

**Program: ESE 4009\_2**

**INSTRUCTOR:** Prof**.** Mike Aleshams

# Group# 6

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**Project Proposal**

**Project Title: Automatic Watering System for Plants**

**Description of the latest similar system:**

**Automatic Watering System for Plants**

Gardening is a practice of growing and cultivating plants and is considered by many people as a relaxing activity. Studies also show the positive effects of gardening on mental and physical health in this very hectic world. One of the top concerns for every gardener is how often to water their plants and how much. So here in this project, we are implementing a new system to ensure plants to be watered automatically while making sure the ideal amount of water at the ideal time.

The circuit is built using an Arduino and a soil moisture sensor. The sensor tracks the moisture content in the soil and through Arduino, a pump is controlled which provides water to the plants. The soil is never completely dry or fully wet to avoid over or under-watering. At a reasonable level, the moisture content is maintained. The soil moisture sensors are placed in the pots and a submersible mini water pump(12V) is placed inside a water tank. Its water outlet is provided through a nozzle to the pots. According to the moisture content of the soil in the pots, the water automatically pumps whenever needed. Once the moisture content of the soil reaches an adequate level the pump shuts off. So, this system ensures the plants are properly watered even without human assistance.

Mini Water Pump

Arduino

Nano

Soil Moisture Sensor

Transistor

Relay

12V Battery

Figure 1: Block Diagram of Automatic Watering System For plants

Working principle of the project:

The moisture sensor provides analog voltage output; therefore, it has to be connected with Arduino’s analog input pins A0 and A7 which are given 5V Vcc supply from the board. To turn the water pump ON and OFF, the relay is used and is connected between the “NO” (Normally Open) terminal and the circuit ground. Arduino drives the relay through the NPN transistor BC547. The digital pin D2 of Arduino is used to switch ON/OFF the relay by using the transistor. The relay and the water pump operate at 12 V provided by the battery.

Circuit operation:

When the soil begins to get dry the sensor will output to the Arduino board which switches ON the water pump. Once the soil is watered adequately Arduino switches off the water pump. The soil moisture sensor is of variable resistance. Its resistance varies according to the conductivity changes between two sensor rods. The conductivity of these rods changes as per the soil's moisture content when it is inserted into the soil. If the soil is dry, the conductivity is less and the resistance is high, and vice versa. From this, we can say that the sensors resistance changes from high to low as per the moisture content. This change in resistance is converted into an analog voltage output.

The Arduino takes the sensor output voltage as the analog input and then it is converted into a digital value to measure the soil's moisture level from 0 to 100 percent.

A threshold level is set to switch on the relay through the transistor. If the moisture level is less than the threshold level the relay will be turned on which turns on the pump. So, when the soil begins to moisten its moisture level will be monitored by the Arduino from both sensors. When the set moisture level is reached the Arduino switches off the relay which turns off the pump.

**Hardware Requirements**

1. Arduino Nano: It is a small breadboard-friendly board based on ATmega 328P. The Arduino Nano is programmed using the Arduino software (IDE). It has 8 pins from A0 to A7 used to measure analog voltage in the range of 0-5 v. It comes with the same functionality as in Arduino Uno but quite small. They act as input pins while interfacing with sensors but if we are driving some loads, it works as an output.
2. Soil moisture sensor: It consists of probes used to measure the volumetric content of water. These probes allow the current to pass through the soil which gives the resistance value to measure the moisture value. When there is water present, the electrical conductivity of the soil will be more which means that there will be less resistance. On the other hand, the electrical conductivity of the dry soil is poor when there is no water presence which makes the soil conduct less electricity and there will be more resistance. This sensor can be connected in analog and digital modes. It requires an input voltage of 3.3 – 5V.
3. Arduino relay module:

A relay is an electrically operated switch that can be turned ON or OFF letting the current go through or not and can be controlled with low voltages, like the 5V provided by the Arduino pins. The relay modules having one-eight channels are available in the market. This module should be powered with 5 V which is appropriate to use with Arduino. Other relay modules are powered using 3.3V, which is ideal for ESP32, ESP8266, and other microcontrollers.

