IoT based Smart Irrigation System by using ESP32 and Adafruit IO

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Abstract

In India, agriculture has a prominent role and most of the farmers are using the traditional methods in farming. Due to the latest advancements in the technology, the agriculture sector is progressing to witness a drastic change in the near future. The Internet of Things (IoT) is one particular technological area which can help the farming community in numerous ways. The IoT can be utilized at various stages in agriculture starting from ploughing the field to selling the final agricultural produce in the market. This paper proposes a low cost method of smart irrigation by using ESP 32 microcontroller and Adafruit IO.

Keywords

Agriculture, ESP32, Adafruit IO, MQTT, Feeds, Dashboards.

1. Introduction

The agriculture sector is witnessing a drastic change throughout the world in recent times due to the advancements in the technology. The technologies like Internet of Things (IoT), Artificial Intelligence, Machine Learning, Big Data, etc., are providing many technological solutions for the agriculture sector. This paper is primarily focused on the implementation of "Internet of Things based smart irrigation system by using ESP32 and Adafruit IO". "The Internet of Things is the network of internet-connected devices which sends and receives data without manual intervention". As compared to the traditional methods, the implementation of IoT technology can bring many developments in the agricultural domain. The usage of IoT technology can simplify the tasks involved in the agriculture. The IoT along with Artificial Intelligence, Machine Learning, Big Data can bring tremendous changes by providing many simplified solutions in the agricultural domain.

2. Proposed methodology

The proposed model as shown in Figure 1 is built by using ESP32 microcontroller, light dependent resistor, thermistor, soil moisture sensor, DC water pump and Adafruit IO cloud platform.

ESP32 microcontroller is released by Espressif Systems. It is a new variant microcontroller after the ESP8266 with advanced features. It is a series of low priced, low-power system on chip microcontroller with features of inbuilt Wi-Fi and Bluetooth in dual-mode. It is programmed by using Arduino Integrated Development Environment.

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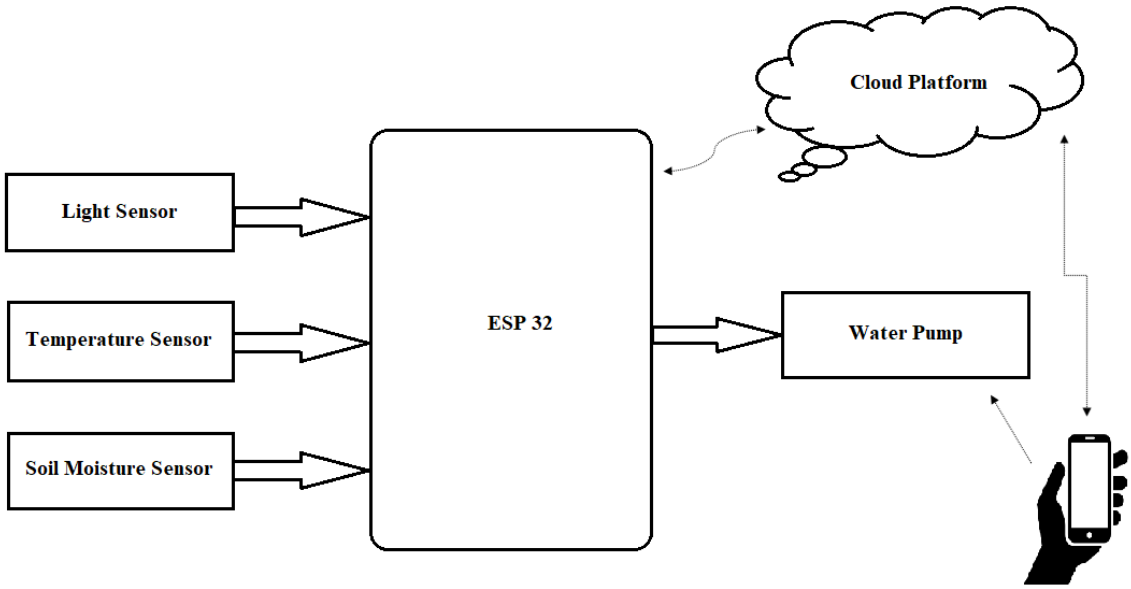

Figure 1: Block diagram of the proposed methodology

The light sensor used in this proposed architecture is a “Light Dependent Resistor”, popularly called as LDR. The working principle of LDR is based on photo conductivity. It’s resistance decreases whenever the light falls on it and the resistance increases in the dark.

