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Lora based smart irrigation system

Dr. C. Rajasekaran
Professor, Department of ECE, K.S. Rangasamy College of Technology, Tiruchengode, Tamil Nadu, India

L. Gokul
Under Graduate Students, Department of ECE, K.S. Rangasamy College of Technology, Tiruchengode, Tamil Nadu, India

D. Gowsalya
Under Graduate Students, Department of ECE, K.S. Rangasamy College of Technology, Tiruchengode, Tamil Nadu, India

R. Manimaran
Under Graduate Students, Department of ECE, K.S. Rangasamy College of Technology, Tiruchengode, Tamil Nadu, India

***Abstract*---**Among many countries in the world, India is considered as the greatest agricultural producer. On the other hand, the water consumption in India for agricultural purposes is highest in the world. It leads to water deficit in the country. The development of agriculture in India improves crop yields and reduces water use. Water is the important key factor for any form of life on Earth which includes humans, animals and plants. Among these plants consume more world's water resources. The amount of water intended for irrigation represents 70% of the total water Irrigation forms one of the primary components of agriculture and food-production. Huge volume of water is wasted in Agriculture due to outdated techniques in Agriculture irrigation field. In order to reduce water consumption without decreasing the crop yields, there are many modern technologies available, Among the many technologies, LoRa technology has many advantages like long rage wireless communication, low power consumption, compact size etc... This project is to present several efficient irrigation systems using "LoRa based wireless sensor networks", which consists of soil moisture sensor, soil temperature sensor, light sensor, water flow sensor, 3 phase voltage sensor and current sensor. the sensor data obtained from LORA nodes are uploaded to the database through LORA gateway if the sensor data meets below the threshold level, the irrigation automatically turns on and off vice versa. This leads to improve water usage efficiently

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***Keywords*---**LoRa node, Microcontroller, LoRa WAN, Light sensor, Voltage sensor, Current Sensor, Soil moisture sensor, Soil temperature sensor.

I. Introduction

In most countries including India, water is used for irrigating land more than any other purpose and any decrease in water supply can compromise production and yield of the agriculture. A network of small devices consists of soil moisture sensor, LDR sensor, temperature sensor, water flow sensor, 3 phase AC voltage sensor and current sensor which collect soil moisture level, soil temperature level, brightness level of the farming field, voltage level for water pump and current consumption of water pump, it will process real time information from the fields in which they are deployed. The use of this technique makes the irrigation system more accurate and easier than the traditional technique and also reduce human intervention
The determination of soil moisture status has been considered regarding plant-water relations, while the climatic data are considered to perform a model-based real-time decision support system for irrigation systems together with the soil moisture status, such as air temperature, air humidity, solar radiation, and wind speed. Furthermore, the smart watering system was developed for irrigation scheduling based on Block-chain and fuzzy logic approach by employing economical sensor devices. Similarly, the urban irrigation systems were introduced in aiming at saving water and maintaining crop yields; nevertheless, the system was simply based on a soil moisture set-point to make a decision for irrigation. Subsequently, the data were analysed for the watering process and notifying to users via mobile application.

The lora based smart irrigation system was developed and implemented using a low-cost soil moisture sensor, LDR sensor, temperature sensor, 3 phase voltage sensor, water flow sensor and current sensor. The system was applied by the Neuron network for irrigation decisions, while the environment information can be monitored via the web-page. Also, the IoT-based smart irrigation system was developed driven by a fuzzy logic system.This system can provide acknowledgment messages of the job’s statuses via mobile phone. Besides, the weather-based approach has been developed using environment variables and forecast methods. In, the environment parameters were monitored and controlled through WSN, including temperature sensor, humidity sensor, and illumination sensor, to provide optimal crop conditions.

