttons (tactile sensor) and lamps which dim or brighten by touching the base, besides innumerable applications of which most people are never aware. With advances in micromachinery and easy-to-use microcontroller platforms, the uses of sensors have expanded beyond the more traditional fields of temperature, pressure or flow measurement,[1] for example into MARG sensors. Moreover, analog sensors such as potentiometers and force-sensing resistors are still widely used. Applications include manufacturing and machinery, airplanes and aerospace, cars, medicine and robotics.

A sensor's sensitivity indicates how much the sensor's output changes when the input quantity being measured changes. For instance, if the mercury in a thermometer moves 1 cm when the temperature changes by 1 °C, the sensitivity is 1 cm/°C (it is basically the slope Dy/Dx assuming a linear characteristic). Some sensors can also have an impact on what they measure; for instance, a room temperature thermometer inserted into a hot cup of liquid cools the liquid while the liquid heats the thermometer. Sensors need to be designed to have a small effect on what is measured; making the sensor smaller often improves this and may introduce other advantages. Technological progress allows more and more sensors to be manufactured on a microscopic scale as microsensors using MEMS technology. In most cases, a microsensor reaches a significantly higher speed and sensitivity compared with macroscopic approaches.

A good sensor obeys the following rules :

- Is sensitive to the measured property only

- Is insensitive to any other property likely to be encountered in its application

- Does not influence the measured property

The sensitivity is then defined as the ratio between output signal and measured property. For example, if a sensor measures temperature and has a voltage output, the sensitivity is a constant with the unit [V/K]; this sensor is linear because the ratio is constant at all points of measurement.

For an analog sensor signal to be processed, or used in digital equipment, it needs to be converted to a digital signal, using an analog-to-digital converter.

Sensors that we are going to use in this projectare:

- ➢ Moisture Sensor
- ➢ Temperature Sensor
- ➢ Light Sensor
- ➢ UltraSound Sensor
- ➢ GSM Module

1. Moisture sensor

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighting of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant as a proxy for the moisture content. The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the soil moisture and is used for remote sensing in hydrology and agriculture. Portable probe instruments can be used by farmers or gardeners.

Figure 15: Moisture Sensor

Features

- Soil moisture sensor based on soil resistivity measurement
- Easy to use
- 2.0cmX 6.0cm grove module

Applications

- Botanical gardening
- Moisture sensing
- Consistency measurement

Specifications

Item	Parameter	Min	Typical	Max	Unit
Voltage	-	3.3	~	5	V
Current	-	0	~	35	mA
Output Value	Sensor in dry soil	0	~	300	/
	Sensor in humid soil	300	~	700	/
	Sensor in water	700	~	950	/

Platforms Supported

- Arduino
- Raspberry Pi
- TI LaunchPad

This is a summary of the moisture sensor which can be used to detect the moisture of the soil. When the soil moisture reduces, the sensor output value will decrease. You will know whether a plant needs water or not by observing the results that the sensor outputs. The following sketch demonstrates a simple application of sensing the moisture of the soil.

- Connect this module to one of analog port A0 of Grove - Base Shield with the 4 pin Grove cable, and then insert the Sensor into the soil or place it anywhere you want.
- Plug Grove - Base Shield into the Arduino/Seeeduino and connect Arduino to PC via a USB cable.

The hardware installation as shown below:

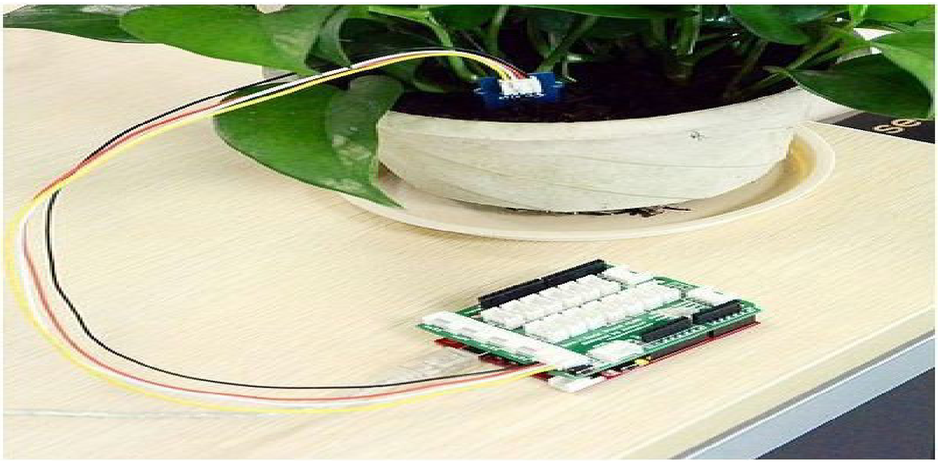


Figure 16: Implementation of Moisture Sensor

2. Temperature sensor

Temperature is the most-measured process variable in industrial automation. Most commonly, a temperature sensor is used to convert temperature value to an electrical value. Temperature Sensors are the key to read temperatures correctly and to control temperature in industrials applications.

The Grove - Temperature Sensor uses a Thermistor to detect the ambient temperature. The resistance of a thermistor will increase when the ambient temperature decreases. It's this characteristic that we use to calculate the ambient temperature. The detectable range of this sensor is -40 - 125℃, and the accuracy is ±1.5℃

This is a multifunctional sensor that gives you temperature and relative humidity information at the same time. It utilizes a DHT11 sensor that can meet measurement needs of general purposes. It provides reliable readings when environment humidity condition in between 20% RH and 90% RH, and temperature condition in between 0°C and 50°C, covering needs in most home and daily applications that don't contain extreme conditions.

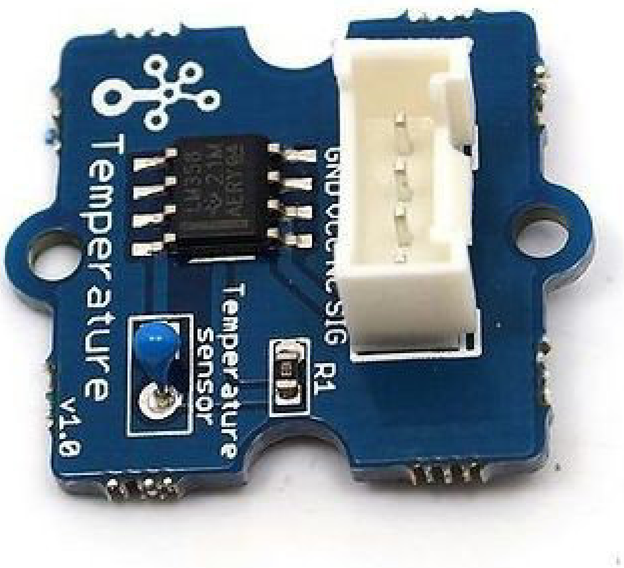


Figure 17: Temperature Sensor

Specification

- Voltage: 3.3 ~ 5V
- Max power rating at 25℃: 300mW
- Zero power resistance: 10KΩ
- Operating temperature range: -40 ~ +125℃

Demonstration

Here is an example to show you how to read temperature information from the sensor.

1. Connect the module to the Analog port 0 of Grove - Basic Shield using the 4-pin grove cable.
2. Plug the Grove - Basic Shield into Arduino.
3. Connect Arduino to PC by using a USB cable.

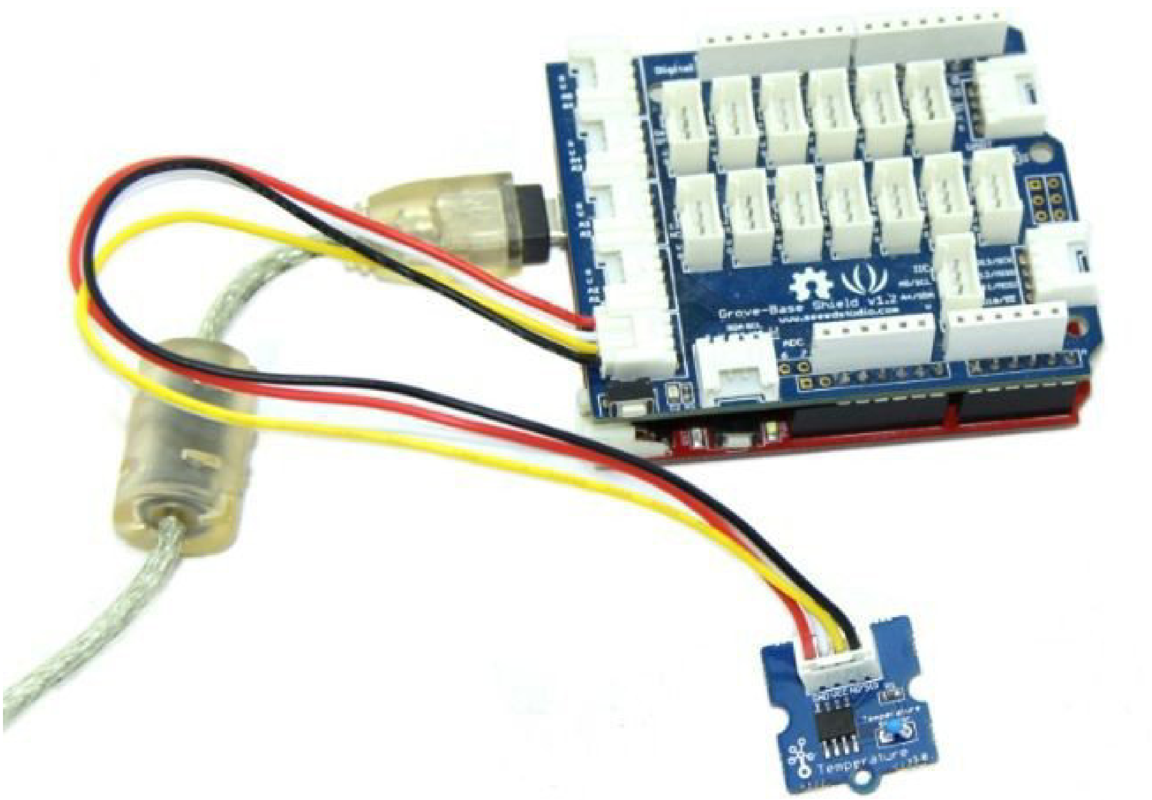


Figure 18: Temperature Sensor Connector

Output Format

The temperature sensor functional module consists of two parts: the function module box and the probe head.

