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Automated Smart Irrigation for Indoor Farming Using IoT-Enabled API Integration

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Abstract: *Agriculture contributes to a major share in the Indian economy and most of its people are dependent on it for their livelihood but now a days whether is unpredictable in India therefore farmers are getting loss in farm. Automated Smart Irrigation for Indoor Farming system is presented in this paper that is assisted with an Android application for smart consumption of water, temperature and light in Indoor farming. The proposed system banks on a set of accessible and economical sensors that capture real-time data of plants and environment conditions such as Soil Moisture Level, Light Intensity, temperature, etc. Once the data is collected from sensors on a server, the proposed Automated smart Irrigation indoor farming system processes the data to decide about the watering schedule using IoT approach. Here, IoT approach helps in taking smart decisions with respect to watering requirements, cooling a farm if temperature high and provide necessary amount of light intensity. Once the IoT based system decides the action on the bases of values of the input variables, Automated Smart Irrigation system activates the actuators to take watering actions such as turning water motor, fan, lights ON/OFF in periodical manner. The system uses Android application to keep the user informed about the current crop situation even from a distant location and also control the actuators. User can see live streaming on mobile application. The proposed system is highly efficient and economically feasible. with this, the human intervention can be decreased and an accurate amount of water supply can be provided and optimized use of water.*
Keywords: *Indoor farming; IoT; irrigation;*

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I. Introduction

The current situation of the world demands the urgent need for sustainable food production. Sustainability means the ability to be maintained at a certain growth level. According to recent statistics, the current food production is carried out on deforested lands, smothering crops with toxic pesticides, and killing natural habitat of the wildlife. Urbanization and Population growth further impacts the problem of food production. Furthermore, we must protect the welfare and financial security of farmers because farming is the backbone of country's economic growth. The problem of water scarcity is age old and every year countries are affected due to drought and shortage of water resources. In several parts of the world, Industrial wastes are released in the nearby areas which causes infertility in the soil. The right choice of soil and sufficient supply of water can lead to a healthy growth of plant life. Indoor Farming is a method of growing crops or plants usually on a large scale entirely indoors. It can be further classified based on the choice of growing medium.

Indoor Farming is a great implement to meet the burgeoning demands of the world's food. It not only fulfils the demand for fresh foods but also plays a significant role in producing nutritious foods. Enormous amounts of pesticides are used to protect the crop from pests. As a result, the crops that are being produced every year are not nutritious and toxic-free, so we suffer in malnutrition and chronic disease. We also have to depend on our environment when it comes to food production. Global warming is causing climate change rapidly, which is pernicious for our agriculture. Indoor agriculture is very important for bringing to an end such problems. Advanced technology is being used to make indoor farming more efficient and easier. By using technology, it is very easy to change the rate of food production. These include automatic monitoring of plants, managing adequate light and ventilation. Indoor agriculture has chosen to meet the demand for healthy food in developed countries as well as in developing countries. Several people are doing this as a hobby and many are adopting this method for commercial reasons. They are using their land, roof, or porch for indoor agriculture.

Smart Farming technology is the use of IOT which connects devices such as Arduino with the sensor and performing task such as getting reading from the Arduino software and making decision according to it. It helps to manage the Temperature, Humidity.

The below Fig(1). Depicts that through smart farming concept, we can enhance the software application, communication system, provide solution to data analytics, uses hardware and software system, sensors like Temperature, LDR and Soil moisture sensor. Software application, builds up communication system between the sensors and the user in a form of notification

