

# TESTBED IMPLEMENTATION TOWARDS IoT BASED SMART FARMING

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**Abstract:** *In the present scenario of agriculture, production of crop has become a great challenge in places with scarce resources. Hence a data driven approach using Internet of Things to determine the volume of water required for irrigation has been taken into consideration. Sensors are implemented all over the crop field to collect the parameters of crop field in real time that are processed remotely to determine the volume of water. Therefore, accurate readings from the sensors in a crop field play an important role to determine the amount of water to irrigate in the field. In this paper the authors have created a testbed to show about the effect of improper placement of sensors in soil can spoil the readings obtained from testbed. In this testbed model a client server model has been prepared using ESP32 that collects soil moisture, temperature and relative humidity over the area and sends it to the central node (server) using ESP-NOW protocol. The field parameters collected from this model have been plotted to show the variation among the field parameters.*

**Key words:** *ESP-NOW, IoT, Precision agriculture, Smart Farming, Sensor*

## 1. INTRODUCTION

Agriculture is the backbone of the Indian economy that not only helps to feed people of the country but also able to export the food grains and agricultural products to the neighbouring countries. With increase in the global population and demands from other sectors, requirement of crop production has received a tremendous attention due to scarcity of resources like arable land and water. Nowadays, to overcome the scarcity of resources, non-arable lands, even in desert areas are getting attention for the cultivation of crops. But traditional farming [1] is unable to utilize the resources properly because traditional farming is conducted by the experience of farmer with all sufficiently available resources. But the challenges [2] the traditional farming faces are the lack of knowledge about utilization of resource during abrupt climatic condition, distance of crop field from home, less monitoring of fields, less knowledge about the amount of water and nutrient requirement by the crop etc. Hence farming techniques are now moving to the data driven approach where the challenges can be minimized by the help of internet of things. Like other sectors, internet of things is gaining its popularity through data driven approach by implementing different types of sensors equipped with wireless communication devices in the field so that, data can be accessed by remote devices, analyzed and necessary command can be issued to the actuators in the field from the remote end. Internet of things based wireless sensor network provide the farmers necessary data [3] e.g., soil temperature, soil moisture, humidity, ambient temperature, nutrient profile etc., all to the remote end which helps the farmer to make necessary decision about irrigation, manuring and pest control.

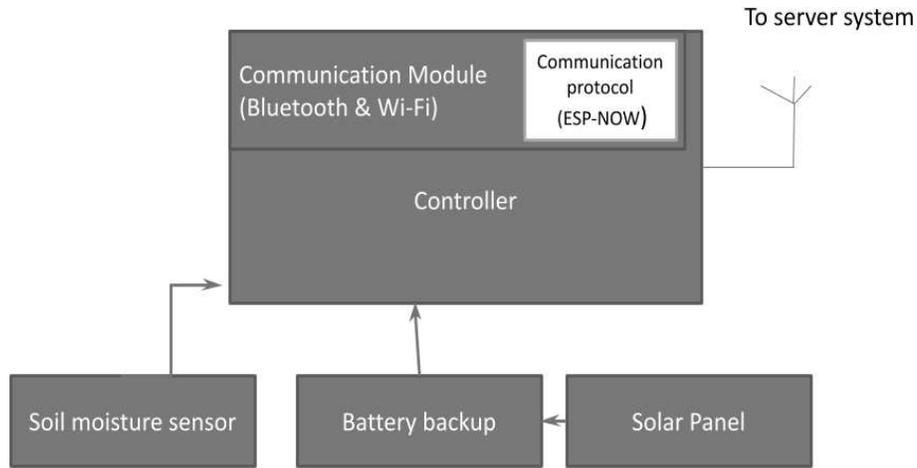
The most obvious benefits is that, the scarce resources are properly utilized without compromising the quality and quantity of the yield. Implantation of climatic condition monitoring at the remote end and use of machine learning algorithms to schedule the irrigation is an added advantage. In this paper a small wireless sensor network has been implemented to acquire environmental data and transmit them to remote end through wireless devices without using internet.

