Arduino-Based Smart Irrigation Using Water Flow Sensor, Soil Moisture Sensor, Temperature Sensor and ESP8266 WiFi Module

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***Abstract*—Emergence of Controlled Environment Agriculture (CEA) ranging from computer controlled water irrigation system to lightning and ventilation has changed the conventional scenario of farming.**
This paper proposes and demonstrate an economical and easy to use arduino based controlled irrigation system. The designed system deals with various environmental factors such as moisture, temperature and amount of water required by the crops using sensors like water flow sensor, temperature sensor and soil moisture sensor. Datas are collected and received by arduino which can be linked to an interactive website which show the real time values along with the standard values of different factor required by a crop. This allows user to control irrigation pumps and sprinklers from far distance through a website and to meet the standard values which would help the farmer to yield maximum and quality crops. Studies conducted on laboratory prototype suggested the designed system to be applicable which can be implemented.

I. Introduction

The evolution of information technology has opened door to many impossibilities. Over years, our cell phones, tablets, automobiles, the rise of "smart" technology have consumed the market and have become the new standard in the industries. Smart irrigation is one such technology which have attracted interest of many researchers and is evolving and improving from about a decade.This smart irrigation industry where water waste is minimised and is no longer sustainable socially, economically and conventionally as well. The idea and development of smart irrigation is basically focused onto reduce human efforts as well as reduce resources (water) and power consumption (electricity). Insatiable appetite for convenience and comfort and also to overcome natural barriers, there is a constant pull on technology to develop more and more. On the other hand growing demands for food due to population expansion put farmers to face many issues regarding the quantity and quality of crops which infact made another challenge on researchers to develop and approach a fine smart irrigation system that would provide farmer a smart tool which support them in yielding quality crops.
Although smart irrigation has developed but so far no solution is obtained to measure accurate flow of water along with availability of datas over website which could be fetched from anywhere in the world. Hence our prime move throughout the project work have been to design an irrigation system which provide all the above features along with conventional features available in smart irrigation such as measuring moisture profile of the field in order to prevent crops from water logging issues, temperature sensing is done so that one can check the temperature of the surrounding because crops are temperature sensitive too. The calculation are done by using different sensors. Further another advantage of the designed irrigation system is that it would keep the farmer up to date and also aware before any adverse situation come in. Thus helping the farmer to have control on the field 24x7.

II. SMART IRRIGATION SYSTEM

Irrigation is the artificial way of watering crops in fields. In the present era, water scarcity due to over exploitation have resulted the urge of developing a new technology that could save water from being wasted and since, agriculture is the most water consuming occupation, hence making irrigation system smart would be a smarter way of checking water loss. Smart irrigation system is an effective and efficient way of watering fields. It monitors weather, soil conditions, evaporation and plant water use and automatically adjusts watering schedule.Hence approaching smart irrigation system has become a prime concern to give farmer a smart tool which would support them in yielding quality crops
Since India is an agro based country and around 61% of total land in india is responsible to feed around 1.3 billion population. India occupies second rank in rice export and as rice crop require huge amount of water for irrigation purpose, hence smart irrigation has immense importance in India.
In smart irrigation project we use different types of sensor to make a farmer up to date about the field. Sensors used are - soil moisture sensor, water flow sensor and temperature sensor(ds18b20) like a sensor which can calculate the amount of water used in the field, a soil moisture sensor which can calculate the moisture profile of the field in order to prevent crops from water logging issues and a temperature

sensing sensor so that one can check the temperature of the crops because crops are temperature sensitive too and if the smart system awares the farmer before then farmer can use sprinklers in order to cool down temperature of the crops it would save both crop and farmer. our approach is to make this system accessible from even far distance so that farmer have the information and control on the field 24x7 throughout a year. the whole setup is controlled by an arduino which is a microcontroller and the data is sent and received by a wifi module i.e ESP8266.