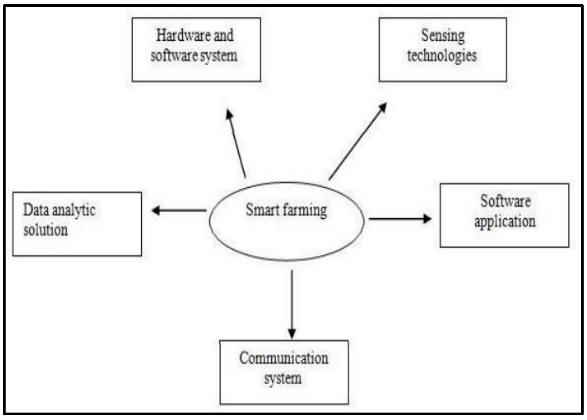


Fig 1 Tools used in Smart Farming

II. Background Study

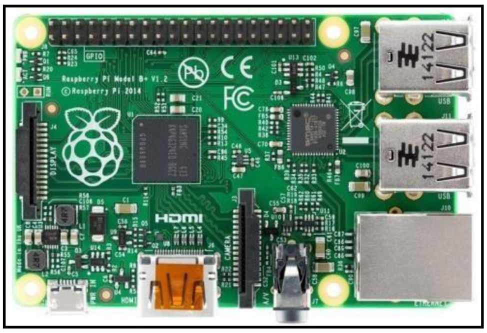
Numerous work of indoor farming has done by a lot of researchers using different methods. The authors of paper [3] have worked on crop management that focuses on indoor farming. Raspberry Pi 3 module, FC-28 sensor, and DHT22 sensor are used on this system. The sensors check soil moisture, humidity, and temperature, respectively. The system can operate the pump according to the moisture sensor value. In addition, it can store humidity and temperature sensor's real-time data in Excel sheets.

A farming box for a small house was designed by the authors of paper [6]. This system is controllable by mobile apps and computer software. Here the author's emphasis on three things that are the box's temperature, humidity, and light intensity for the crop. etc

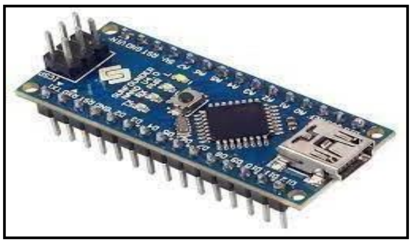
Taking ideas from the above studies, we have designed a system to increase food production keeping in mind the nutritional value of food and the challenges of indoor farming. Which will also make indoor farming easier.

III. Hardware and Implementation

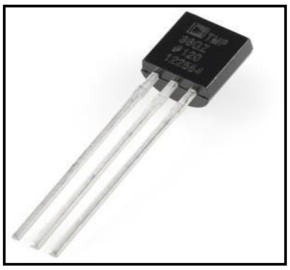
- **Raspberry Pi :** The Raspberry Pi is a low cost CPU which act as a mother board for our project using standard keyboard and mouse. The language which are used by the raspberry Pi are Scratch and Python. The below Picture illustrate how raspberry Pi looks like.



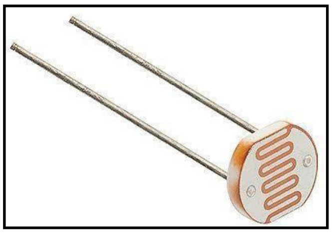
- **Arduino Nano :** The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328P released in 2008. It offers the same connectivity and specs of the Arduino Uno board in a smaller form factor. The Arduino Nano is equipped with 30 male I/O headers, in a DIP-30-like configuration, which can be programmed using the Arduino Software integrated development environment (IDE), which is common to all Arduino boards and running both online and offline. The board can be powered through a type-B mini-USB cable or from a 9 V battery. It features a more powerful ATmega4809 processor and twice the RAM.



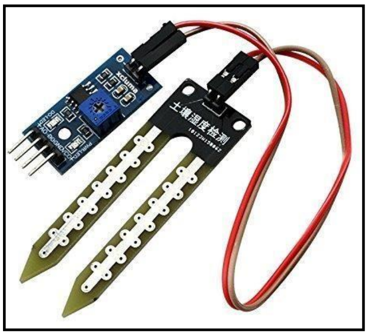
- **Temperature Sensor :** It has three pin [1] Power supply VCC 3-5V85 [2]Output/Data [3] Ground The first Pin(power supply) is connected to Arduino Pin with 5 v, second Pin (output data) with A1 port of Arduino which reads the data and ground is connected to the ground of Arduino.



- **LDR Sensor :** LDR's are light sensitive devices. The light sensor is a passive device that converts this "light energy" whether visible or in the infra-red parts of the spectrum into an electrical signal output. Light sensors are more commonly known as "Photoelectric Devices" or "Photo Sensors" because they convert light energy (photons) into electricity (electrons).