## 2. LITERATURE REVIEW

Precision agriculture paradigm can be broadly arranged into three-layer architecture. The bottom layer is the device layer where sensors are implemented, the middle layer is the data communication layer and the top layer is the data processing and prediction layer. Still now various research works have been done to solve the problems associated with these three layers. But managing the number of resources to be applied over the field at the right time needs more attention. To manage the fundamental requirement of water by plants, data acquisition from the field needs to be precise. Researchers [4] have identified that in the device layer, precision of received data from sensor depends on the environment as well as material characteristics of the sensor. But the cost of the precise sensors plays a bottleneck to the poor farmers to implement costly sensors in the field. Hence prediction of the resource amount becomes erroneous due to lack of precision from low-cost sensors. To predict soil moisture research works have been done by Goap [5] who has proposed a method to predict the irrigation requirements of a field. Environmental conditions, Weather forecast data from the weather station, soil moisture, soil temperature, air temperature, Ultraviolet (UV) light radiation, and relative humidity of the crop field are used as input parameters to determine the next day's soil moisture. This paper proposes an IOT based smart irrigation architecture along with a hybrid machine learning based approach to predict the soil moisture. The proposed algorithm uses real time sensors' data from field, weather forecast data of the recent past to predict the soil moisture of upcoming days. In another paper Fan TongKe [5] have tried to implement sensor networks through IoT to utilize the computational power of cloud computing, together, to build a plant factory for automatic production of crops instead of conventional techniques. This paper concentrates on plant factories based on soilless culture, artificial photosynthesis technology and intelligent irrigation systems. With closed environment control, density of carbon dioxide, humidity of air, wind pressure, temperature and speed of air are monitored for intelligent irrigation control. An agro ecological environment is controlled by monitoring Water quality, accurate fertilization, soil constituent, temperature, irrigation, disease and pest over the field area. Cloud computing forms an abstraction layer between the services available to the user and the hardware or software information required to be delivered on demand among hardware devices over the internet. Cloud computing has made it possible to analyze, compute and create production plans, do mathematical modeling and simulation of production management according to plant groups. In this paper a testbed has been created to receive data using low-cost sensor over wireless network and check applicability.

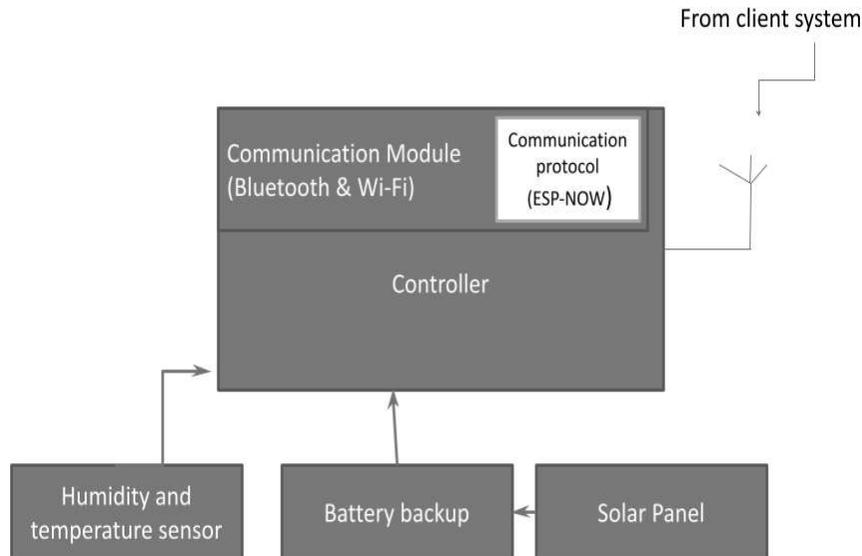
## 3. PROPOSED MODEL

In this section a model has been proposed for the testbed to transmit the data from field without using internet. This section also describes the block diagram of the model along with the flow chart of operation of the model. The proposed model contains two ESP32 development board that contains Wi-Fi and Bluetooth inbuilt connectivity, a resistive soil moisture sensor, solder less bread board, 16x2 LCD display and dht11 temperature and humidity sensor. The client system as shown in Fig. 1 is composed of soil moisture sensor connected with ESP32 controller.