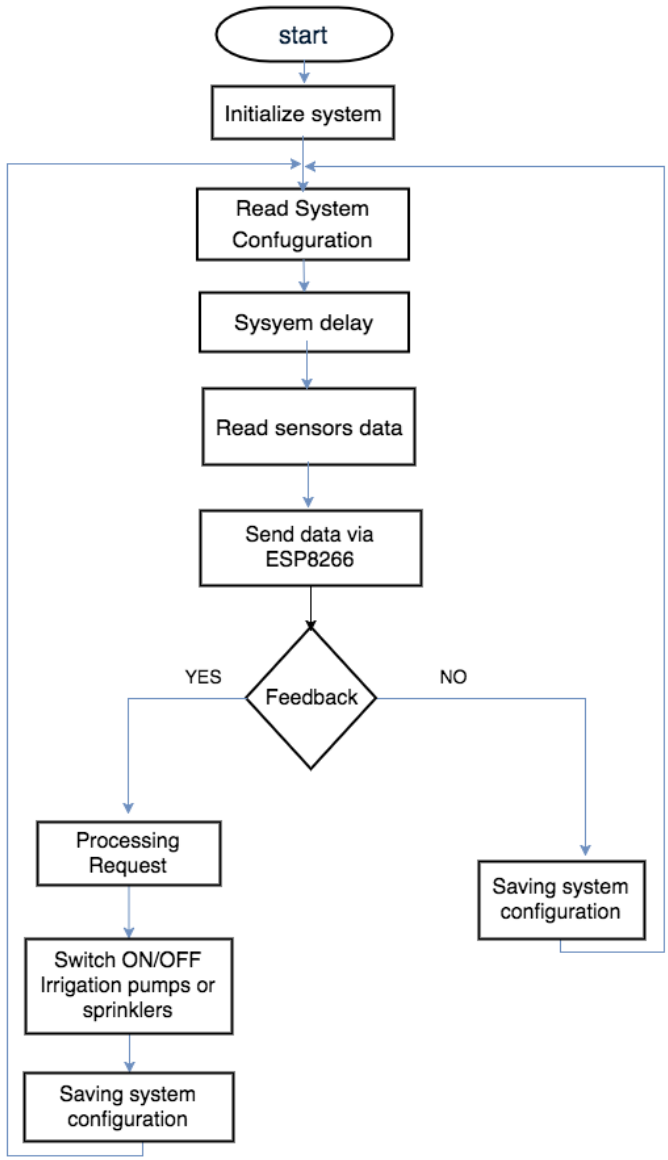


Fig. 1. Flow Chart of Smart Irrigation using ESP8266.

III. WORKING OF ARDUINO-BASED SMART IRRIGATION SYSTEM

The main part of the system is Arduino micro-controller[1]-[4]. Arduino is an open source electronics platform accompanied with a hardware and software to design, develop and test complex electronics prototype and products. To communicate with user over a website, a server is required which can send and receive data from micro-controller to user and vice-versa. In order to achieve a desired output, a correct algorithm is required.
The algorithm consist of the following steps:
Step 1: Power ON the system which includes the micro-controller, sensors and other peripherals.
Step 2: Initialise the system, which consists of sensors, wifi module and User Interface.
Step 3: Read the system configuration file which means to read the instructions from the configuration file and the system operation according to the configuration file.
Step 4: Read data from the sensors and analyse data to check whether it is require to alert the user or continue monitoring.
Step 5: Send the data to the user upon request using ESP8266 and wait for the feedback from the user.
Step 6: If feedback is YES then check the state of irrigation pumps and sprinklers, toggle the state and save the current state in system configuration file.

User can send different commands to choose between sprinklers and irrigation pumps.
The sensors which are using in this prototype are as follows:

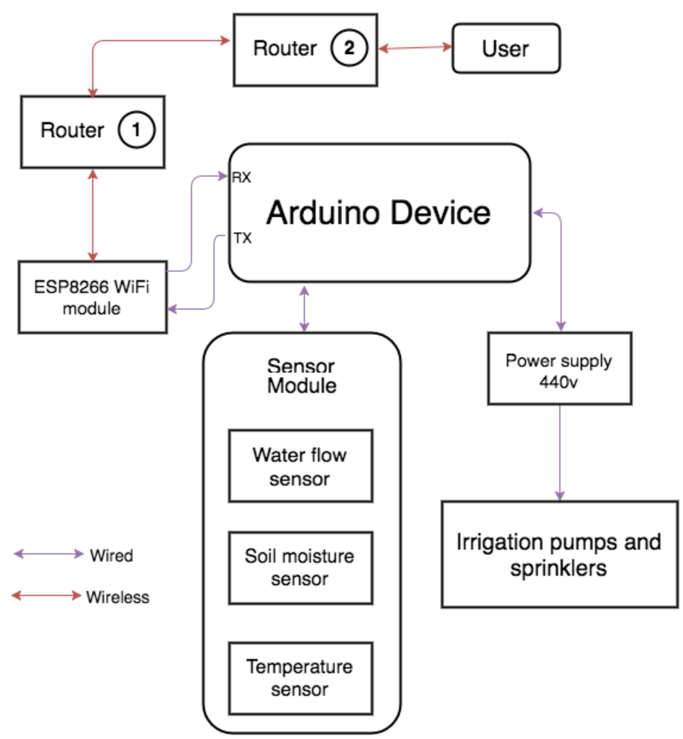
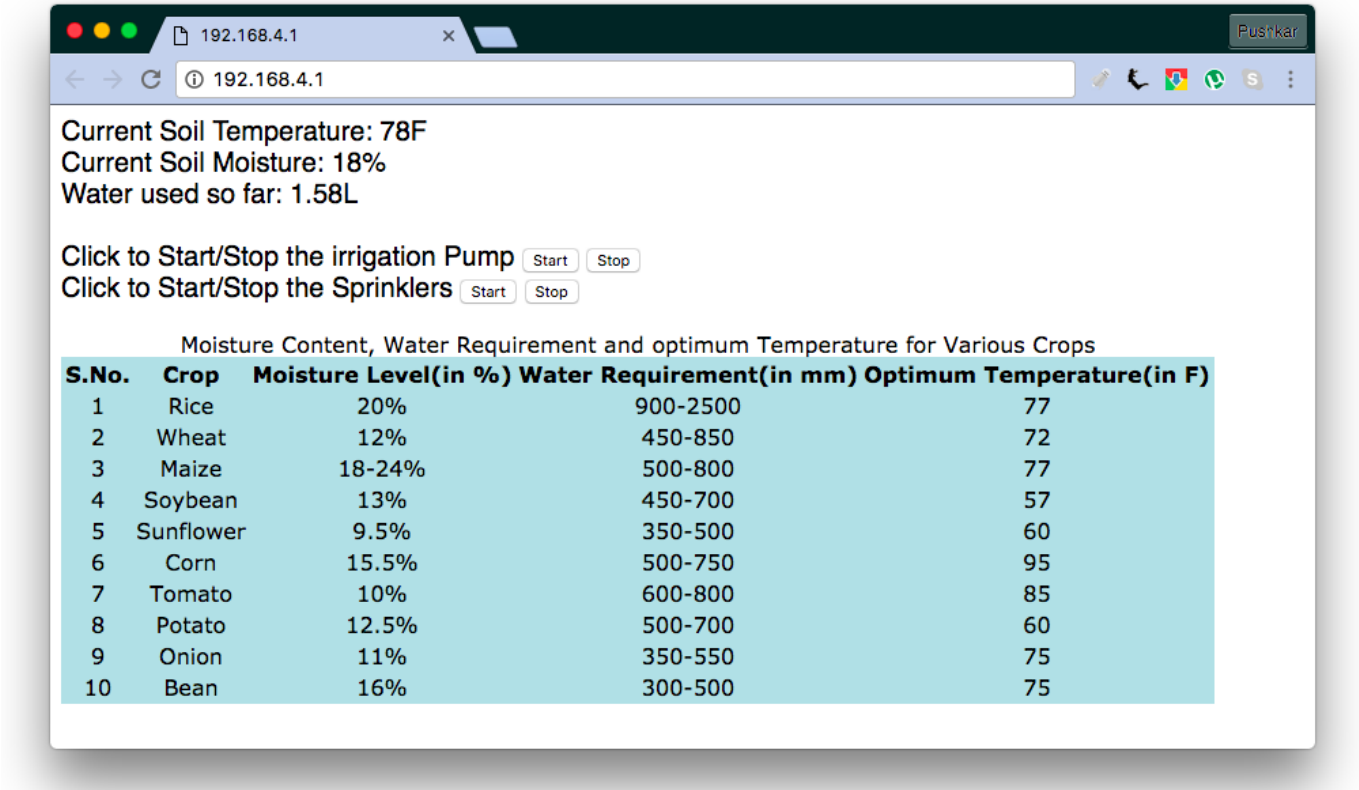