The 70% of water usage occurs outside for irrigation? Even more alarming is this statistic from the Environmental Protection Agency: As much as 50% of irrigation water is wasted. Think about your water bill. There is a huge amount of water that is being wasted. The Lora based Smart irrigation system reduce water waste and allow you to save money and the environment.The proposed project is to automate the farming field including all factors and parameters needed for farming, considering the details of crops grown in the field and also this Project is to present several efficient irrigation systems using “LORA based wireless sensor networks”, which can save a ton of money by reducing water waste, enhanced landscape health and beauty, helps you prepare for the future of water, smart irrigation controllers help you reduce hardscape loss and avoid fines with your smart irrigation controller, In the literature, automatic irrigation and monitoring systems are typically based on a soil approach.

Each paper uses different concepts and logics except one thing that they measured some parameter like soil moisture level, soil nutrition, sun light level, temperature level of the agriculture land. Based on the crops the water and nutrition level of the agriculture land was maintained. The following are the drawbacks of the papers.

- The accuracy of Fuzzy logicsystem mostly works on inaccurate data and inputs. There is no single systematic approach to solve a problem using Fuzzy Logic[1]
- Implementation of a Zigbee technology can be expensive and the transmission rate is comparatively lower than Bluetooth and Wi-Fi[2]
- Electromagnetic sensors not suitable for low velocity. It is more expensive. It is suitable for fluids having conductivity greater than 20 micro ohm/cm[3]
- During dry periods, transpiration can contribute to the loss of moisture in the upper soil zone, which can have an effect on vegetation and food-crop fields[4]
- Deploying IoT devices often comes with high time and money investment requirements[5][9][10]
- Closed loop controller system are costlier, complicated to design and required more maintenance[6]
- Bandwidth lag because of multiple users shares the same bandwidth so the transmission can encounter interface[7]
- In MIT app inventor the transistion to an editor will be difficult and not so user friendly[8]

II. Methodology

In Field Monitoring process, to analyse the soil moisture level, soil temperature level, brightness level, 3 phase voltage, current consumption of water pump and water flow level in the agriculture field, the sensor data obtained from LORA nodesare uploaded to the database through LORA gateway. Based on the crop the threshold of soil moisture level is used to store in the database, if the soil moisture meets below the threshold level, the irrigation automatically turns on and off vice versa. We can change or update the crops in database which are currently farmed in agriculture field. Based on the crop selection the threshold level of soil moisture will be changed.

All the information is stored in the database and periodically updated. Even beginners, who are new to farming will be benefitted from information on various parameters and will know about the farming in detail, with the information available from various processes in farming given by experts which is made available in the system. Figure1 shows the process flow chart of the proposed project.