The temperature sensor is an electronic component which measures the temperature of its surroundings. There are mainly four types of temperature sensors; thermocouples, thermistors, resistive temperature detectors (RTD) and thermostats. “NTC (Negative Temperature Coefficient) Thermistor” is employed in this proposed architecture. Basically, NTC is a type of Thermistor that reacts directly to even a few temperature changes. It presents a great resistance at low temperatures. As the temperature increases, the resistance starts to drop immediately. They work in the range of -50 to 250^{o}C.

The “soil moisture sensor” is a sensor that is used to find out the water content in the soil. It contains two leads which are to be inserted into the soil to measure the water content in the soil. The moisture content in the soil is feed as input to the ESP32 microcontroller which inturn takes the appropriate action as per the programmed values for auto irrigation.

The “water pump” used is a DC mini submersible centrifugal pump. A motor is used for powering the impeller which is basically designed for rotating and pushing the water outside. The motor is enclosed closely to the body of water pump in a sealed waterproof structure. It operates on 3-6V power supply and is available at a low price and small size. It pumps upto the capacity of 120 liters per hour and consumes a very low current of 220mA.

Adafruit IO is a cloud platform designed to display, respond and interact with the projects data. It acts as a MQTT broker. It supports MQTT protocol; “Message Queue Telemetry Transport protocol (MQTT) is basically a light weighted protocol used for device communication”. Using the MQTT library, users will be able to publish to the feeds as well as subscribe to the feeds; and at the same time they can send the data to the feeds or receive the data from the feeds.

The functionality of Adafruit MQTT Broker is shown if Figure 2. The real time values sensed by LDR, thermistor and soil moisture sensor will be published as per the pre-programmed time intervals to the Adafruit MQTT broker. The MQTT broker publishes these values to the subscribed clients which are basically any subscribed devices like smart phones or computers. The subscribed clients can monitor the values published by the broker. The DC water pump is pre-programmed to auto-irrigate the field as per the given limits of the soil moisture given at the source code and it can also be controlled from Adafruit IO through an ON/OFF switch mechanism provided in the dashboard.