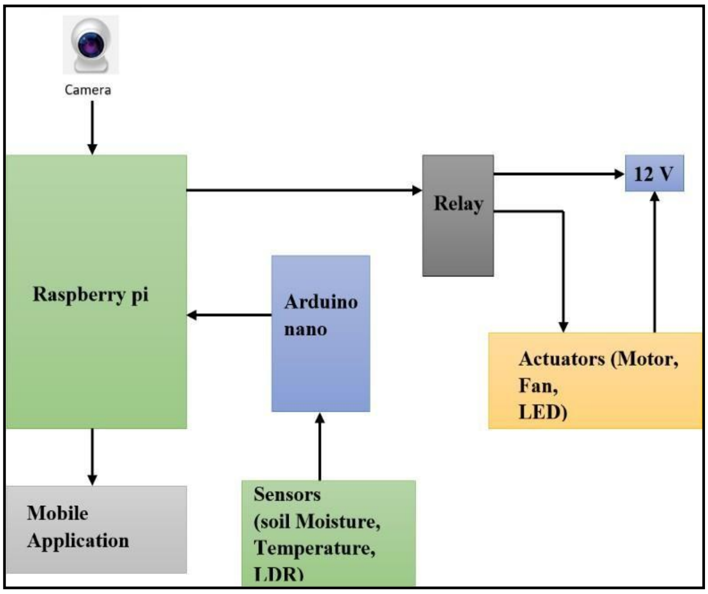
- **Soil Moisture sensor:** To measure the wetness and the water intensity we use soil moisture sensor and the connection is done through these steps. Connect two Pins from soil moisture sensor with the two Pin of raspberry Pi using hooked wires. Connect VCC (source voltage) from raspberry Pi to the Arduino and ground Pin to GND Pin on the Arduino. We use analog data by connecting the analog data Pin A0 on the Arduino to get the readings.



Implementation: The sensors are connected to the Arduino board. This hardware communicates through Wi-Fi transmission so that user can access the data through his mobile that has an android application which can get the sensor data from the Raspberry Pi via Wi-Fi. The Arduino board is programmed using Embedded C in order to control the transmission of sensor data and the working of motor according to the decision made. The sensors continuously send data regarding moisture content of the soil. If sensor indicates low moisture content motor is switched on and then water is pumped, if it indicates high moisture content pumping of water is stopped by switching of the motor. All these are managed by the program that has been written into the Arduino Microcontroller. The threshold values for soil moisture, temperature and LDR sensors will be set and stored in the Raspberry Pi and shows on mobile application. The threshold value is fixed. The motor will be switched on automatically if the soil moisture value falls below the threshold and vice versa. The Light will get turned on automatically if the LDR values falls below the threshold value and vice-versa. The fan will get turn ON when temperature value is more than threshold value. The farmer can even switch on the motor, fan, light from mobile using mobile application also, the live streaming is done continuously. The system is automated and also can be controlled via Mobile application.

IV. Results

The Automated Smart Irrigation for Indoor Farming is an intelligent system that enjoys the benefits of the true decision-making ability of the IoT approach. The architecture of the proposed system and its implementation details are given in the previous sections. To test the performance of the proposed system, three types of sensors (light, temperature & humidity and moisture sensors) were planted on a testing field. The input data received from the sensors is forwarded to the server and results are shown on Mobile application. Mobile



Application development in English and regional languages like Hindi, Kannada and Marathi to display the sensor readings, monitoring and controlling the actuators. Live streaming of the field is display on Mobile application. The three types of sensor data are received from three sensors and the calibrated output is processed using IoT approach with the help of classification tables shown below.

Table 1 shows three classes (high/wet, normal, low/dry) for various levels of soil moisture detected by the HL-69 Hygrometer sensor. A typical HL-69 Hygrometer sensor gives output in the range of 0 to 1023

Table 1. Moisture level

Moisture	Class
>700	High/Wet
350-650	Normal
<300	Low/Dry

Table 2 shows three classes (high, normal, low) for various levels of temperature detected by the LM35 sensor. A typical LM35 sensor gives a real-time temperature value in the range of −55°C to 150°C.