**Figure 1: Client system**

The server system as shown in Fig. 2 is composed of the ESP32 controller. The ESP32 module of client and server uses a ESP-NOW [7] protocol which uses 2.4 GHz frequency and peer to peer communication like Bluetooth. But the benefit is that the distance of communication is quite larger than Bluetooth. The connection is secure and is developed by expressive system [6]. Server relates to a humidity and temperature sensor. This proposed model can be extended from one client to multiple client nodes at different regions and able to communicate with a single server node. In both client and server systems, LCD display is connected which is not shown in the block diagram.



**Figure 2: Server system**

Fig. 3 and Fig. 4 are the circuit diagram for the client and server systems.

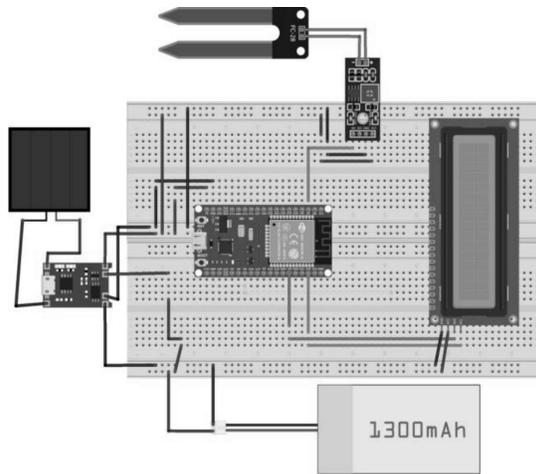


Figure 3: Client system

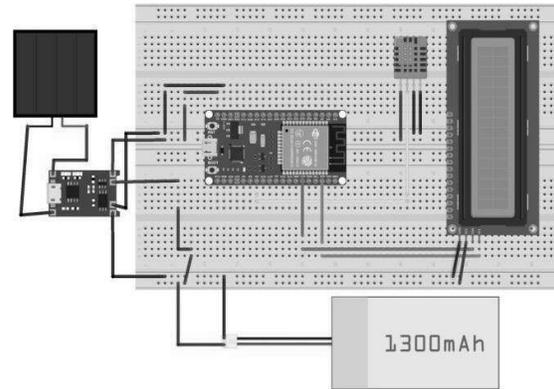


Figure 4: Server system

Fig.5 is the client server algorithm which runs on the client and server system respectively. Fig. 6 provides the hardware model of the prototype.