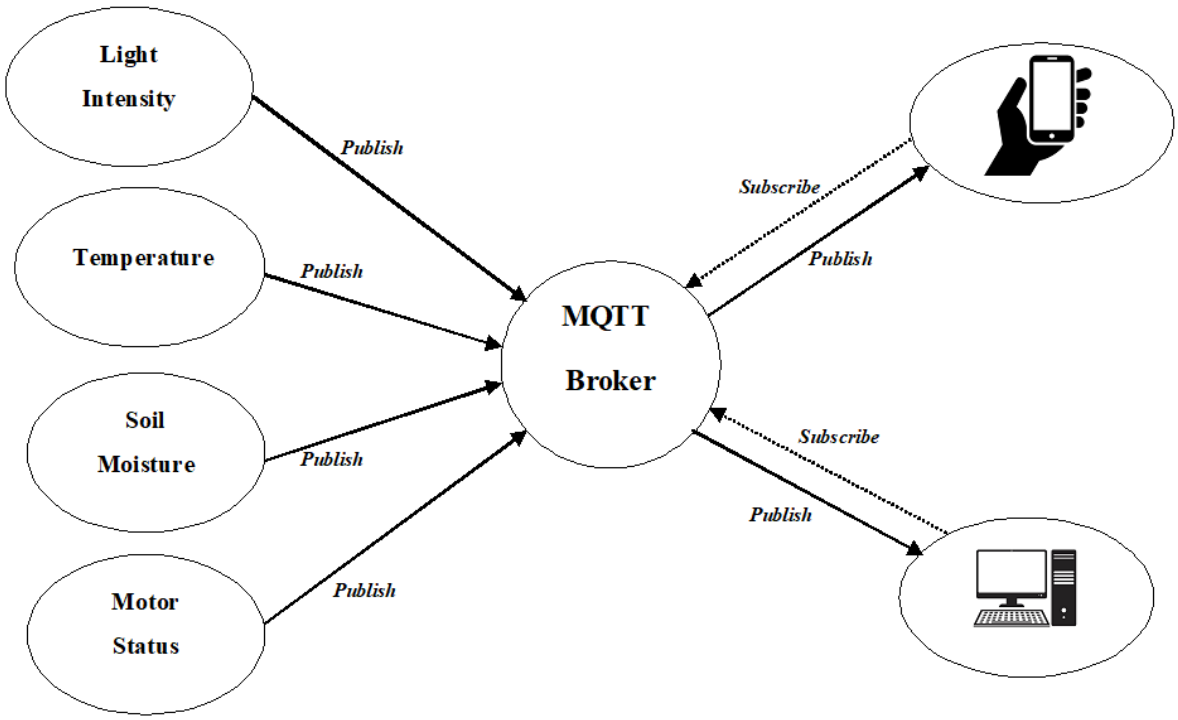

Figure 2: Functionality of MQTT broker

3. Experimental results

The experimental set-up is done on a breadboard by connecting the ESP32 to the computer and local Wi-Fi network.

Table 1
Tabular data of real time sensed data in Adafruit IO feeds

Date and Time	Light Percentage	Soil Moisture Percentage	Temperature in °C	Motor	Motor Status
2021/05/29 8:21:56PM	56	64.28	38.13	0	0
2021/05/29 8:21:36PM	54	60.5	38.16	0	0
2021/05/29 8:21:15PM	54	64.43	39.65	0	0
2021/05/29 8:20:55PM	54	64.5	39.81	0	0
2021/05/29 8:20:33PM	54	64.58	40.04	0	0
2021/05/29 8:20:13PM	54	65.23	40.45	0	0
2021/05/29 8:19:52PM	54	64.58	40.92	0	0
2021/05/29 8:19:32PM	54	64.77	40.92	0	0
2021/05/29 8:19:11PM	54	64.45	40.99	0	0

The accurate results as per the prevailing environmental conditions related to light intensity, soil moisture percentage and temperature are published in the individual feeds of Adafruit IO as shown in the summary of Table 1. The feeds data is displayed in the dashboards of Adafruit IO and at the same time, the dashboards data can also be monitored by using the subscribed smartphones or computers from any location through Adafruit MQTT. The Motor turns ON and OFF automatically as per the pre-programmed threshold value based on soil moisture percentage in the source code. Similarly, the motor can also be controlled from the Adafruit IO dashboard by using the subscribed smart phone or a computer. The results obtained are satisfactory as per the prevailing environmental conditions at the time of experiment.

"IoT based Smart Irrigation System by using ESP32 and Adafruit IO" is more advantageous as compared to other developed systems as it can be implemented at low cost. This system can further be implemented by integrating with Raspberry Pi and can be deployed to monitor larger cultivativable areas.

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5. References

There are various methods proposed by authors in the area of smart irrigation by using IoT. Each method is based on different hardware and software platforms. [1] This paper proposed the smart irrigation system based on Arduino UNO and a GSM module. [2] The authors proposed the model by using Arduino UNO, ESP8266 along with Thingspeak cloud. [3] Authors presented a detailed survey of the articles from 2015 to 2020 in the field of agricultural IoT. [4] The authors proposed an agricultural monitoring system based on Arduino UNO and ESP8266 for auto irrigation and intrusion detection. [5] The authors illustrated a low cost intelligent module for smart irrigation based on IoT with MQTT and HTTP. [6] Smart agriculture by using IoT is implemented using Arduino Uno, motion sensor and an android application. [7] The authors presented a model by machine learning along with open source technologies by using Raspberry Pi and Arduino UNO. [8] This paper proposed a low priced smart irrigation system. ESP8266 along with an ultrasonic sensor are used to detect the water level in the tank. The results are monitored in a mobile application by MQTT. [9] This paper proposed a model for smart irrigation along with nutrient detection and disease analysis by using Raspberry Pi and MATLAB. [10] Smart irrigation monitoring and controlling by using IOT is proposed by employing the ATMEGA 328 microcontroller and an android application. [11] A mobile controlled smart irrigation by using Rasperry Pi has been proposed and is implemented by bluetooth technology to control the system by using android application in smart phone.

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