Table 2. Classes of Temperature

Temperature (◦c)	Class
>27 ◦c	High
20-26 ◦c	Normal
<18 ◦c	Low

Table 3 shows the classes (high, normal, low) for various levels of light intensity detected by the LDR sensor. A typical LDR sensor gives real-time light intensity values in a range from 0 to 1023.

Table 3. Classes of light intensity

light intensity	Class
>1000	High
300-700	Normal
<200	Low

All the sensors were activated and the data Table 3 shows the five classes (high, normal, low) for various levels of light intensity detected by the LDR sensor. A typical LDR sensor gives real-time light intensity value in range of 0 to 1023 lux. Input data collected from the sensors is shown in Table 4 highlighting the range of the input data collected from the sensors.

Table 4. Sensor data for the experiments

S. No.	Temperature (◦C)	Light Intensity (lux)	Soil Moisture Level
1.	25.9	16	790
2.	36.16	150	597
3.	27	80	890
4.	34.7	200	725

The results of the experiments reveal that the use of an intelligent approach for efficient decision-making certainly helps in improving the results of a sensor-based system. An approach that is intelligent can not only improve the performance of IoT- and sensor-based systems but also the throughput of such systems can be enhanced but more accurate and intelligent decisions taken by such smart systems.

Fig 2 Project Setup

The system consists of different sensors such as Soil moisture sensor to measure water content of soil, temperature sensor to detect the temperature and LDR sensor to detect light intensity.Fig (2) shows the setup of our project in that one box is to store water and one is to do irrigation. Water will be supplied to the root of the plants. Sensors are placed in soil container; also camera is there to do live streaming.

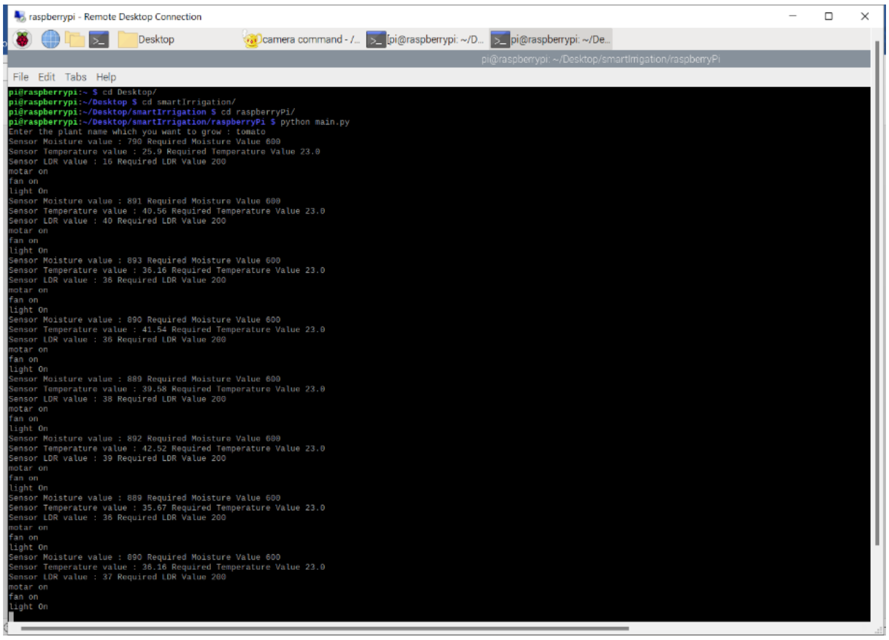


Fig 3 start execution of the system

Crop has to register with required temperature value, moisture value and light intensity value; it will be stored in Database. Farmer start the system with executing a python file as show in fig (3). In that crop name has to give which farmer wants to grow. Further this execution shows the current sensor values, required sensor values and actuators status(Fan, LED, Motor).