Fig. 2. The Structure of smart irrigation using ESP8266.

A. Water Flow Sensor

This sensor uses a pinwheel sensor to measure how much liquid has moved through it. The pinwheel has a little magnet



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Current Soil Temperature: 78F
Current Soil Moisture: 18%
Water used so far: 1.58L

Click to Start/Stop the irrigation Pump Start Stop
Click to Start/Stop the Sprinklers Start Stop

Moisture Content, Water Requirement and optimum Temperature for Various Crops

S.No.	Crop	Moisture Level(in %)	Water Requirement(in mm)	Optimum Temperature(in F)
1	Rice	20%	900-2500	77
2	Wheat	12%	450-850	72
3	Maize	18-24%	500-800	77
4	Soybean	13%	450-700	57
5	Sunflower	9.5%	350-500	60
6	Corn	15.5%	500-750	95
7	Tomato	10%	600-800	85
8	Potato	12.5%	500-700	60
9	Onion	11%	350-550	75
10	Bean	16%	300-500	75

Fig. 3. A webpage screen with the sensor data and controls

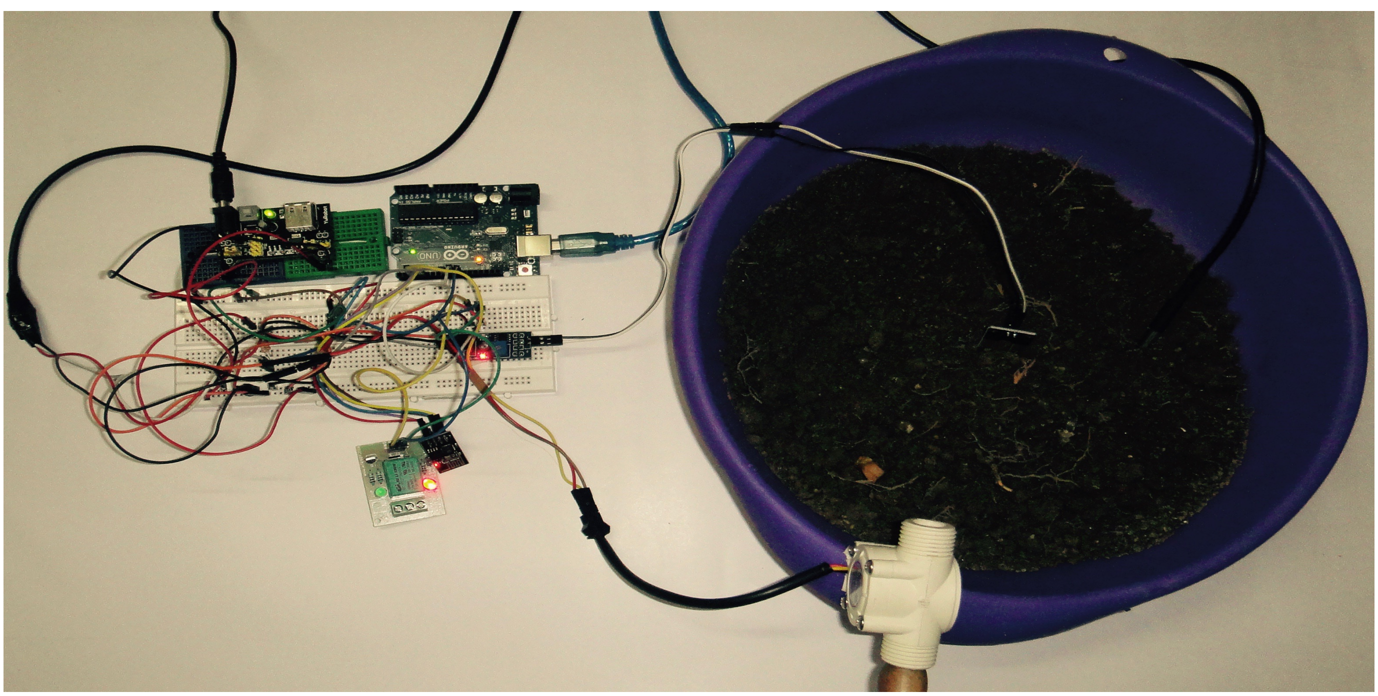

Fig. 4. The prototype control system of smart irrigation.

attached, and there's a hall effect magnetic sensor on the other side of the plastic tube that can measure how many spins the pinwheel has made through the plastic wall. This method allows the sensor to stay safe and dry.
By counting the pulses from the output of the sensor, we can easily track fluid movement: each pulse is approximately 2.25 milliliters.

B. Soil Moisture sensor

The Soil Moisture Sensor uses capacitance to measure dielectric permittivity of the surrounding medium. In soil, dielectric permittivity is a function of the water content. The sensor creates a voltage proportional to the dielectric permittivity, and therefore the water content of the soil. The sensor averages the water content over the entire length of the sensor.

C. Temperature Sensor(DS18B20)

The core functionality of the DS18B20 is its direct-to-digital temperature sensor. The resolution of the temperature sensor is user-configurable to 9, 10, 11, or 12 bits, corresponding to increments of 0.5C, 0.25C, 0.125C, and 0.0625C, respectively. The DS18B20 powers up in a low power idle state. To initiate a temperature measurement and A-to-D conversion, the master must issue a Convert T command.The resulting thermal data is stored in the 2-byte temperature register in the scratchpad memory and the DS18B20 returns to its idle state. If the DS18B20 is powered by an external supply, the master can issue (read time slots) after the Convert T command and the DS18B20 will respond by transmitting 0 while the temperature conversion is in progress and 1 when the conversion is done.