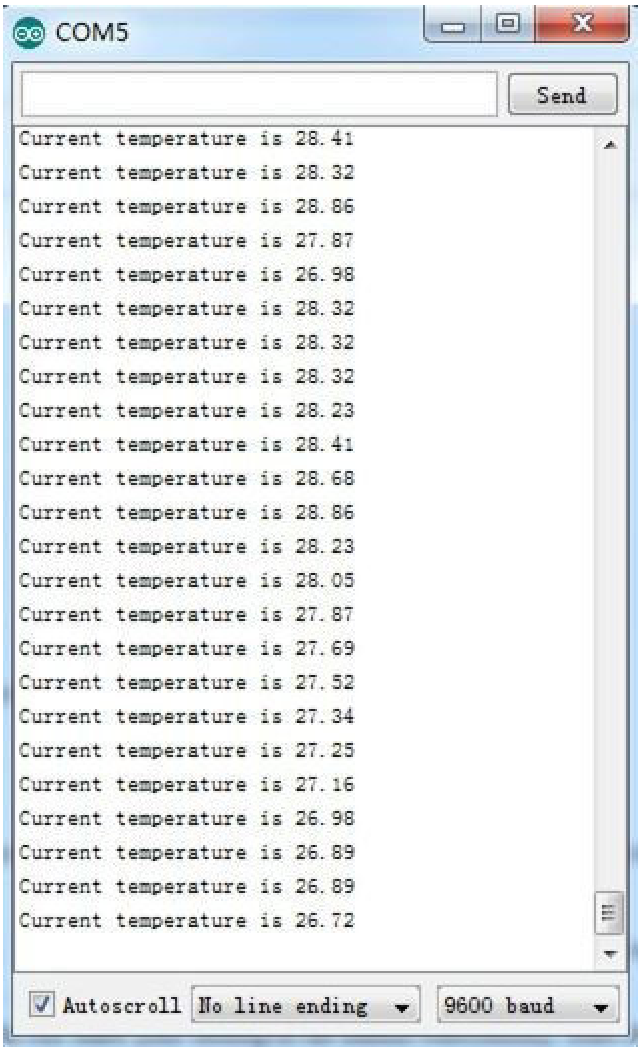


Figure 19: Temperature sensor score

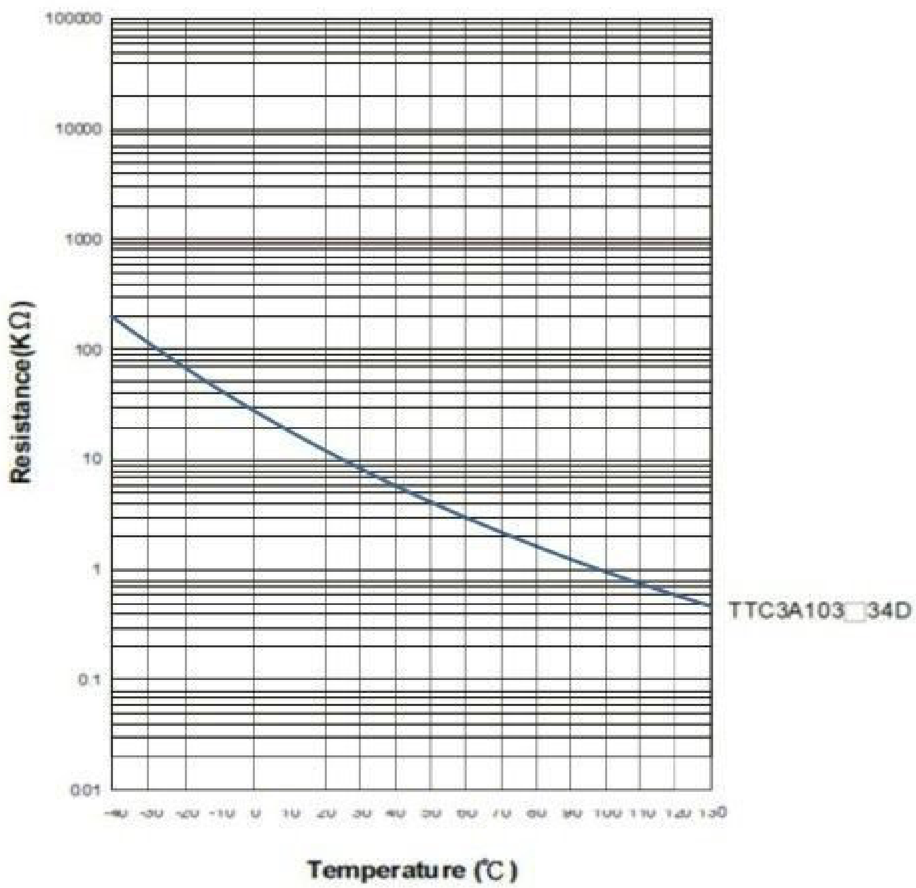


Figure 20: Temperature Sensor Value Graph

A temperature sensor measures temperature using four measurement scales that are divided into various degree units. The measurement scales use the metric Celsius scale, and they start at zero. The Rankin scale is the absolute scale that uses Fahrenheit temperature sensing. Temperature sensors determine absolute zero measurements as close to minus 460 degrees Fahrenheit. The Rankin scale measures absolute zero as 492 degrees Rankin. A popular thermal measuring method is thermocouple, which is composed of two different metal alloy wires. Combining two different metals generates a strong voltage that has the same capacity as temperature. Thermocouples typically provide vast measurement ranges. They work using the Seebeck effect which involves changes in temperature in electrical circuits. The sensors read temperature by taking measurements of voltage outputs.

Thermistors are another type of temperature sensor, and they're mostly used in human thermometers and appliances. Their predictable resistance reacts to temperature change. When temperature changes, the electrical current or resistance also changes.

Wiring Instructions

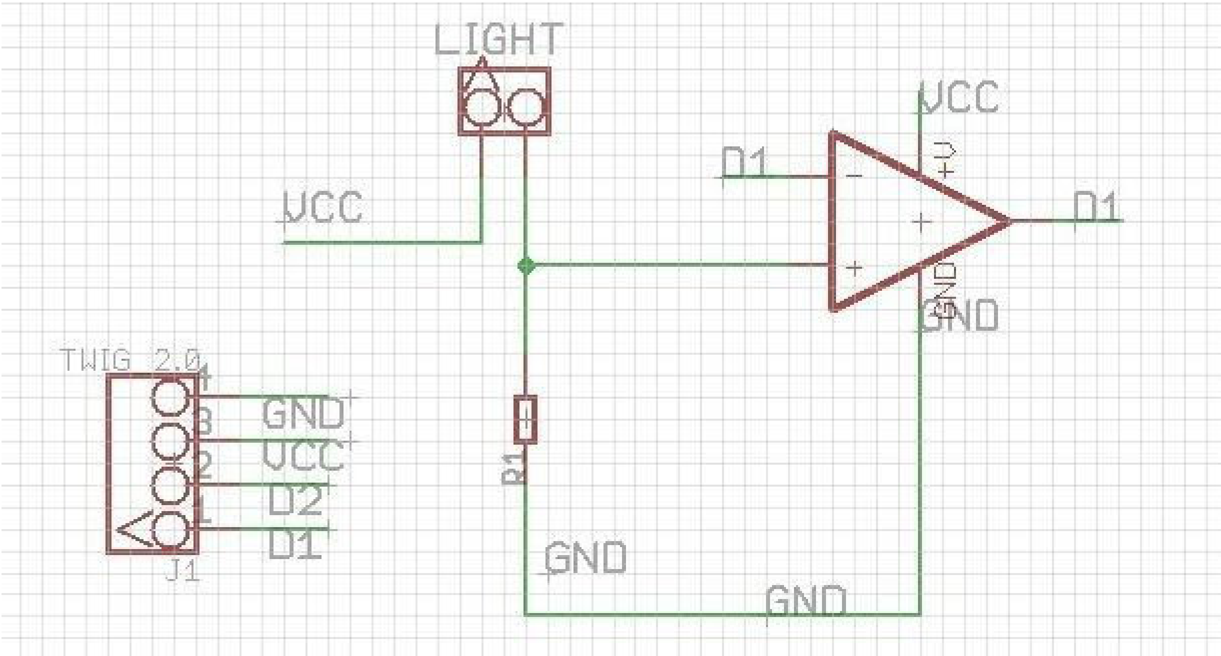


Figure 21: Wiring Circuit Diagram

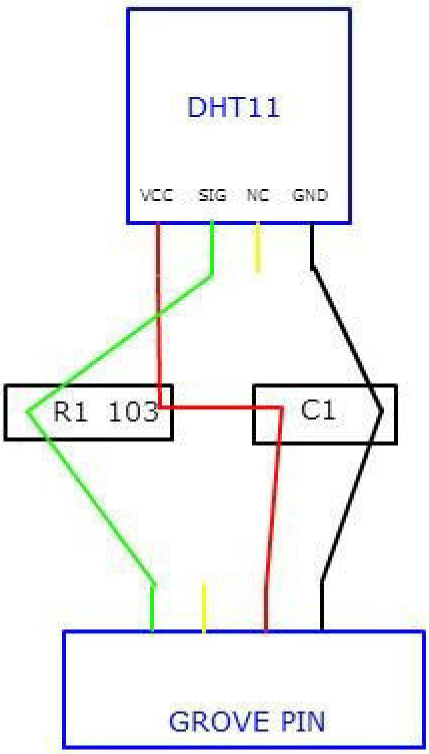


Figure 22: Wiring Diagram for Grove Temperature Sensor

3.Light Sensor

The **Light Sensor** is a passive devices that convert this "**light** energy" whether visible or in the infra-red parts of the spectrum into an electrical signal output.**Light sensors** are more commonly known as "Photoelectric Devices" or "Photo **Sensors**" because the convert **light** energy (photons) into electricity (electrons).