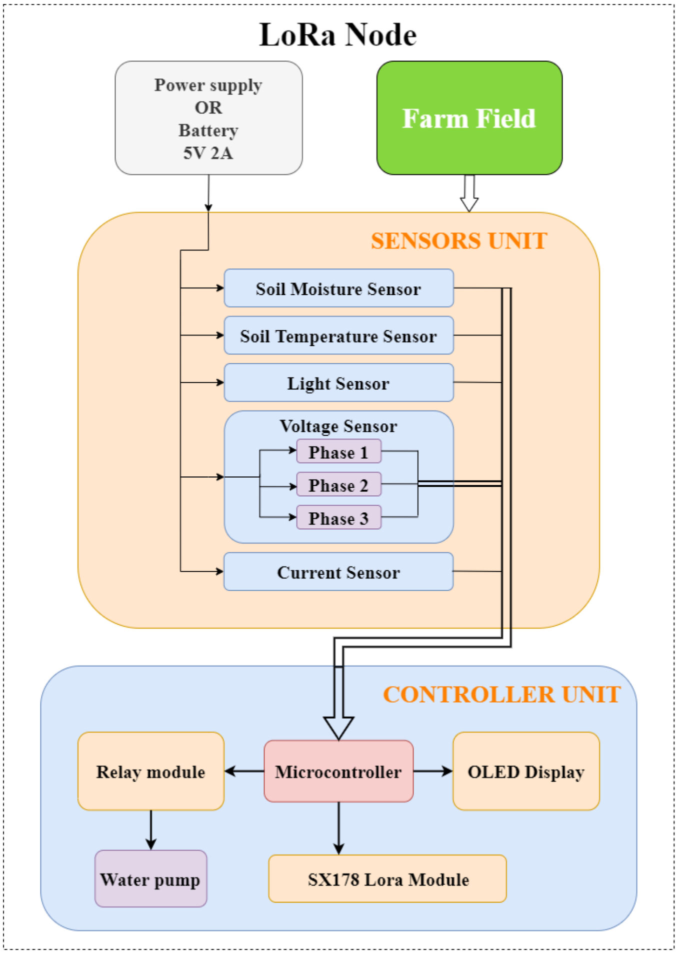

Figure no:1 Block Diagram of LoRa node

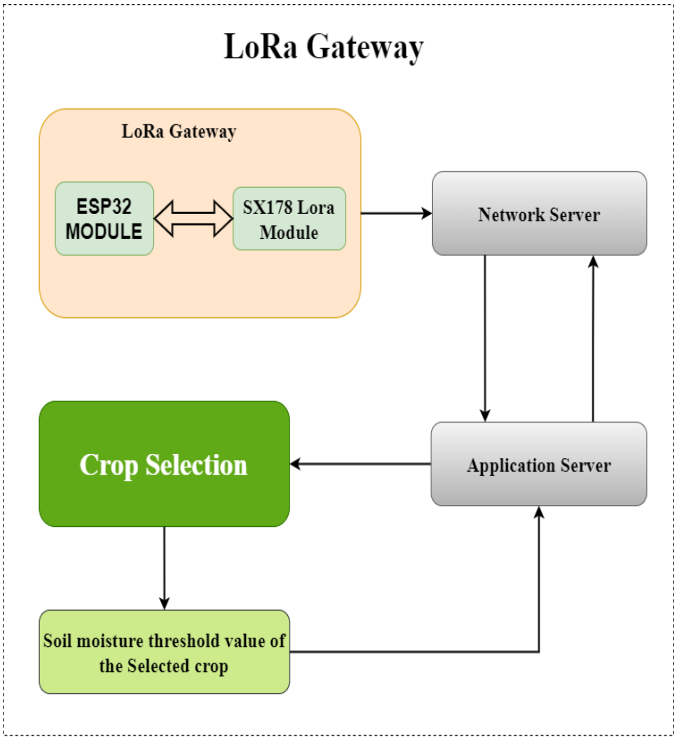

Figure no:2 Block Diagram of LoRa Gateway

III. Irrigation System

The vital role of farming is to maintain the correct soil moisture level for the different variety of crops. Experienced farmers know correct soil moisture level based on their experience. Since climate is becoming unpredictable these days, and to help the younger generation entering farming, guidance for correct soil moisture level for selected crop. The user can select the crop from the available list and the area of the field that the user is going to use for production of the selected crop. The water irrigation plans are provided to the farmer based on the data available in the system. The sensor information from the sensors deployed in the field is also available in the system. Sensors provide information on the water necessity of the crops. Based on the water irrigation plan, irrigation system will be turned on automatically for supplying water to the crops when needed.

The soil moisture and DH11 sensors are connected to the LORA node. The collected sensor data is send from LORA node to LORA gateway, similarly all the LORA nodes are connected to single LORA gateway. The Lora gateway is connected to the internet through WIFI or WAN port. All the collected sensor data is send to database from the Lora gateway. Based on the crops selected, the threshold soil moisture level which is already stored in the database will now compared with the collected sensor data. The irrigation system will on or off according to the condition set in database. To monitor all the collected sensor data and condition of irrigation system through mobile or website. Automatic irrigation is provided based on the moisture level in the field and necessary fertilizers are applied by checking the soil nutrients regularly. The LoRaWANIOT Network as shown in figure2.

IV. Wireless Sensor Networks (WSN)

A wireless sensor network consists of an area populated with distributed autonomous devices equipped with sensors to measure physical or environmental constants, such as temperature, pressure, vibrations and emissions. WSN are suitable for a great variety of environments and conditions, which broadens the scale of their applications.