IV. EXPERIMENTAL PROTOTYPE

The feasibility and design of the proposed arduino based smart irrigation system using ESP8266 wifi module was tested using a prototype fabricated in a laboratory. We used every device which shown in figure 3 except for the irrigation pump and sprinklers. The main component in the prototype next to arduino is the ESP8266 WiFi module which allow us to send and receive data over a website. ESP8266 basically works on AT commands. For experimental purpose we use ESP8266 in a Local Area Network(LAN) [5][6] mode but for actual use ESP8266 can be reconnected to a router which allow us to access the data from anywhere in the world over the internet[7]-[9]. We use AT commands in a setup function so that whenever user turn on the arduino, AT commands runs automatically and make the ESP8266 ready to transfer data. The one and only problem that we face while working on the prototype is with ESP8266, it is its data sending capacity which restrict us to send data of only 64 character in one string and we resolved this by sending data in the form of various small strings instead of sending it in a single string, furthermore the prototype works fine and provide real time readings of various sensors with a single click, on the basis or readings user can decide to turn the irrigation pumps and sprinklers ON or OFF which can be done by clicking on respective buttons which a ESP8266 can detect and toggle the state of relays corresponding to the irrigation pump and sprinkler. We used only one relay for experimental purpose which can be increase or decrease as per the requirement of user[10]. The controlling system consume very low energy which allows system to work continuously for several months on a single 9 V battery.

V. CONCLUSION

The Arduino-based communication agent has been devised taking into account the ease of implementation, operation, maintenance and cost.The device is completely automatic and reliable. The website communication allows user to communicate with sensors from a long distance in no time which make the user more productive. The whole system is based on arduino which is a low cost micro controller, this system can be implemented over a large area for a comparatively minor investment.

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