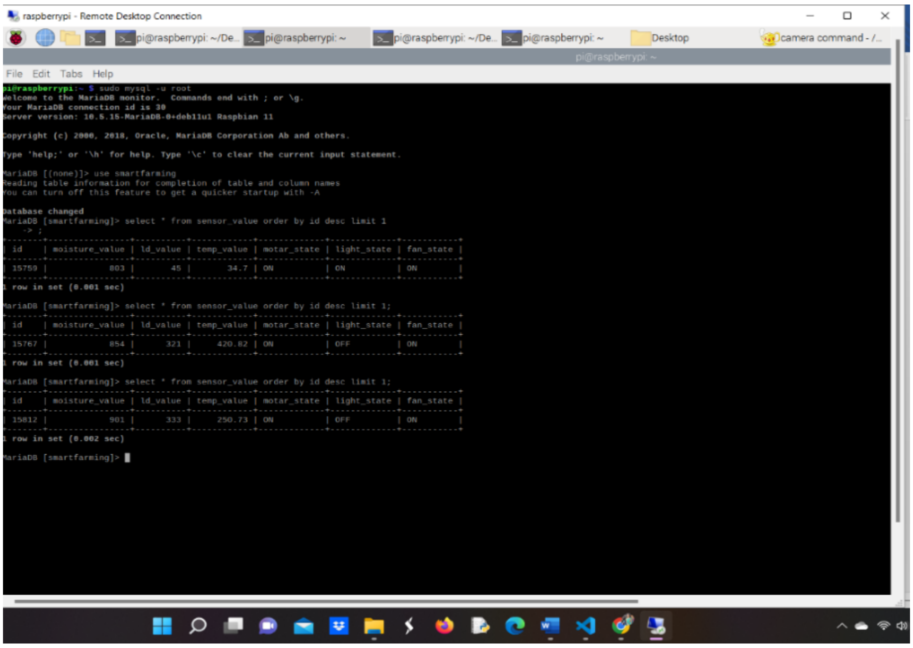


Fig 4 Database

Fig (4) shows the sensors reading stored in data base with there actuators status. In this we have executed query select * from sensor value order by id decs limit 1; therefore is show last value from the Database.

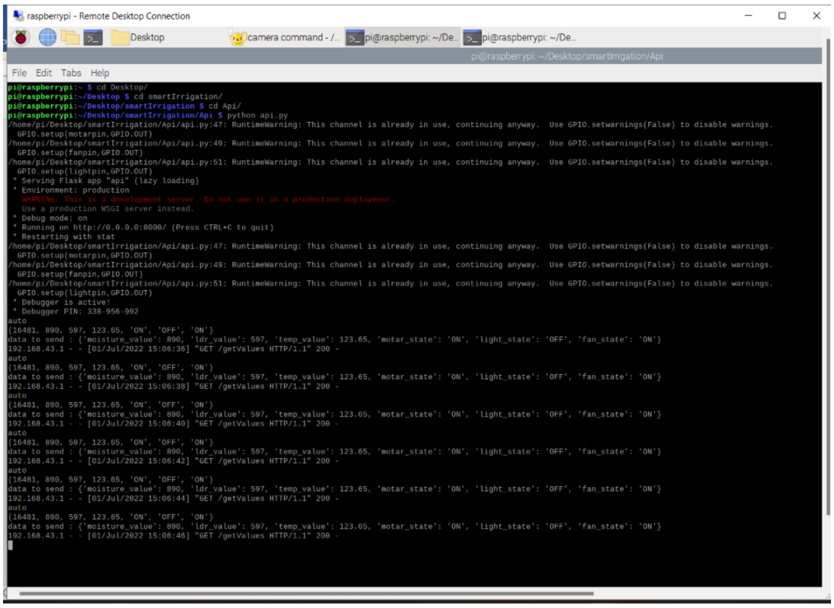


Fig 5. Execution of Api file

Fig (5) shows execution of api.py file. It's work as interface between system and real time user. It is python file use to send the current sensors reading from Database to Android Application. It also transfers the user operation (ON/OFF actuators) during manual mode to system.