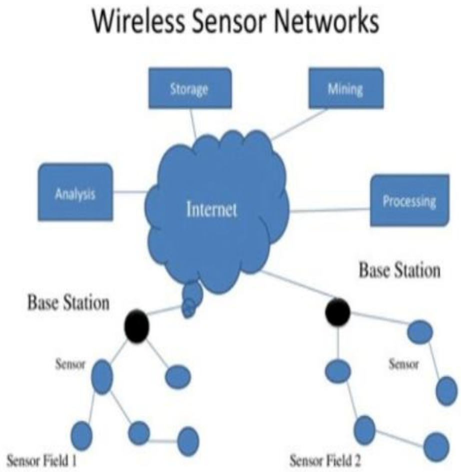

Figure no:3 Wireless Sensor Networks

In LoRa based Smart Irrigation System many nodes are used. The node consists of sensors. So, this is called as Wireless Sensor Networks. The Wireless Sensor Networks as shown in figure3.

V. Sensor Node Architecture

Sensor node is the basic block of a WSN. It is composed of a transceiver, sensor (s), external memory and power source. The function of each node is to collect specified data and send it to the base station unit. In the irrigation field, the sensors are used to monitor temperature (soil/air), humidity, wind speed, water level, and barometric pressure, level of carbon dioxide (co) gasses, soil moisture and soil acidity «ph».LoRa based Smart Irrigation System consists of many nodes and the node architecture is called as sensor node architecture. The sensor node architecture as shown in figure4