The **Grove - Light Sensor** module incorporates a Light Dependent Resistor (LDR). Typically, the resistance of the LDR or Photoresistor will decrease when the ambient light intensity increases. This means that the output signal from this module will be HIGH in bright light, and LOW in the dark.

In 2014 a technique for extending semiconductor-based photodetectors frequency range to longer, lower-energy wavelengths. Adding a light source to the device effectively "primed" the detector so that in the presence of long wavelengths, it fired on wavelengths that otherwise lacked the energy to do so.

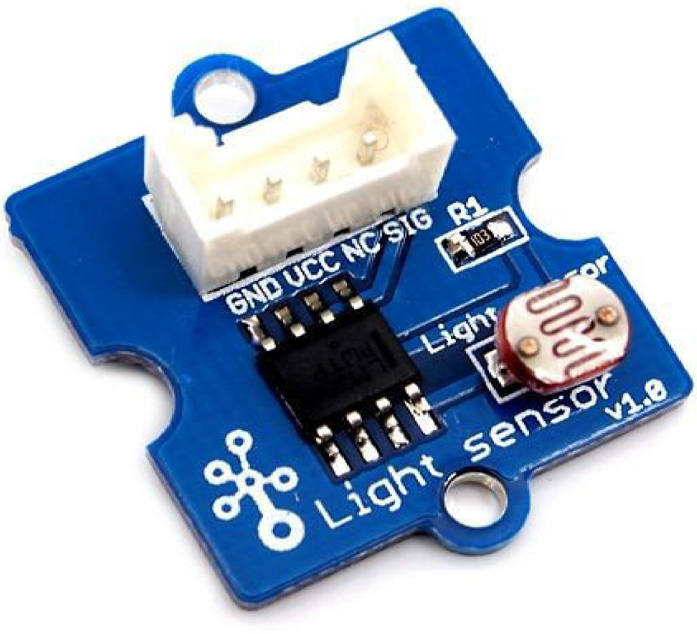


Figure 23: Light sensor

Features

- Easy to use light sensor module
- Resistance decreases as luminance increases
    - Low resistance (in bright light) triggers a HIGH signal towards the output module
    - High resistance (in darkness) triggers a LOW signal towards the output module
- Easily integrates with Logic modules on the input side of Grove circuits
- Uses Standard 4-pin Grove Cables to connect to other Grove modules such as Grove Power Modules, Logic Gates and Grove - Base Shield

Specifications

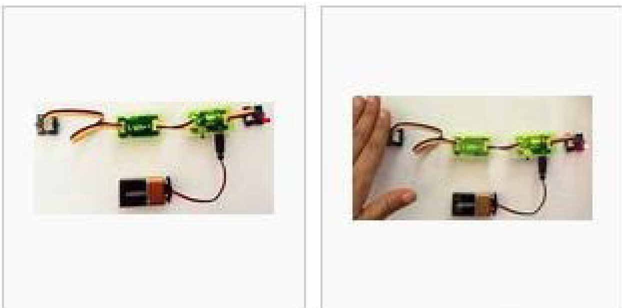
- Voltage: 3-5V
- Supply Current: 0.5-3mA
- Light resistance: 20KΩ
- Dark resistance: 1MΩ
- Response time: 20-30 secs
- Peak Wavelength: 540 nm
- Ambient temperature: -30~70℃
- LDR Used: GL5528

Usage

Follow these steps to build a sample circuit using this module but without using any microcontroller:

1. Connect the light sensor module to the input side of your circuit (to the left of the power module). On the output side of the circuit, you may use a range of User Interface modules (Grove - Red LED, Grove - LED String Light, Grove - Mini Fan, Grove - Buzzer, Grove - Recorder etc.)
2. Power up the circuit when complete.
3. The light sensor module can now be used to trigger an output. For example:

- When used in conjunction with a Grove - Red LED output module, observe that the LED turns ON when the light sensor detects bright light and turns off in the dark. To simulate the dark, just cover the light sensor module with your hand and see what happens. The same behavior can be seen when the light sensor is used with the Grove - LED String Light module.
- Add a Grove - NOT module between the light sensor and the power module to reverse the logic that triggers the LEDs on the Grove - Red LED or Grove - LED String Light modules. With the addition of the Logical NOT gate on the input side, you should see that the LEDs remain OFF in bright light and turn ON in the dark.



LED stays OFF in bright light   LED turns ON in the dark

Figure 24 : LED running status

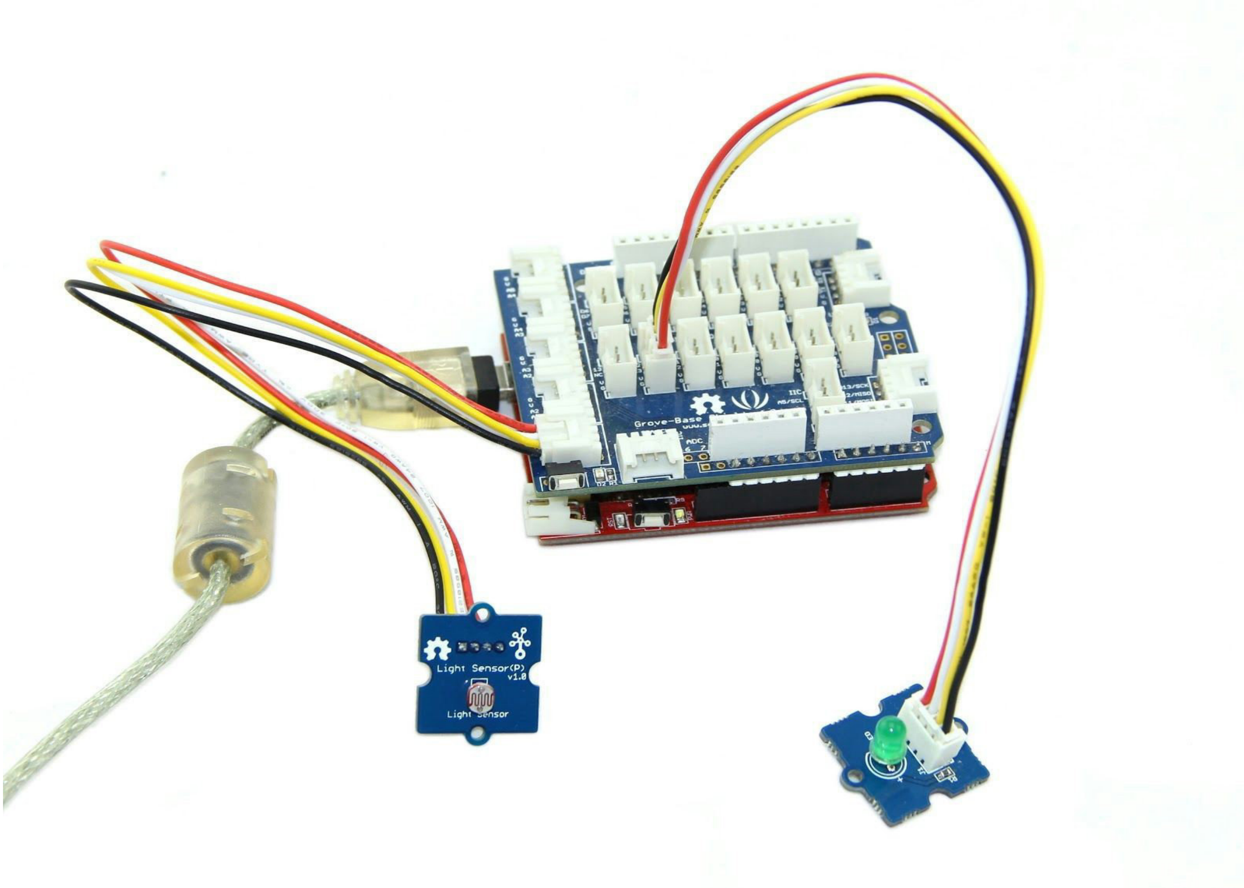


Figure 25: Light Sensor Connector

4. Ultrasound Sensor

Figure 26 : Ultrasound Sensor

Ultrasonic sensors are based on measuring the properties of sound waves with frequency above the human audible range. They are based on three physical principles: time of flight, the Doppler effect, and the attenuation of sound waves. Ultrasonic sensors are non-intrusive in that they do not require physical contact with their target, and can detect certain clear or shiny targets otherwise obscured to some vision-based sensors. On the other hand, their measurements are very sensitive to temperature and to the angle of the target. Our PING)))™ ultrasonic sensor provides an easy method of distance measurement. This sensor is perfect for any number of applications that require you to perform measurements between moving or stationary objects. Interfacing to a microcontroller is a snap. A single I/O pin is used to trigger an ultrasonic burst (well above human hearing) and then "listen" for the echo return pulse. The sensor measures the time required for the echo return, and returns this value to the microcontroller as a variable-width pulse via the same I/O pin.
Ultrasonic sensors “are based on the measurement of the properties of acoustic waves with frequencies above the human audible range,” often at roughly 40 kHz [1)]. They typically operate by generating a high-frequency pulse of sound, and then receiving and evaluating the properties of the echo pulse.