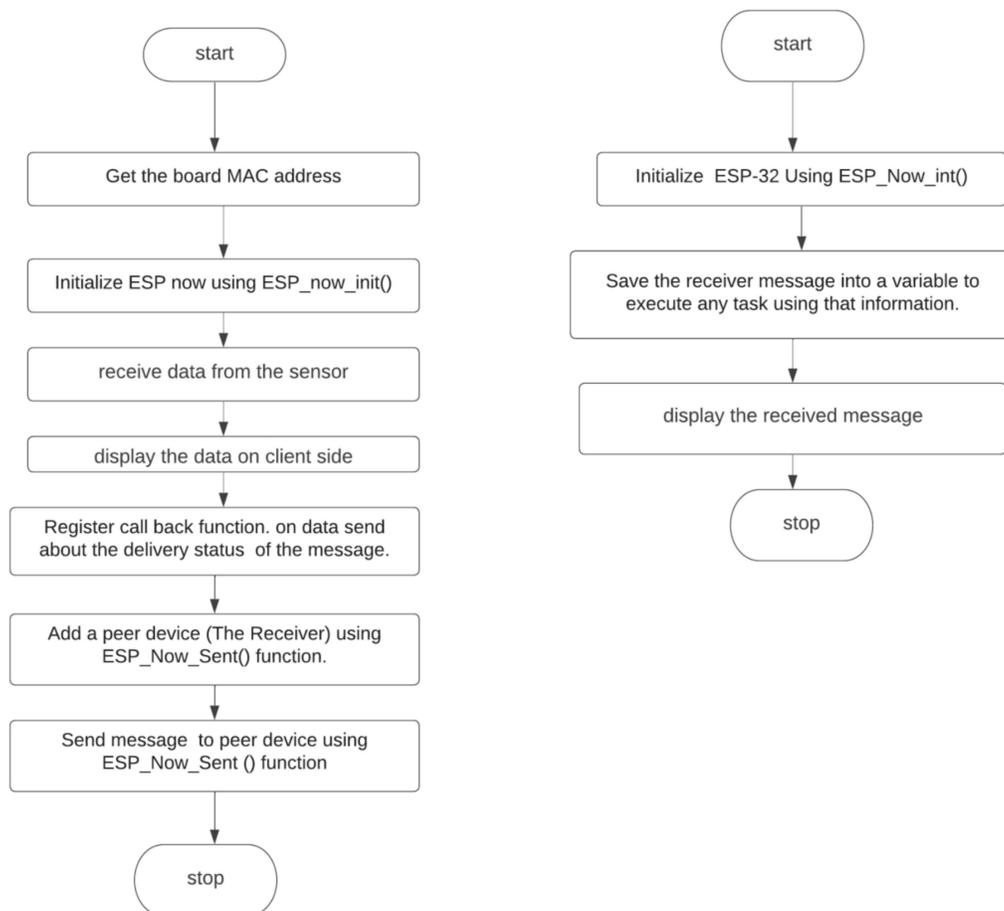


Figure 5: Client- server algorithm

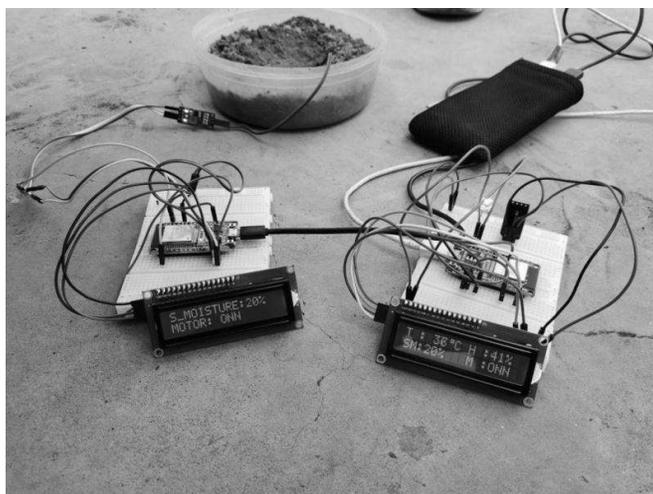


Figure 6: Hardware model of the proposed system

#### 4. RESULT AND DISCUSSION

To do the experiment, the resistive soil moisture sensor has been placed about 1cm below the moist soil whose moisture has been initially sensed as 30% at 1.25 P.M. About 1.5 hours has been spend to take the readings in the month of summer to determine the variation of soil moisture with respect to the temperature and humidity of environment. The following table Table 1. shows the data collected from the field.