1. A 12V battery:
2. Mini submersible water pump:

A submersible pump also called an electric submersible pump, is a pump that can be fully submerged in the water pushes water to the surface by converting rotary energy into kinetic energy into pressure energy.

**Software requirements**

Arduino IDE

**Limitations of the latest similar system:**

* Problems in moisture distribution.
* The maximum number of sensors that we can connect to this Arduino is eight since it has pins A0 to A7.
* A plant needs a different amount of water in different seasons, also different plants have different water intakes.
* Lack of IoT technology.
* Less number of sensors in this system.
* Slow processing speed of Arduino
* Arduino is not a good option to support real time operations.
* Different natural factors like sunlight, rain, etc.. that promotes the growth of a plant is not considered in this system.

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**Solution 1 :(Block Diagram, Features, Hardware and Software Requirement, Milestones: Deliverables and Time Schedule, References):**

Moisture Sensor

Beagle Bone Black

Relay

Humidity sensor

Temperature sensor

Motor

Light Sensor

Power Supply of 5V

Figure 2: Block Diagram for Solution 1 of Automatic Irrigation System

Features of solution 1:

* Use of the 32-bit microprocessor beagle bone black as the main device which provides high processing speed
* This system provides uniform and required level of water for the agricultural farm and avoids the water wastage.
* Here we have implemented a digital temperature and humidity sensor.
* The humidity sensors are used to measure the moisture content.
* A light sensor is included to water the plants by sensing the sunlight and thereby watering it according to the required needs.
* The use of drip irrigation method helps to reduce the percentage of waste water and also improves the moisture distribution level.

Software and Hardware requirements for solution 1:

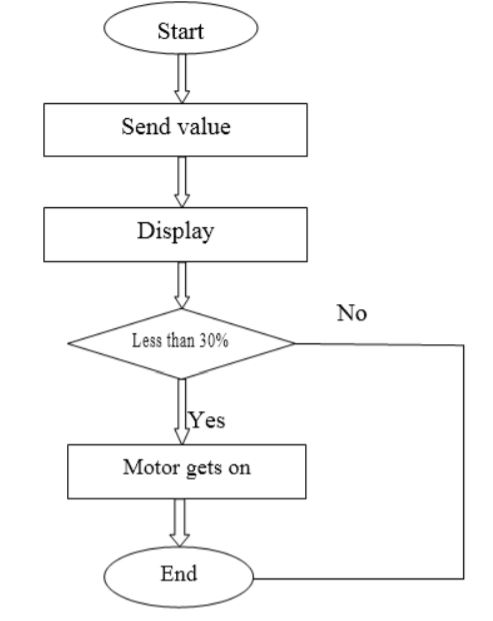
Software requirements:

* Debian latest image for the beagle bone black
* C programming
* Eclipse: Eclipse is an integrated development environment used in computer programming. It contains a base workspace and an extensible plug-in system for customizing the environment.  Eclipse is written mostly in [Java](https://en.wikipedia.org/wiki/Java_(programming_language)) and its primary use is for developing Java applications, but it may also be used to develop applications in other [programming languages](https://en.wikipedia.org/wiki/Programming_language) via plug-ins
* GCC compiler or any cross compiler: It 'translates' the programming languages to machine language. Or to put it in another way, it converts our source code to executable instruction file for computers. GCC stands for “GNU Compiler Collection”. GCC is an integrated distribution of compilers for several major programming languages.