Three different properties of the received echo pulse may be evaluated, for different sensing purposes. They are:

- Time of flight (for sensing distance)
- Doppler shift (for sensing velocity)
- Amplitude attenuation (for sensing distance, directionality, or attenuation coefficient)

Key Features:

- Provides precise, non-contact distance measurements within a 2 cm to 3 m range
- Ultrasonic measurements work in any lighting condition, making this a good choice to supplement infrared object detectors

- Simple pulse in/pulse out communication requires just one I/O pin
- Burst indicator LED shows measurement in progress
- 3-pin header makes it easy to connect to a development board, directly or with an extension cable, no soldering required

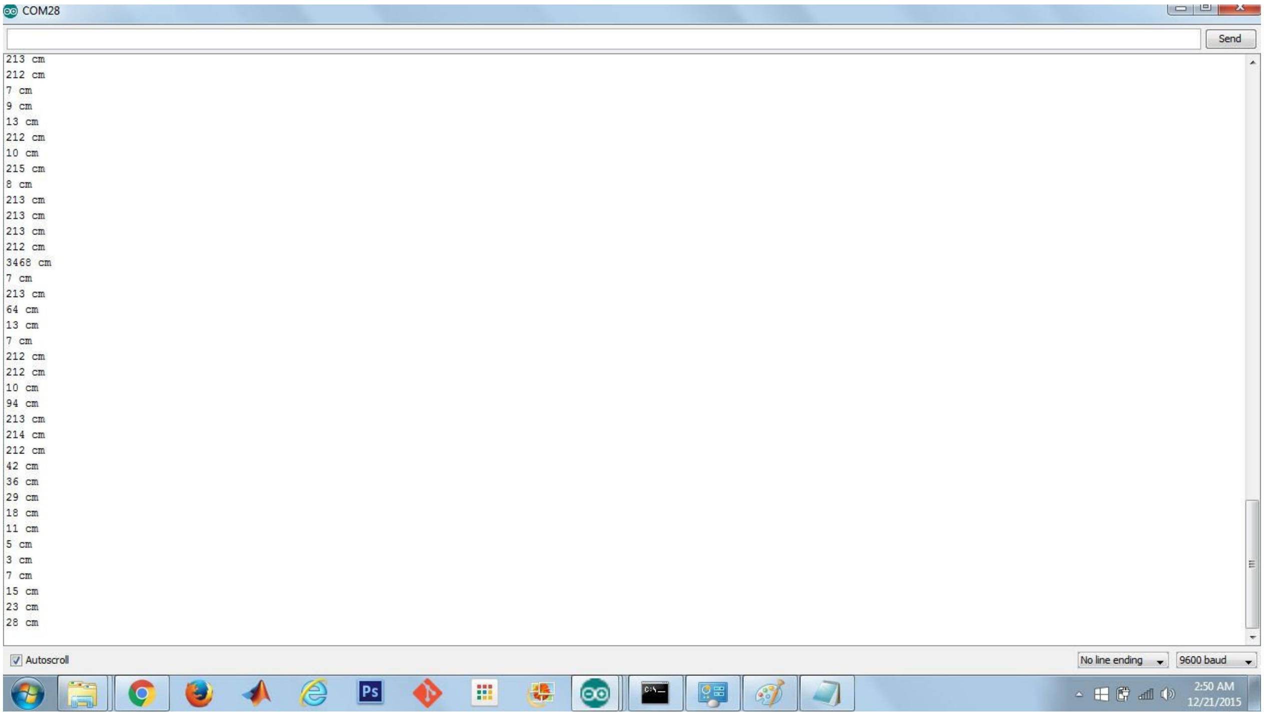


Figure 27: Ultrasound Sensor Readings

Application Ideas:

- Security systems
- Interactive animated exhibits
- Parking assistant systems
- Robotic navigation

The main advantage of ultrasonic sensors is that measurements may be made without touching or otherwise impeding the target. In addition, depending on the distance measured, measurement is relatively quick (it takes roughly 6ms for sound to travel 1m). However, many factors such as temperature, angle, and material may affect measurements.

5. GSM Module

A **GSM modem** is a specialize type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem loo s just like a mobile phone.

When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. While these GSM modems are most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages.

Figure 28: GSM Module

A GSM modem can be a dedicated modem device with a serial, USB or Bluetooth connection, or it can be a mobile phone that provides GSM modem capabilities. For the purpose of this document, the term GSM modem is used as a generic term to refer to any modem that supports one or more of the protocols in the GSM evolutionary family, including the 2.5G technologies GPRS and EDGE, as well as the 3G technologies WCDMA, UMTS, HSDPA and HSUPA. A GSM modem exposes an interface that allows applications such as NowSMS to send and receive messages over the modem interface. The mobile operator charges for this message sending and receiving as if it was performed directly on a mobile phone. To perform these tasks, a GSM modem must support an "extended AT command set" for sending/receiving SMS messages, as defined in the **ETSI GSM 07.05** and and **3GPP TS 27.005** specifications. GSM modems can be a quick and efficient way to get started with SMS, because a special subscription to an SMS service provider is not required. In most parts of the world, GSM modems are a cost effective solution for receiving SMS messages, because the sender is paying for the message delivery. A GSM modem can be a dedicated modem device with a serial, USB or Bluetooth connection, such as the Falcom Samba 75. (Other manufacturers of dedicated GSM modem devices include Wavecom, Multitech and iTegno. We've also reviewed a number of modems on our **technical support blog**.) To begin, insert a GSM SIM card into the modem and connect it to an available USB port on your computer. A GSM modem could also be a standard GSM mobile phone with the appropriate cable and software driver to connect to a serial port or USB port on your computer. Any phone that supports the "extended AT command set" for sending/receiving SMS messages, as defined in **ETSI GSM 07.05** and/or **3GPP TS 27.005**, can be supported by the Now SMS & MMS Gateway. Note that not all mobile phones support this modem interface. Due to some compatibility issues that can exist with mobile phones, using a dedicated GSM modem is usually preferable to a GSM mobile phone. This is more of an issue with MMS messaging, where if you wish to be able to receive inbound MMS messages with the gateway, the modem mobile phone automatically processes received MMS message notifications without forwarding them via the modem interface. It should also be noted that not all phones support the modem interface for sending and receiving SMS messages. In particular, most smart phones, including Blackberries, iPhone, and Windows Mobile devices, do not support this GSM modem interface for sending and receiving SMS messages at all at all. Additionally, Nokia phones that use the S60 (Series 60) interface, which is Symbian based, only support sending SMS messages via the modem interface, and do not support receiving SMS via the modem interface.