Table 1 Field data

Time stamp (pm)	Soil moisture (%)	Temperature (c)	Humidity (%)
1:25	30	36	38
1:27	30	36	36
1:29	30	37	36
1:31	30	36	38
1:33	30	36	38
1:35	30	36	38
1:37	30	38	37
1:39	30	38	34
1:41	30	38	33
1:43	30	38	33
1:45	30	38	33
1:47	30	39	32
1:49	30	38	31

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Time stamp (pm)	Soil moisture (%)	Temperature (c)	Humidity (%)
1:51	30	38	32
1:53	30	37	36
1:55	30	37	36
1:57	30	37	32
1:59	30	37	32
2:01	30	37	35
2:03	30	38	35
2:05	30	37	35
2:07	30	37	36
2:09	30	37	36
2:11	30	37	36
2:13	30	37	36
2:15	30	37	36
2:17	30	37	36
2:19	30	36	38
2:21	30	36	36
2:23	30	36	34
2:25	30	38	33
2:27	30	38	32
2:29	30	38	33
2:31	30	38	29
2:33	30	38	28
2:35	30	39	28
2:37	30	39	28
2:23	30	36	34
2:25	30	38	33
2:27	30	38	32
2:29	30	38	33
2:31	30	38	29
2:33	30	38	28

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Time stamp (pm)	Soil moisture (%)	Temperature (c)	Humidity (%)
2:35	30	39	28
2:37	30	39	28
2:39	30	39	28
2:41	30	39	25
2:43	30	39	25
2:45	30	39	25
2:47	30	39	25
2:49	20	39	26
2:51	20	40	29
2:53	20	40	29
2:55	20	40	28
2:57	20	40	26
2:59	20	40	23

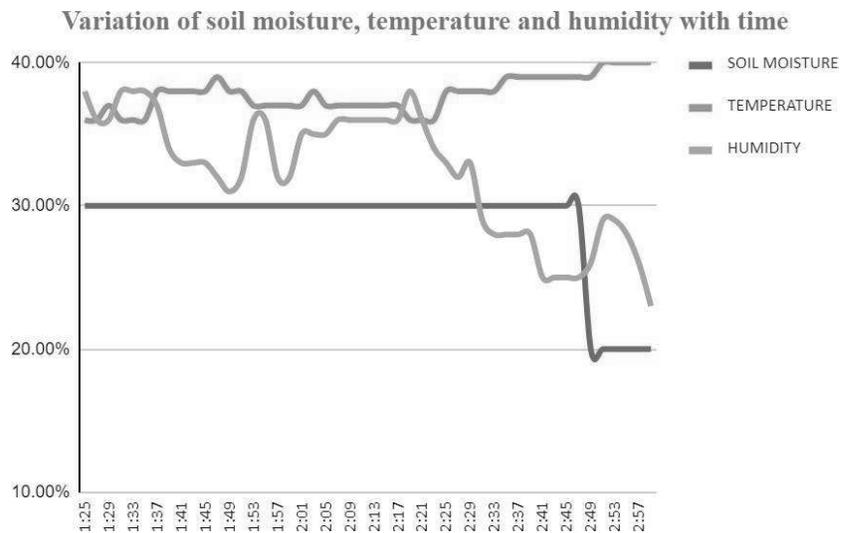


Figure 7: variation of soil moisture, temperature, and humidity with respect to time

From the above Fig. 7, the temperature and humidity values have been plotted along with the soil moisture with respect to time. The time has been taken from 1.25p.m to 3.00p.m. It has been observed from the figure that the soil moisture variation has got very sharp change from 30% to 20% in two minutes which is not normally happen.

## 5. CONCLUSION AND FUTURE SCOPE

From this experiment variation of soil moisture with respect to temperature has been tested. It has been found that the soil moisture decreases with respect to temperature which is an obvious result. But there should be more precise reading from the soil moisture sensor and the drifting of values with respect to temperature from the sensor could result inappropriate values which may cause improper scheduling in the farming management procedures. In the future experiment, better calibration of sensors and compactness of soil required to be investigated to minimize such abrupt changes in the moisture level which may cause inappropriate values in the result.

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