Hardware requirements

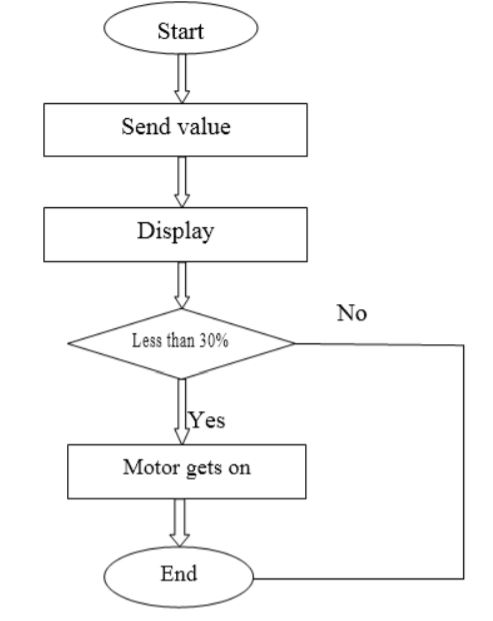
1. Beagle bone black

It is a low-cost community-supported platform for developers. It ships with Debian GNU/Linux in onboard to start evaluation and development. The other Linux distributions and operating systems are also supported on beagle bone black including Ubuntu, Android, Fedora. It performs all the duties of a computer on a single chip.

1. Temperature and Humidity sensor

The DHT11 is a digital temperature and humidity sensor. It uses a capacitive device. The humidity sensor and thermistor are used to measure the surrounding air and spit out the air. Digital data pin signal (no analogue pins needed). It's easy to use, but needs to be used. Careful timing for data collection. Humidity sensors are used to measure moisture content. It was in the atmosphere. Current temperature, humidity values,

1. Moisture sensor:



The Moisture sensor is used to measure the moisture content of the soil. When the soil has a water shortage, the output of the module is at a high level, otherwise the output is at a low level. This sensor reminds users to water their plants and also monitors the moisture content of the soil. It has been widely used in agriculture, land irrigation and botanical gardening.

1. Light Sensor:

Light sensors sometimes use a component called a photodiode to measure the illumination. When light beams strike a photodiode, they tend to loosen electrons, causing an electrical current to flow. The brighter the light, the stronger the electrical current. The current can then be measured to give back the illumination of the light. If light-induced electrical current sounds familiar, it is because this is the operating principle of solar panels used to power road signs and homes. Solar panels are basically very large photodiode light sensors.

1. Power supply:

A power supply of 5V is provided here.

1. Motor:

DC Powered Pumps use motor or solar power direct current to transfer fluid in a number of ways. Motorized pumps run with DC power of 6, 12, 24, or 32 volts and use hand-operated, mechanical, pneumatic, or hydraulic engines. Photovoltaic (PV) panels with solar cells that produce direct current when exposed to sunlight are used by solar-powered DC pumps.

1. Relay:

Relays are electrical switches that transform small electrical impulses into greater currents using electromagnetism. These transitions arise as electrical inputs activate electromagnets to help form or weaken internal circuits. By manipulating weak inputs to power stronger currents, relays, depending on the intended application, essentially serve as either a switch or an amplifier for the electrical circuit.

# References

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**Solution 2 (Block Diagram, Features, Hardware and Software Requirement, Milestones :Deliverables and Time Schedule, References):**

Soil Moisture Sensor

Beagle Bone Black

Relay

Humidity Sensor

Pump

Temperature

Android Device

Light Sensor

Power Supply Of 5V

Figure 3: Block Diagram of Solution 2 IoT Based Automatic Irrigation System

Features of solution 2

* Use of the 32-bit microprocessor beagle bone black as the main device which provides high processing speed
* This system provides uniform and required level of water for the agricultural farm and avoids the water wastage.
* Here we have implemented a digital temperature and humidity sensor.
* The humidity sensors are used to measure the moisture content.
* The use of drip irrigation method helps to reduce the percentage of waste water and also improves the moisture distribution level.
* The sensed parameters from the sensor and the current status of the motor will be displayed on the android applications.
* A light sensor is included to water the plants by sensing the sunlight and thereby watering it according to the required needs.
* The current temperature and the humidity values are sent to the beagle bone and are displayed in the users android app.
* This implements IoT technology using an android device, a master device and various sensors to measure different parameters.
* Use of IoT through Wifi for the cloud storage, such as, Thing Speak.