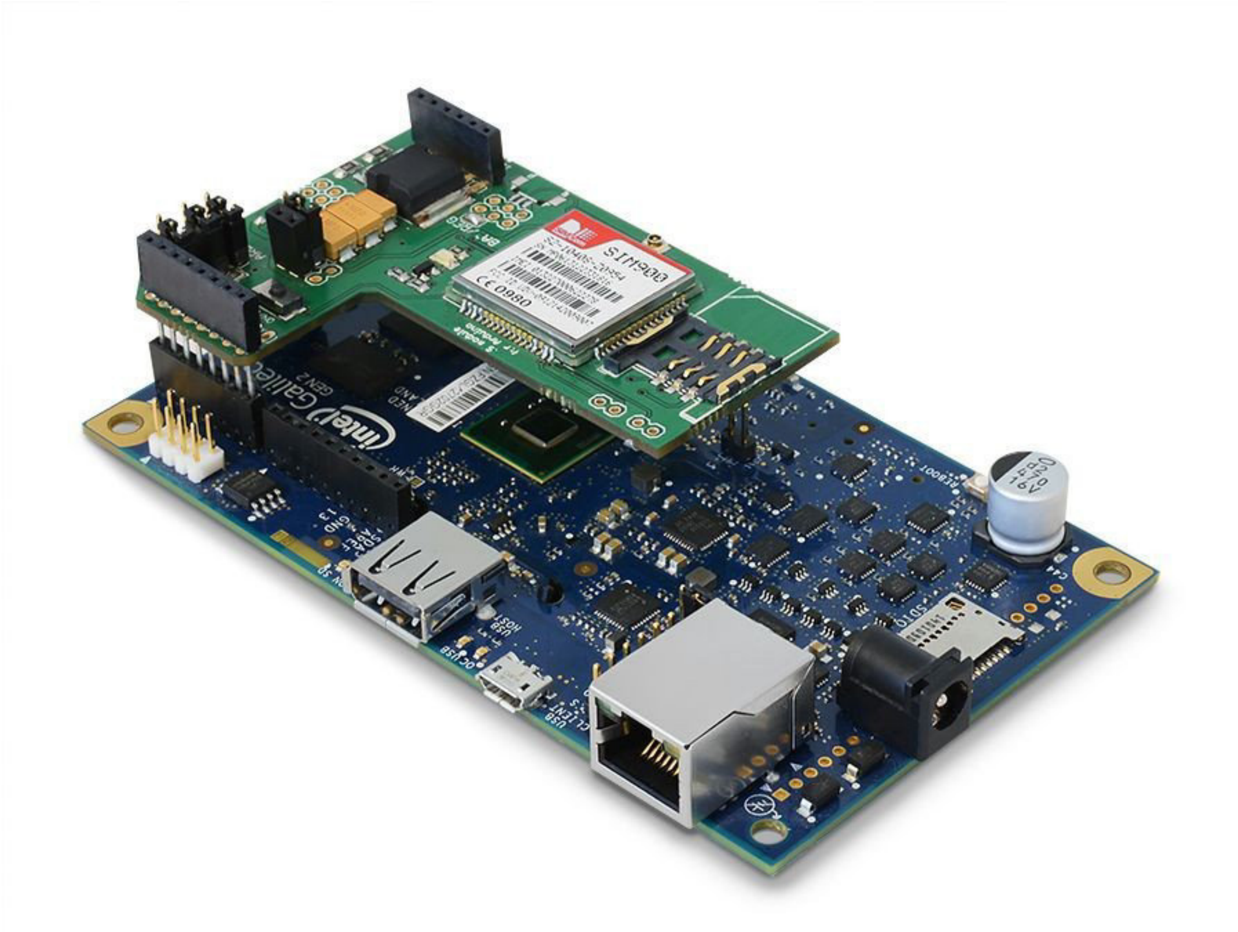


Figure 29: GSM Module with Galileo

IR : An infrared light-emitting diode (LED) is a type of electronic device that emits infrared light not visible to the naked eye. An infrared (IR) LED operates like a regular LED, but may use different materials to produce infrared light. This infrared light may be used for a remote control, to transfer data between devices, to provide illumination for night vision equipment, or for a variety of other purposes.

An infrared LED is, like all LEDs, a type of diode, or simple semiconductor. Diodes are designed so that electric current can only flow in one direction. As the current flows, electrons fall from one part of the diode into holes on another part. In order to fall into these holes, the electrons must shed energy in the form of photons, which produce light.

The wavelength and color of the light produced depend on the material used in the diode. Infrared LEDs use material that produces light in the infrared part of the spectrum, that is, just below what the human eye can see. Different IR LEDs may produce infrared light of differing wavelengths, just like different LEDs produce light of different colors.

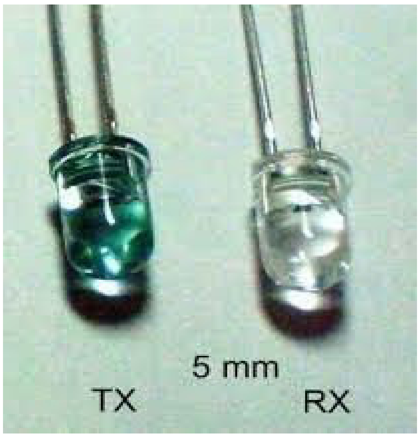


Figure 30: IRs

Infrared light can also be used to transfer data between electronic devices. Mobile phones, personal digital assistants (PDAs), and some laptops may have an infrared LED and receiver designed for short-range data transfer. Some wireless keyboards and computer mice also use an IR LED and receiver to replace a cable.

4.3 Software Requirements

This project needs:

- ➢ An Arduino SDK (version 1.5.3) as the SDK for the programming of the 2nd Gen Intel
  Galileo board.
- ➢ Android Application (for future Implementation)

1. Arduino SDK

The Arduino integrated development environment (IDE) is a cross-platform application written in Java, and derives from the IDE for the Processing programming language and the wiring projects. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. A program or code written for Arduino is called a sketch.

Arduino programs are written in C or C++. The Arduino IDE comes with a software library called “Wiring” from the original Wiring project, which makes many common input/output operations much easier. Users only need define two functions to make a runnable cyclic executive program:

setup( ): A function run once at the start of a program that can initialize settings loop( ): A function called repeatedly until the board powers off

The Arduino IDE uses the GNU toolchain and AVR Libc to compile programs, and uses avrdude to upload programs to the board. Arduino SDK is a software application that provides comprehensive facilities to computer programmers for software development. We will be using Arduino version 1.5.3 which will support Intel Galileo Gen2 board.

Modes of Communication

There are two modes of communication:

I. *Serial:* Used for communication between the Arduino board and a computer or other devices. It communicates on digital pins 0 (RX) and 1 (TX) as well as with the computer via USB. Thus, if we use these functions, we cannot also use pins 0 and 1 for digital input or output. We can use the Arduino environment's built-in serial monitor to communicate with an Arduino board.

II. *Stream:* Stream is the base class for character and binary based streams. It is not called directly, but invoked whenever you use a function that relies on it. Stream defines the reading functions in Arduino. When using any core functionality that uses a read() or similar method, you can safely assume it calls on the Stream class.

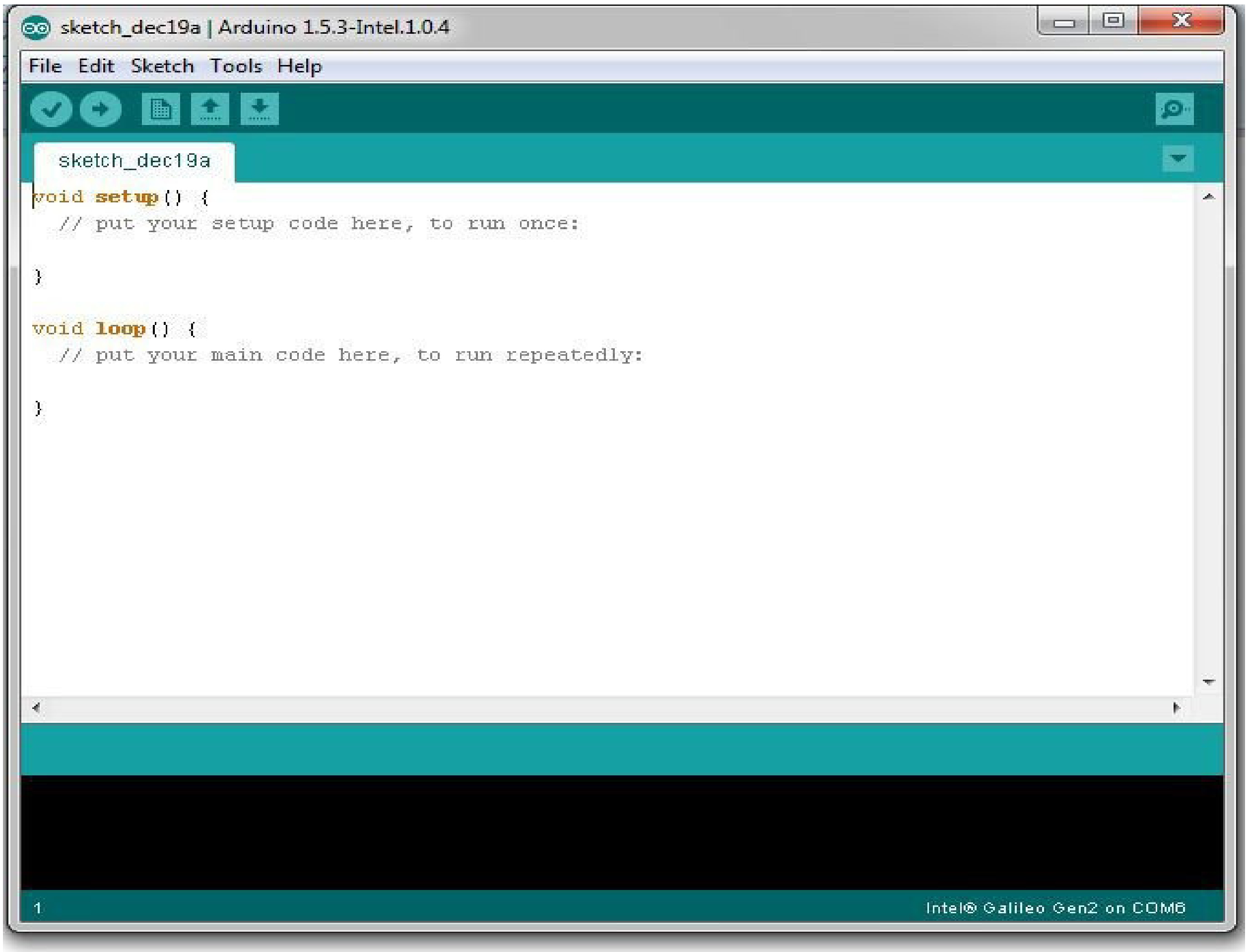


Figure 31 : Front view of Arduino SDK

CHAPTER 5: SIMULATION AND WORK DONE

Program 1: Blink

```
// Pin 13 has an LED connected on most Arduino boards.
 int
led   =
13;
// the setup routine runs once when you press reset:
void setup() {
  // initialize the digital pin as
  an    output.    pinMode(led,
  OUTPUT);
}
// the loop routine runs over and over again
forever: void loop() {
  digitalWrite(led, HIGH); // turn the LED on (HIGH is the
  voltage level) delay(1000); // wait for a second
  digitalWrite(led,   LOW); // turn the LED off by making the
  voltage LOW delay(1000);            // wait for a second
}
```

In this example a LED is repeatedly turned ON and OFF for one second each. Here a simple circuit is implemented on a breadboard and is connected with the Intel Galileo Gen 2 board which is further connected to the power supply by the adapter and also with a micro USB cable that helps us to transfer the code serially to the board.