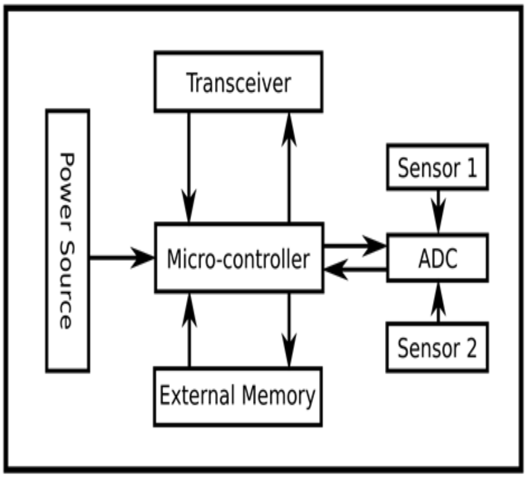

Figure no: 4 Sensor Node Architecture

VI. Result and Discussion

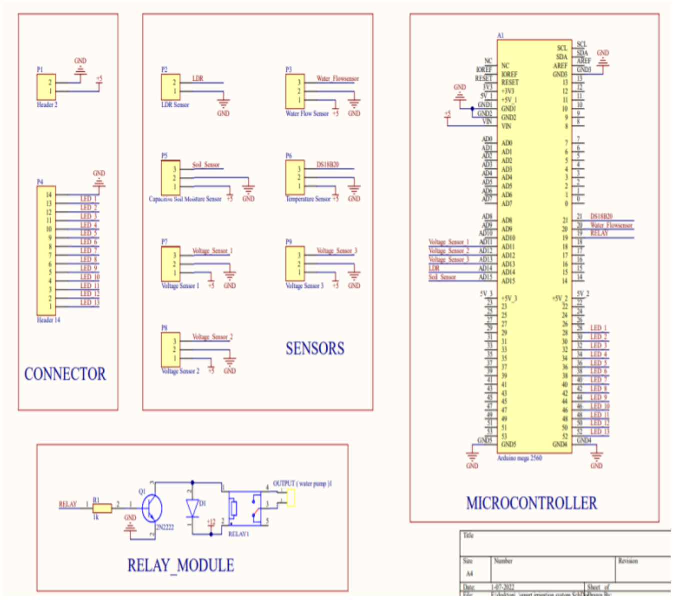

Figure no:5 schematic of lora based smart irrigation system

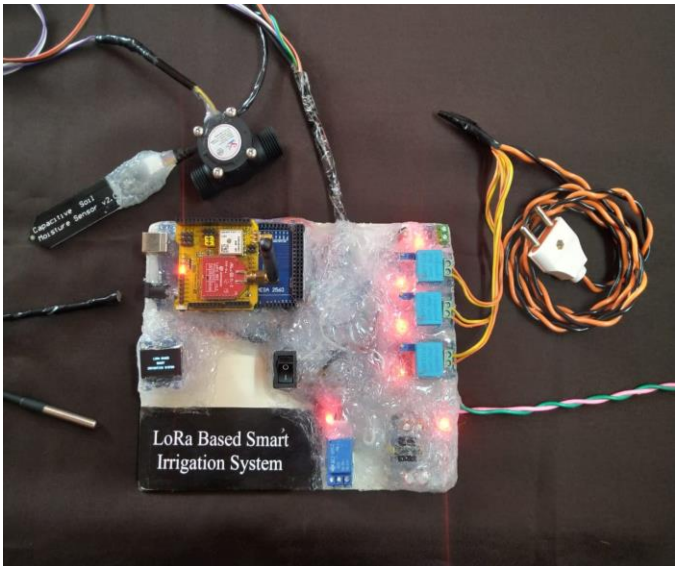

Figure no:6 Hardware Snapshot of LoRa Based Smart Irrigation

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COM4

*************** FIREBASE RECIVED DATA*******************

REALY_ONOFF          : MOTOR_OF
SOIL_MOISTURE_MIN    : 20
SOIL_MOISTURE_MAX    : 80
BRIGHTNESS_MIN       : 20
BRIGHTNESS_MAX       : 99
SOIL_TEMP_MIN        : 25
SOIL_TEMP_MAX        : 40
WATER_USAGE_MIN      : 0
WATER_USAGE_MAX      : 90
PHASE1_VOLT_MIN      : 210
PHASE1_VOLT_MAX      : 240
PHASE2_VOLT_MIN      : 210
PHASE2_VOLT_MAX      : 240
PHASE3_VOLT_MIN      : 210
PHASE3_VOLT_MAX      : 240
CURRENT_RATE_MIN     : 0
CURRENT_RATE_MAX     : 10
RSSI : -38
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Figure no:7 LoRa node Serial monitor output

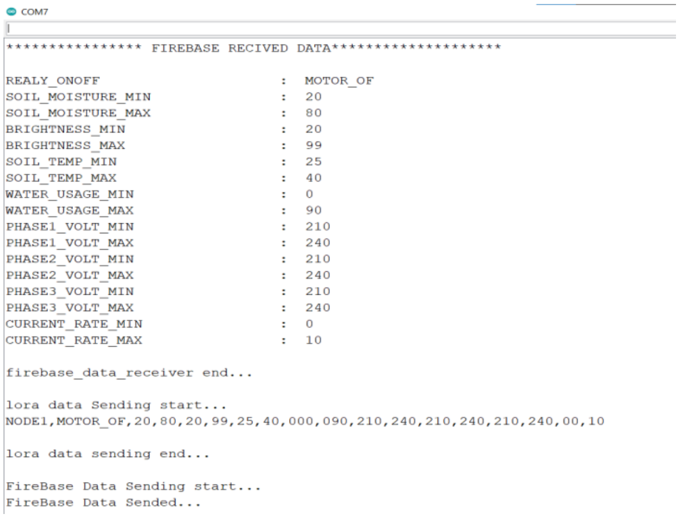

Figure no:8 LoRa Master Serial monitor output

Soil moisture sensor, light sensor, Soil temperature sensor, Water flow sensor, current sensor and Voltage sensor were interfaced with Arduino and all the data were seen through serial monitor as shown in figure 7.