**Software and hardware requirements for solution 2**

Software requirements

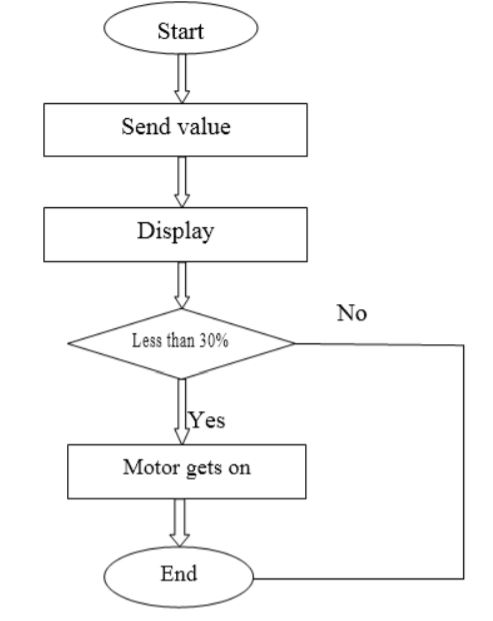
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* Gcc compiler or any cross compiler: It 'translates' the programming languages to machine language. Or to put it in another way, it converts our source code to executable instruction file for computers. GCC stands for “GNU Compiler Collection”. GCC is an integrated distribution of compilers for several major programming languages.
* ThingSpeak: "ThingSpeak is an open-source Internet of Things application and API to store and retrieve data from things using the HTTP and MQTT protocol over the Internet or via a Local Area Network. ThingSpeak provides instant visualizations of data posted by your devices to ThingSpeak. With the ability to execute MATLAB® code in ThingSpeak you can perform online analysis and processing of the data as it comes in. ThingSpeak is often used for prototyping and proof of concept IoT systems that require analytics.

Hardware requirements

1. Beagle bone black

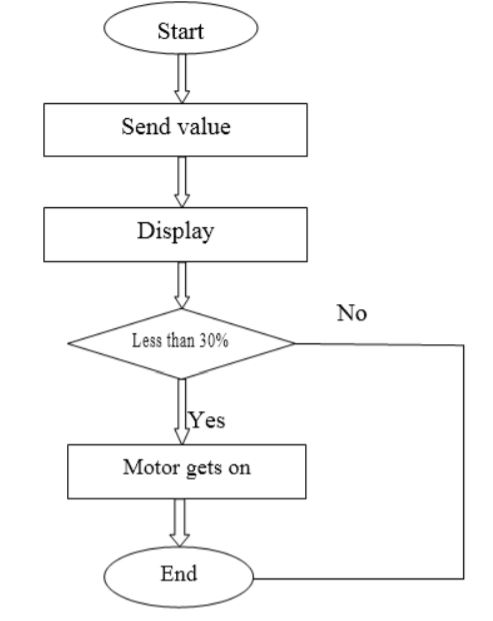
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1. Motor:

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1. Relay:

Relays are electrical switches that transform small electrical impulses into greater currents using electromagnetism. These transitions arise as electrical inputs activate electromagnets to help form or weaken internal circuits. By manipulating weak inputs to power stronger currents, relays, depending on the intended application, essentially serve as either a switch or an amplifier for the electrical circuit.

1. Android device:

The sensed parameters and the current status of the motor will be send to the user’s android application.

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**More Solutions?**

**Final Solution:**

Soil Moisture Sensor

Beagle Bone Black

Relay

Humidity Sensor

Pump

Temperature

Android Device

Light Sensor

Power Supply Of 5V

**Figure: Block Diagram of IoT Based Automatic Irrigation System**

**Working principle:** In this proposed model an embedded system which automatically controls the irrigation of the plants is included. Here the plants are watered by considering the parameters like temperature, humidity, moisture, and light and then monitored and control the system which helps in the improved yield. Using various sensors for temperature, humidity, light, and moisture it will sense all these changing factors in the plants and it will be communicated properly with the system to determine when to turn on and off the system. These sensors are connected to the Beagle Bone Black and the IoT platform Thing Speak will act as a database where we can send these data and retrieve it. By using an android device, the sensed information’s and the data’s can be accessed. The Beagle bone will collect the data from the sensors and sends HTTP requests to the cloud. The Thing Speak will take this HTTP requests which includes the data from the BBB and stores this in the database. Whenever we send and HTTP request, we need to get proper response, then only the whole process will be complete. The Beagle Bone collects the information from the sensors and send it to Thing Speak via cloud and it will respond with an appropriate response. So, at times when we are on a cloud, we can send HTTP requests from a BBB through the cloud to the Thing Speak asking for data and it will send back the data.