Output:

(A) When pin is high

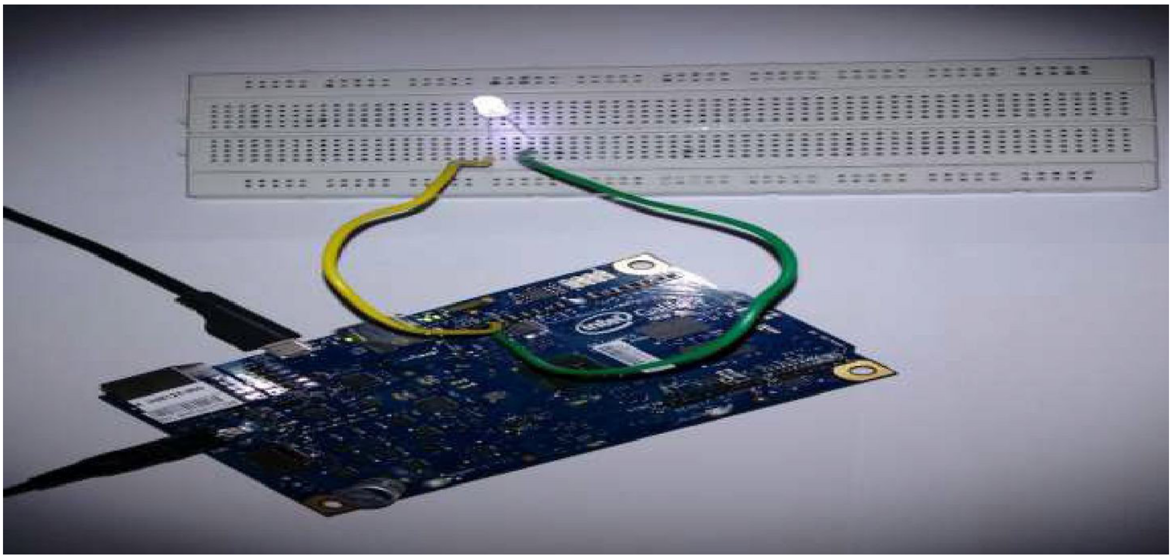


Figure 32: LED is ON

(B) When pin is Low

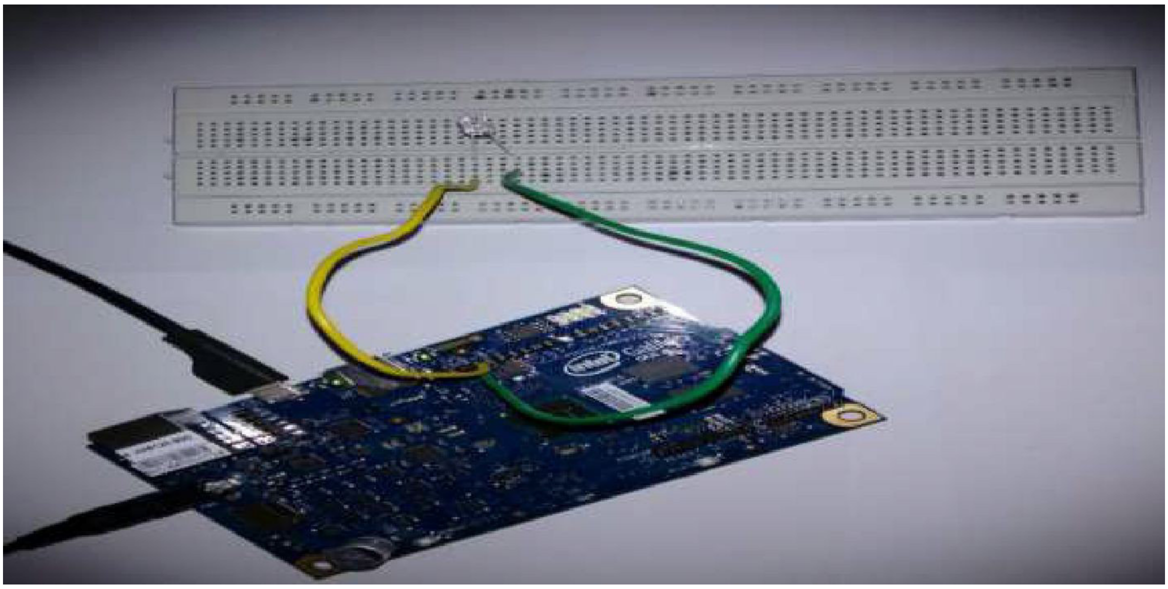


Figure 33: LED is OFF

PROGRAM 2 : Analog Input

```
/*
 It demonstrates analog input by reading an analog sensor on analog
pin 0 and turning on and off a light emitting diode(LED) connected to
digital pin 13.
The amount of time the LED will be on and off
depends on the value obtained by analogRead().

The circuit:
* Potentiometer attached to analog input 0
* center pin of the potentiometer to the analog pin
* one side pin (either one) to ground
* the other side pin to +5V
* LED anode (long leg) attached to digital output 13
* LED cathode (short leg) attached to ground

*/

int sensorPin = A0; // select the input pin for the
potentiometer int ledPin = 13;     // select the pin for
the LED
int sensorValue = 0;  // variable to store the value coming from the
sensor

void setup() {
 // declare the ledPin as an
 OUTPUT:   pinMode(ledPin,
 OUTPUT);
}
void loop() {
 // read the value from the sensor:
```

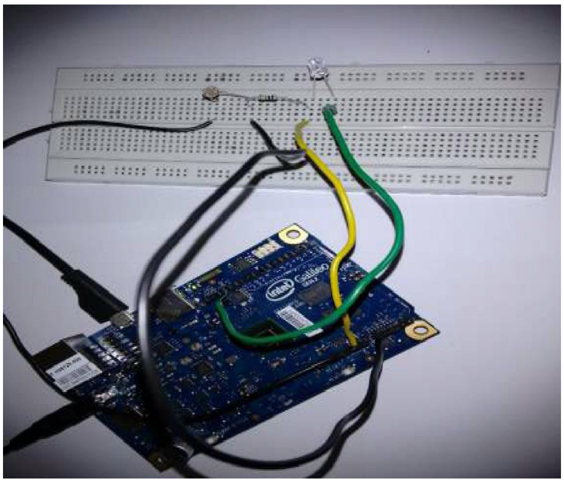
sensorValue = analogRead(sensorPin);

// turn the ledPin on digitalWrite(ledPin, HIGH);

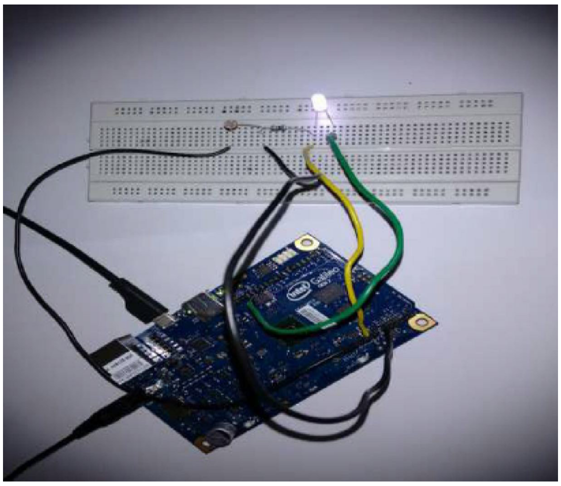
// stop the program for <sensorValue> milliseconds: delay(sensorValue);

// turn the ledPin off: digitalWrite(ledPin, LOW);

// stop the program for for <sensorValue> milliseconds: delay(sensorValue);



(a) When value of sensor is high



(b) When value of sensor is low

<u>Main Code</u> : Web Server

```
#include <SPI.h>      #include <Ethernet.h>

int temp,v,v1;

long duration,distance;

#define trigPin 13

#define echoPin 12

byte mac[] = { 0x98, 0x4F, 0xEE, 0x05, 0x3E, 0x33 };

IPAddress ip(169,254,102,255);

EthernetServer server(80);

void setup() {

Serial.begin(9600);

pinMode(trigPin, OUTPUT);

pinMode(echoPin, INPUT);

pinMode(3, OUTPUT);

while (!Serial) { ;  // wait for serial port to connect. Needed for Leonardo only    }

Ethernet.begin(mac, ip);

server.begin();

Serial.print("Server is at :");

Serial.println(Ethernet.localIP());}

void loop() {

EthernetClient client = server.available();

if (client) {

Serial.println("New Client.");
```

```
boolean currentLineIsBlank = true;

while (client.connected()) {

if (client.available()) {

char c = client.read();

Serial.write(c);

if (c == '\n' && currentLineIsBlank) {

client.println("HTTP/1.1 200 OK");

client.println("Content-Type: text/html");

client.println("Connection: close");

client.println();

client.println("<!DOCTYPE HTML>");

client.println("<html>");

client.println("<body>");

client.println("<meta http-equiv=\"refresh\" content=\"5\">");

delay(1000);

int temp = analogRead(0);

v=(4.8*temp)/10;

v1=300-v;

client.println("<h1 align=center> Implementation of Smart Farming in IOT. </h1>");

client.println("<h2> Statistics of your Plant. </h2>");

client.print("Current Temperature is : ");

client.print(v1);

client.print("degree C");
```

```
client.println("<br />");
digitalWrite(trigPin, LOW); // Added this line
delayMicroseconds(2); // Added this line
digitalWrite(trigPin, HIGH);
delayMicroseconds(10); // Added this line
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
distance = (duration/2) / 29.1;
client.print("Distance is : ");
client.print(distance);
client.print("cm. ");
client.println("<br />");
client.print("Current Moisture level : ");
int moist = analogRead(1);
if(moist>300 && moist<700)
client.print("NORMAL ");
if(moist<300)
client.print("OVER IRRIGATION ");
if(moist>700){
client.print("UNDER IRRIGATION ");
digitalWrite(3,1);
delay(5000);
digitalWrite(3,0);}
```

```
client.println("<br />");
client.print("Current Light Level : ");
int light = analogRead(2);
if(light<150)
client.print("Very High Sunlight ");
if(light>151&&light<600)
client.print("Optimum Light ");
if(light>600){
client.print("Very Low Light ");}
client.println("<h3> For more information : </h3>");
client.print("<a href=main.html>");
client.print("Visit this page.</a>");
client.println("</body>");
client.println("</html>");
break;}
if (c == '\n') {
// you're starting a new line
currentLineIsBlank = true;}
else if (c != '\r') {
currentLineIsBlank = false;}}}
delay(3);
client.stop();
Serial.println("client disonnected");}}
```

Outputs:

1.