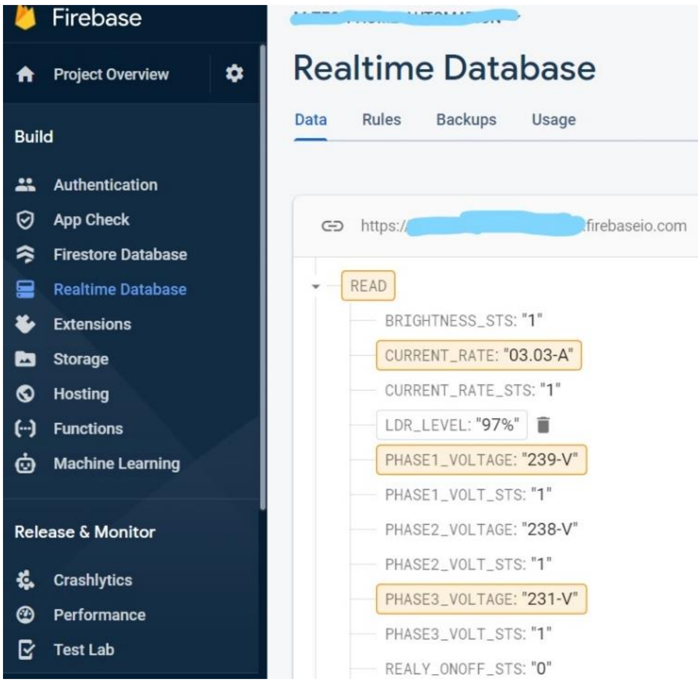

Figure no:9 Firebase real time database output

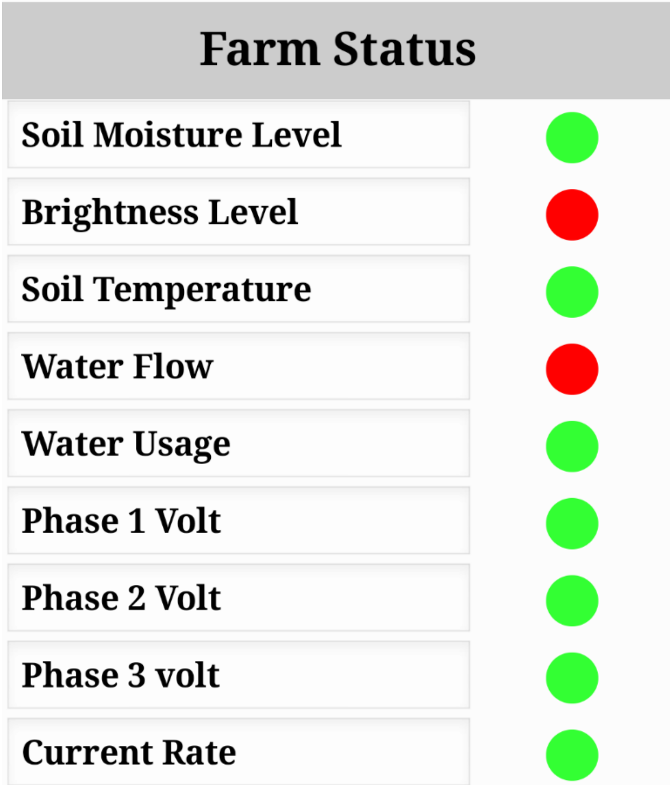

Figure no:10 sensor reading data status (application output)