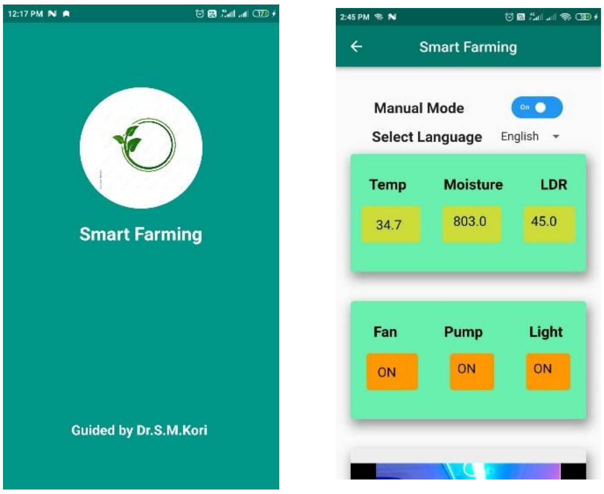


Fig 6. Front and Home page of Application

Fig 6 shows the Front and home page look. When user open the application first it will show welcome page with guide name, after some seconds home page will appear in this sensor's values, actuators status, language selection option and manual mode selection option is shown when user scroll lit bit below user can see live streaming video.

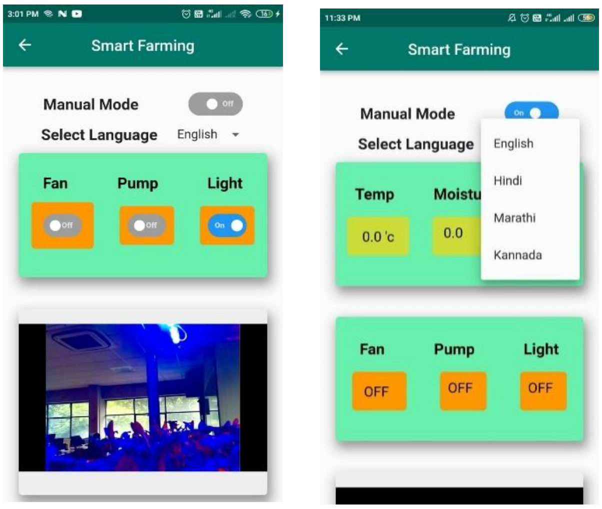


Fig 7 Manual mode & Multilanguage selection

Fig (7) shows the manual mode where user can control the actuators; user can ON/OFF the actuators and also user can go to auto mode by clicking off manual mode. User can select language as per there knowledge or awareness. We have included 4 languages like Hindi, Kannada, Marathi, English.

Discussing Open Issues and Challenges

By adopting IoT in the agricultural sector we get numerous benefits, but still, there are challenges faced by IoT in agricultural sectors. The biggest challenges faced by IoT in the agricultural sector are lack of information, high adoption costs, and security concerns, etc. The biggest challenge is having good internet connectivity, as IoT needs good internet speed. IoT is a network of identifiable devices or objects that can communicate with one another via some kind of connectivity, without human intervention. The Internet of Things (IoT) is growing at a meteoric rate. With IoT innovation, businesses stand a chance to procure hefty growth prospects. Besides, they can also unleash additional revenue sources by significantly reducing the time-to-market.

Most of the farmers are not aware of the implementation of IoT in agriculture. Major problem is that some of them are opposed to new ideas and they do not want to adopt even if it provides numerous benefits. The best thing that can be done to raise awareness of IoT's impact is to demonstrate farmers the use of IoT devices like drones, sensors and other technologies and they could provide them ease at work and accompanied by real-world examples. With the increasing food supply demand, there is opportunity for intelligent farming, especially to understand and operate the equipment, to require certain skills. With technologies such as robots and computer-based intelligence for the operation of machines, it is highly unlikely that a typical farmer will acquire or even grow such skills. Such high-end innovations are not used by farmers. The IOT device is able to regulate water levels depending on soil moisture levels.

V. Conclusion and Future Scope

The Automated Smart Irrigation for Indoor Farming System can be used as destiny factors of agriculture. This would be a relief for farmers since it decreases the load of man power. It reduces the water consumption to a greater extent. The system uses information from soil moisture sensors to irrigate soil which helps to prevent over irrigation or under irrigation of soil thereby avoiding crop damage. It needs minimal maintenance. The irrigation system helps the farmers by making their work smarter. The farm owner can monitor and control the process through an Android Application.

The future scope of this project could be including variety of soil sensors like Rain sensor and fetch more data especially with regard to pest control and by also integrating GPS module in this system to enhance this agriculture IoT technology to full-fledged agriculture precision ready product. This would make the predicting and analysing processes more accurate. The extension work is to make user interface much simpler by just using SMS messages for notifications.

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