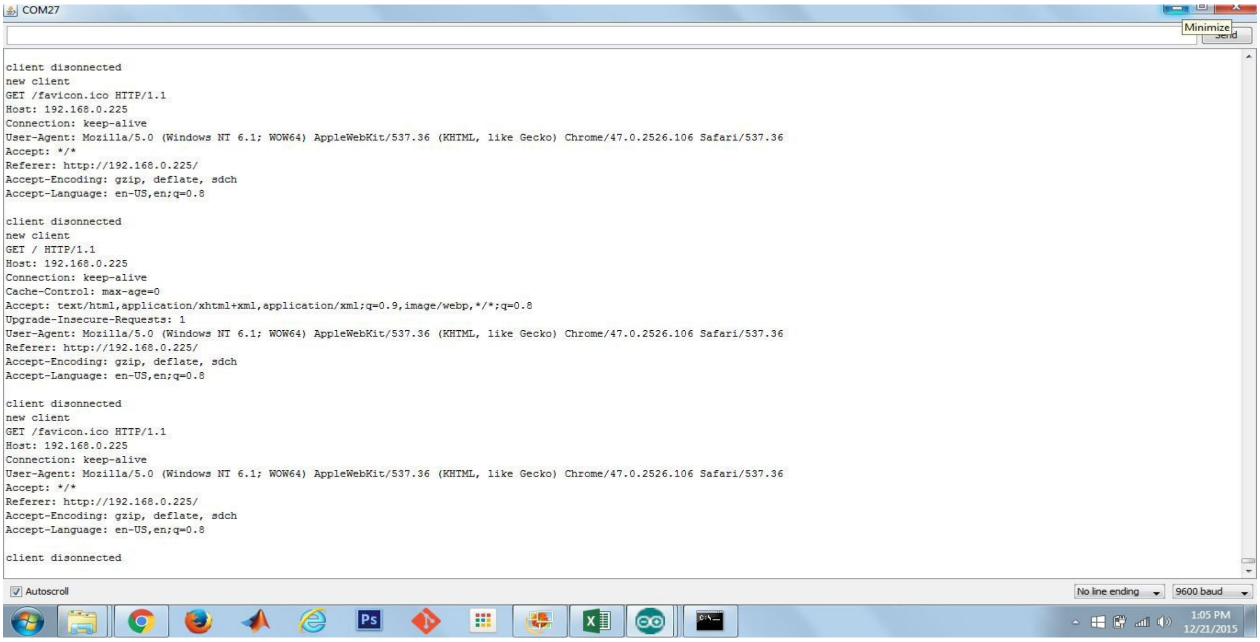


Figure 35: Serial Monitor Output

2.

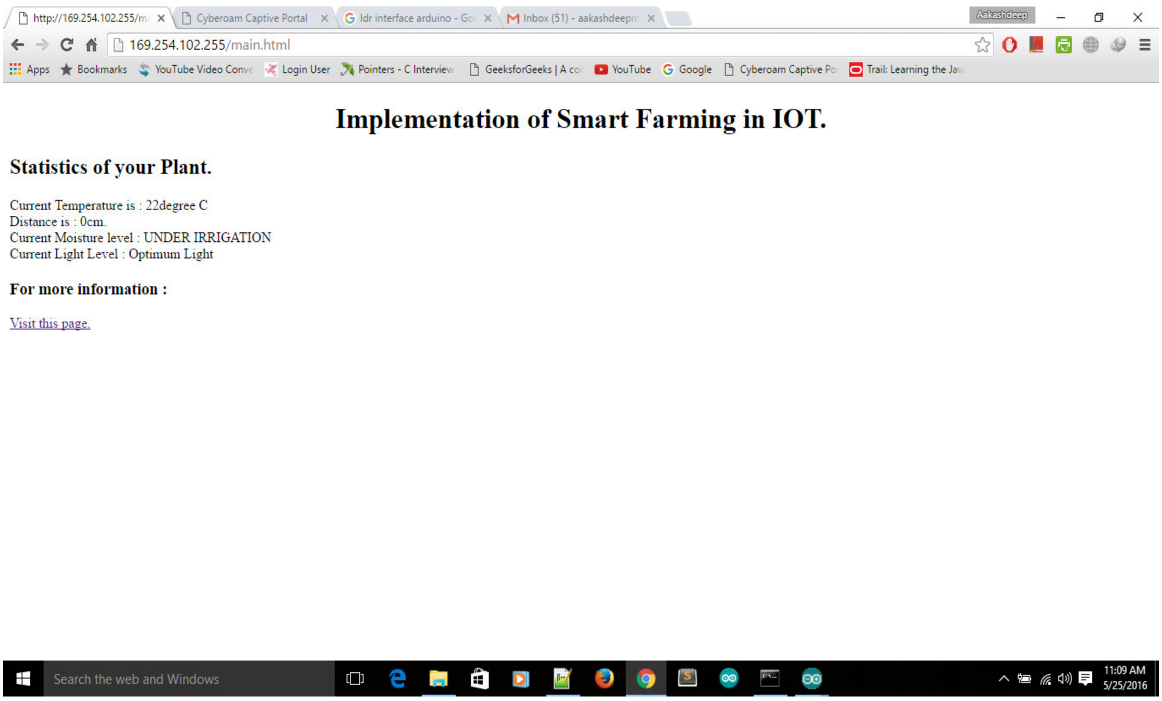


Figure 36: Running Server

3.

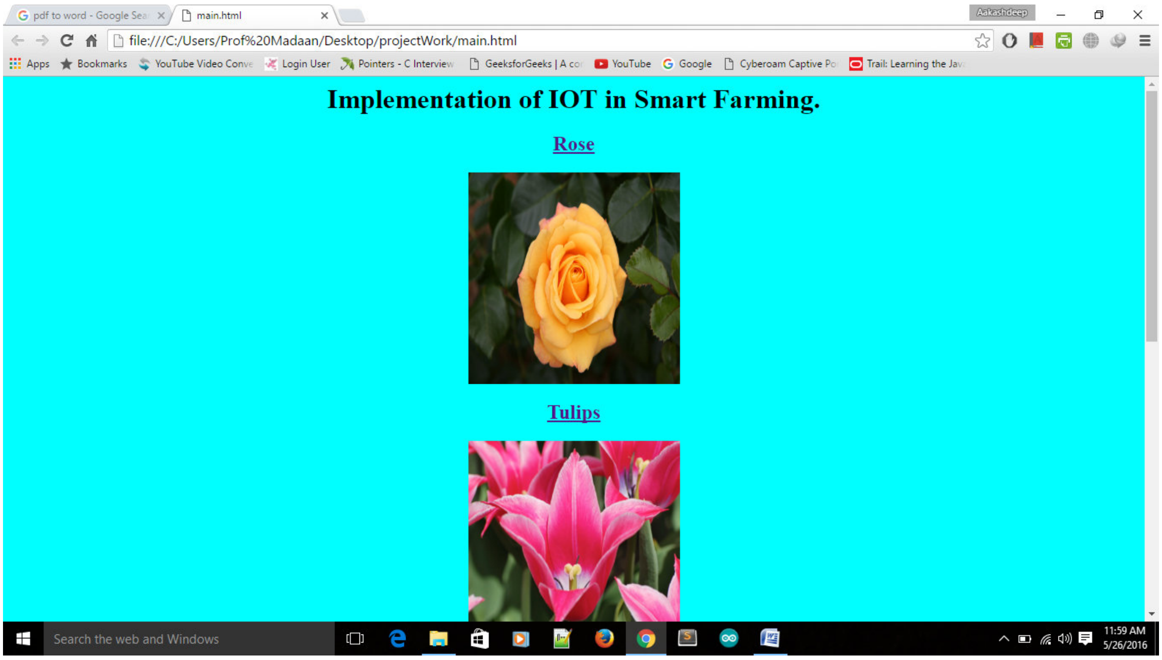


Figure 37: Information of Plants-1

4.