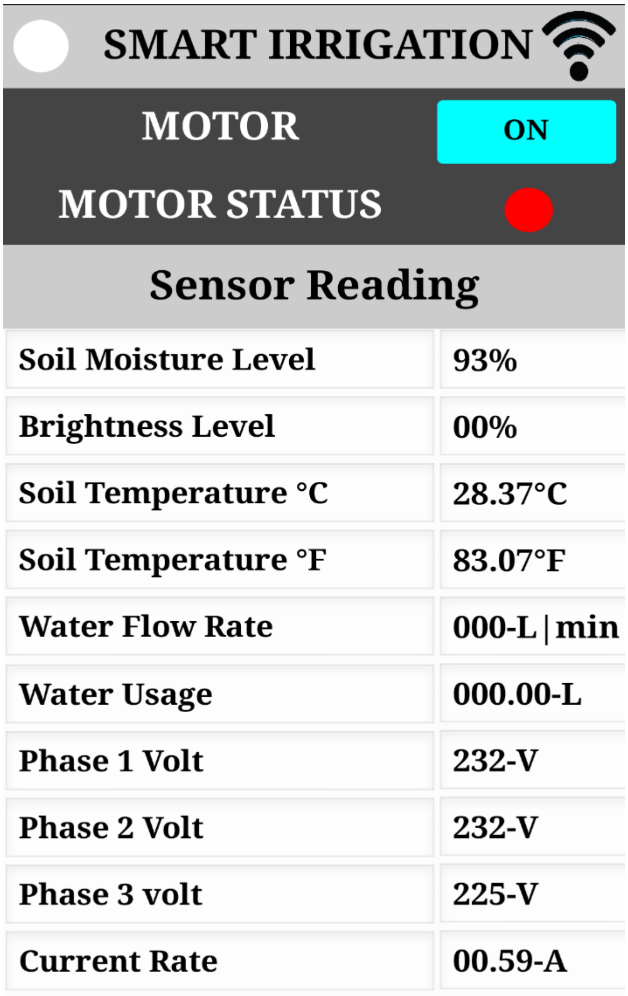

Figure no:11 sensor reading(application output)

Table 1: Real time output

PARAMETERS	MOTOR ON CONDITION-1	MOTOR ON CONDITION-2
Soil moisture level	94%	93%
Brightness level	83%	0
Soil temperature in celcius	28.94 °C	28.37 °C
Soil temperature in Fahrenheit	84.09 °F	83.07 °F
Water usage	0L	0L
Phase 1 volt	231-V	232-V

Phase 2 volt	231-V	232-V
Phase 3 volt	224-V	225-V
Current rate	0.74-A	0.59-A

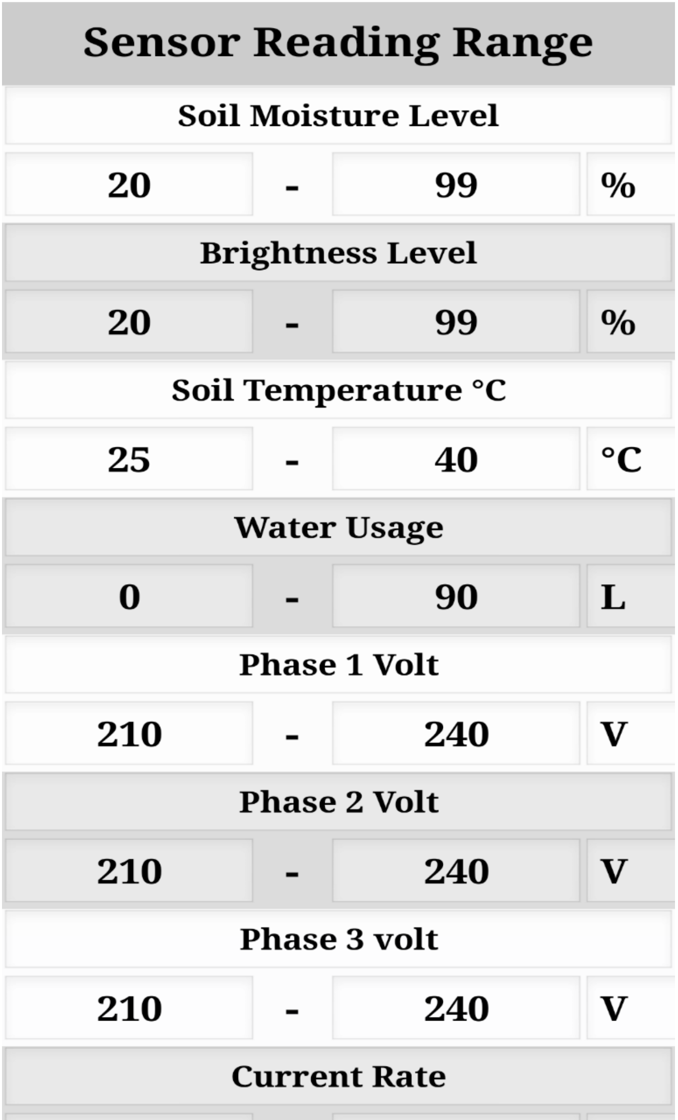

Figure no:12 Farm field sensor reading range (application output)

All the sensors are placed in thefarmingland where soil moisture sensor and soil temperature sensorplaced inside the sand, light sensor is placed where the sunlight is focused, water flowsensor is connected to water pump outlet, parallelly 3 phase voltage sensor are connected to water pump and serially current sensor are connected to water pump.