**Features:**

* Use of the 32-bit microprocessor beagle bone black as the main device which provides high processing speed
* This system provides uniform and required level of water for the agricultural farm and avoids the water wastage.
* Here we have implemented a digital temperature and humidity sensor.
* The humidity sensors are used to measure the moisture content.
* The use of drip irrigation method helps to reduce the percentage of waste water and also improves the moisture distribution level.
* The sensed parameters from the sensor and the current status of the motor will be displayed on the android applications.
* A light sensor is included to water the plants by sensing the sunlight and thereby watering it according to the required needs.
* The current temperature and the humidity values are sent to the beagle bone and are displayed in the users android app.
* This implements IoT technology using an android device, a master device and various sensors to measure different parameters.
* Use of IoT through Wi-Fi for the cloud storage, such as, Thing Speak.
* **Use of various peripherals such as touch screens, cameras, microphones and speakers, GPIOs, timers, GPS modules, Bluetooth, WiFi, and ADC/DACs?**

Beagle bone black as the master device.

Android device is used to view the status of the motor and to view the sensed parameters.

Use of sensors to measure soil moisture, humidity, temperature, and light.

Relay module turns the pump ON/OFF.

GPIO pins to communicate with sensors input.

* **Use of I2C, SPI, RS232/RS-485, IrDA infrared, JTAG, USB, Bluetooth, IEEE 802.11 Wi-Fi, IEEE 802.3 Ethernet, CAN and GPS protocols and systems?**

For communication between sensors and Beagle Bone Black Serial peripheral interface (SPI) protocol is used.

GPIO pins of beagle bone black is used for interfacing.

Motor driver is used to interface the DC motor with beagle bone and it is connected to GPIO pins of beagle bone.

* **Use of preemptive versus cooperative scheduler operation; tick rate and time slicing; critical code; fixed, dynamic and hybrid task priority allocation; application-specific considerations; power management tactics; semaphores, mutexes and queues; debugging strategies; performance estimation?**

This project requires data updating in a real time, so by using beagle bone black in a Linux or real time environment to ensure a real time process, the real time requirements are met.

The sensor data is being recorded and stored in real time.

The data is stored in the cloud and is accessible from anywhere.

**Hardware and software requirements**

Hardware requirements:

* Beagle bone black
* Temperature sensor and humidity sensor (DHT22)
* Moisture sensor (FC-28)
* Light sensor (Grove sunlight sensor)
* Power supply (12V)
* Motor (L293D)
* Relay
* Android device

Hardware tools:

Soldering iron: Soldering of circuit boards is done using the soldering iron. we can assemble the components for the circuit we are making. It is the technique of joining metal parts together which involves melting a metal called solder.

Solder remover: As we have to solder the components together, we also need to desolder them. This is called desoldering. It is the removal of solder from the circuit board.

Bread board: it is used to build and test the circuits quickly before finalising the circuit design.

Wire cutter: since we have to deal with wirings, this is one of the important tools which protects us from getting socks when working with wires.

Wire stripper: it removes the insulation from the electric cables to make contact. With this tool we can easily strip wires without damaging any parts.

Multimeter: it is used for measuring the voltage, current and resistance of the system.

Software requirements:

* Debian latest image for beagle bone black
* C programming
* Eclipse
* Gcc compiler or any cross compiler
* Thingspeak

Software tools:

Coding: here, we use C or C++ language for coding.

Editor: here we are using eclipse IDE as an editor which is compatible with various operating systems.

Gcc Compiler: it is used for the compilation process. It converts our source code to executable instruction files for computer.

Assembler: GNU assembler is used for compiling modern open source software.

Debugger: in this project we are using GNU debugger for debugging the codes.

Internet connectivity: wi-fi is used for the internet connection.

Remote control and desktop sharing: we need team viewer software for remote access and to transfer files between team members.

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**Instructor’s Remarks:**