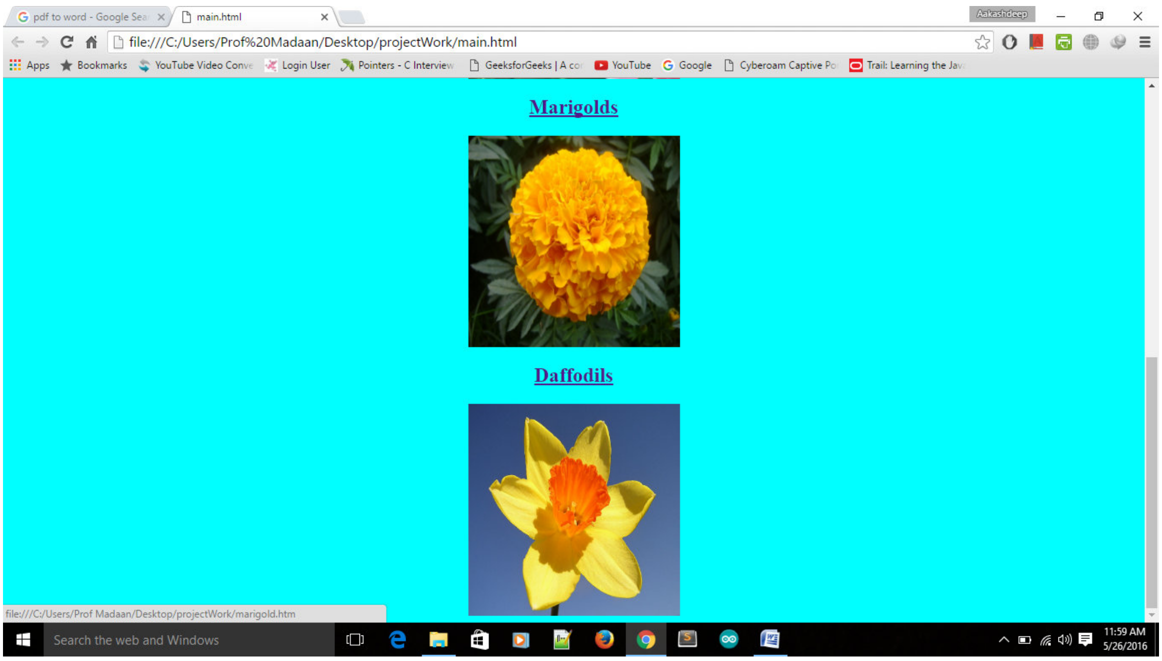


Figure 38: Information of Plants-2

5.

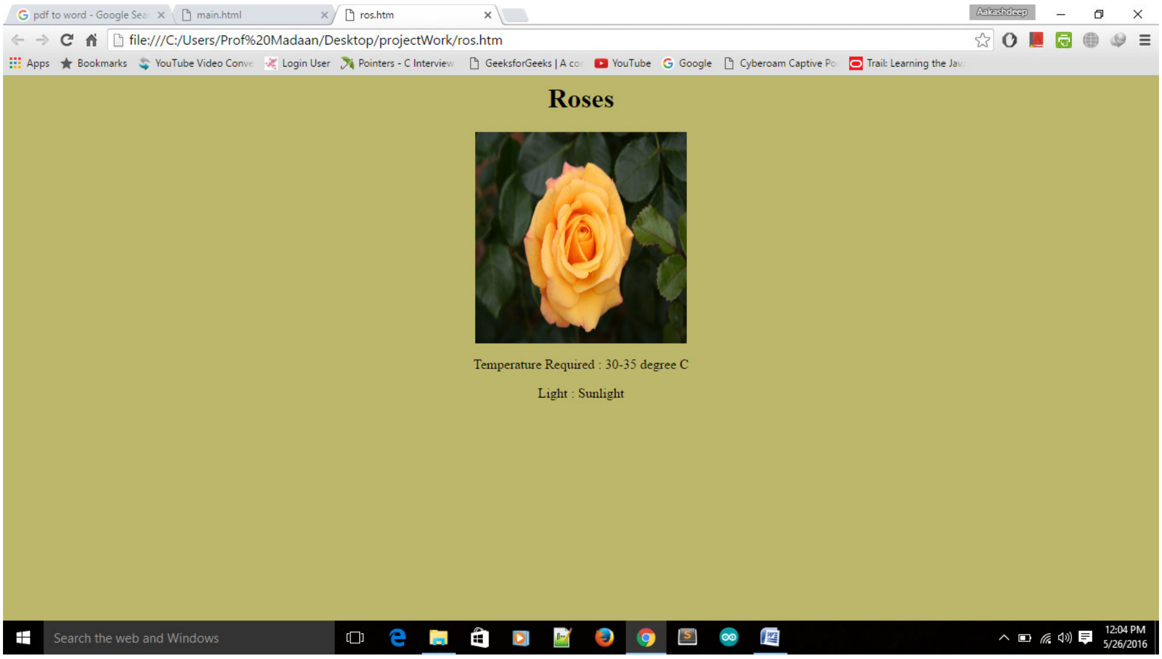


Figure 39: Rose Example

6.

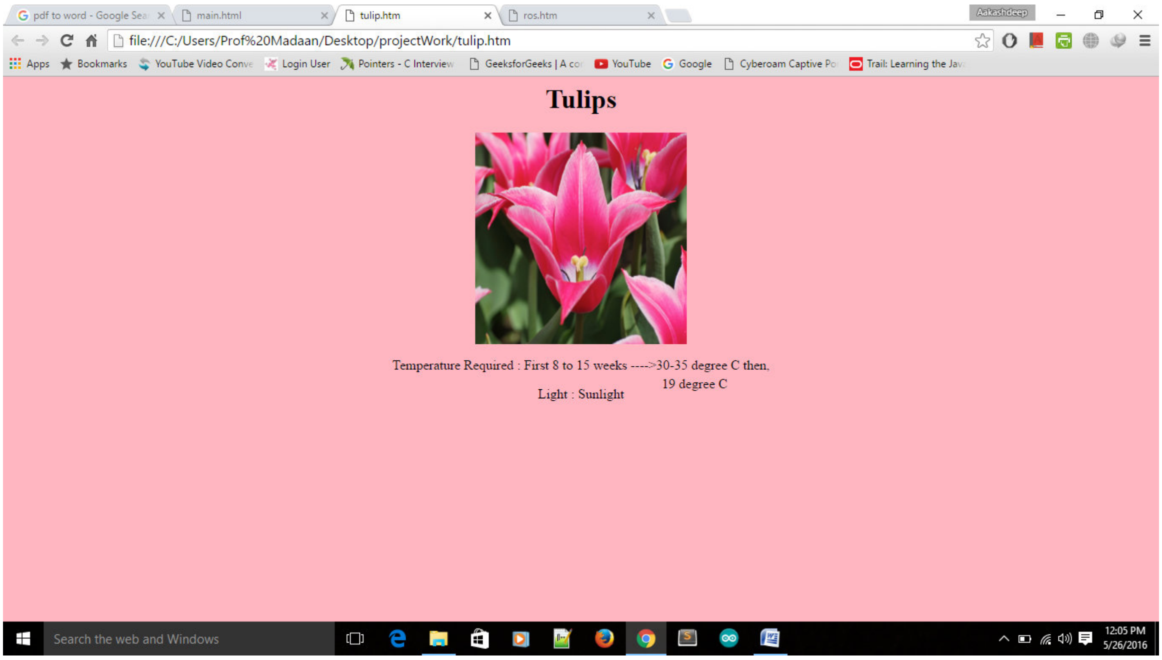


Figure 40: Tulips Example

Chapter 6: Conclusion and Future Work

The hardware implementation part of our project is done, where we have included the major part which is desired by the people interested in gardening. As the main reason why people fail to grow plants is irregular or over/under watering of the plants and people are also busy and tend to forget about their plants and this is where our project comes handy. Hence plant's owner can check health status of his plant anytime and plant can send data to his owner directly. For now we have worked only on Moisture sensor, Temperature sensor and Light Sensor. Now we have to concentrate on emergency scenario i.e how to send an emergency mail or message to the owner by the help of the processor and also to send the sensed data to the server so that owner can see plant's full log report.

The future aspect of our final project will be automatic irrigation using moisture sensors at large scale, automatic indication of harvesting which will send message to the farmer, use of quadcopters or drones for spraying pesticides over large area , solar power wireless irrigation system , will upload all the sensor's data to server for better accessibility. We will also make an android application for farmers which will help them in what crop to sow , when to sow, the amount of pesticides and fertilizers to be used , when to harvest , market value of their harvest and information about government schemes and policies.

CHAPTER 7: REFERENCES

Papers:

[1] Drishti Kanjilal, Divyata Singh, Rakhi Reddy and Prof Jimmy Mathew, "Smart Farm: Extending Automation to the Farm Level", International Journal Of Scientific & Technology Research Volume 3, Issue 7, July 2014.

[2] Constantionos Marias, Sotiris Nikoletseas and Georgios Constantionos Theofanopoulos, "A Smart System For Garden Watering Using Wireless Sensor Networks", University of Patras Research Academic Computer Technology Institute (CTI).

[3] Vimal B. Patel, Rahul G. Thakkar, Bakim L. Radadiya, "An Android Application For Farmers To Disseminate Horticulture Information" , International Journal Of Computer Applications (0975-8887) , Volume 88 – No.4 , February 2014

Web Links:

[1] http://www.senseye.io/internet-of-things-sensors-for-smart-farming-part-1/

[2] http://www.smartfarmapps.com/

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[5] http://www.slideshare.net/MphasisIntern/raju-ece

[6] http://www.slideshare.net/dschutz/urban-smart-farming-presentation