- The capacitive soil moisture sensor is single wireAnalog sensor and the output ADC value range from 230 to 600, based on the ADC value the soil moisture level is calibrated,since it is connected to analog pin in Arduino mega.
- The **DS18B20**temperature sensor is single wire Digital Sensor and it reports degrees in Celsius with 9 to 12-bit precision, from -55 to 125
- The LDR sensor is single wire Analog sensor and the output ADC value range from 200 to 1000, based on the ADC value the brightness level is calibrated, since it is connected to analog pin in Arduino mega.
- The **ZMPT101B**single phase AC voltage sensor is single wire Analog sensor and it measure 50V to 150V AC voltage, in our project there are 3 voltage is used to detect the 3 phase voltage, since it is connected to analog pin in Arduino mega.
- Based on the soil moistureand temperature levelwater pump will turn on or off. For example, if the soil temperature level reach above 90°Cwhile thesoil moisture level is below 10 percentage and the light brightness level is above 30 percent, then it check whether the voltage is 3 phase voltage, only if the voltage is 3 phase voltage the water pump will be turned on. Similarly if the soil temperature level reach below20°C while the soil moisture level is above80 percentage the water pump will turned off and also if the phase voltage suddenly dropped or the brightness level is below 30 percent the water pump will be turned off (protection purpose).
- After the water pump is turned on the controller start to sense the water flow if the water flow is above 1L/min the water pump will be stay at on condition otherwise it wait for 3 minutes, if still the flow is 0L/min the water pump will automatically turned off.
- All the above process are monitoring through the OLED display or application server.
- The threshold value of the soil temperature level, soil moisture level, phase voltage level, water flow waiting time and brightness level, theses all are configurable through the application server.

The LoRa based Smart Irrigation System consists of capacitive soil moisture sensor, Temperature sensor, Voltage sensor, Water flow sensor and LDR. All sensors are working perfectly and the serial monitor output will be shown as in figure7. When the soil moisture level goes below the threshold value the water pump will automatically turn on only during day time. The day time will be determined by LDR It will automatically turn off when the soil moisture level and temperature level sensor reaches above threshold value.During the motor on condition ,if the sun sets the motor will automatically turn off because in night time the photosynthesis will not take place in plants. We can set the voltage level for water pump, based on that either the motor will turn on or off . For example if we set three phase voltage only if the detected voltage is three phase the motor will turn on. If suppose the voltage level suddenly decreases the motor will turn off and the voltage sudden increases the motor will turn off. So that this project have low voltage protection and over voltage protection and also have over current protection and dry run protection. The voltage was detected by voltage sensor and current was detected by current sensor.

VII. Conclusion

The LoRa based Smart Irrigation System consists of Capacitive soil moisture sensor, Temperature sensor, Light sensor, Water flow sensor andVoltage sensor. All sensors are working perfectly and the serial monitor output will be shown as in figure4.2. When the soil moisture level goes below the threshold value the water pump will automatically turn on only during day time. The day time will be determined by LDR It will automatically turn off when the soil moisture level and temperature level sensor reach above threshold value. During the motor on condition, if the sun sets the motor will automatically turn off because in night time the photosynthesis will not take place in plants. We can set the voltage level for water pump, based on that either the motor will turn on or off. For example, if we set three phase voltage only if the detected voltage is three phase the motor will turn on. If suppose the voltage level suddenly decreases the motor will turn off and the voltage sudden increases the motor will turn off. So that this project has low voltage protection, over voltage protection and also have over current protection and dry run protection. The voltage was detected by voltage sensor and current was detected by current sensor.

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