ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR2108

Detecting Environmental Conditions in Cultivation Lands Using Bionic Devices

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Abstract:- Climate change has an impact on crops, fruits, vegetables, and pest infestation, hence agricultural output is a top priority for most nations. As a result, professional growers have the problem of reaching maximum output results, and greenhouses have emerged as an excellent choice for ensuring these results. Farmers can employ innovative technologies inside greenhouses to prevent insect damage to plants and increase indoor growth through climate management. However, in order to manage agricultural fields and greenhouses successfully, farmers must now use Industry 4.0 technology such as robotics, Internet of Things devices, machine learning software, and so on. In this setting, sensor deployment is critical for gathering data and obtaining knowledge to help farmers make decisions. As a practical option for small farms, this research proposes an autonomous robot that drives along greenhouse crop paths with previously specified routes and can collect environmental data provided by a wireless sensor network when the farmer has no prior knowledge of the crop. An unsupervised learning method is used to cluster the optimal, standard, and deficient sectors of a greenhouse in order to identify improper crop development patterns. Finally, a user interface is built to assist farmers in planning the robot's route and distance while gathering sensor data to monitor crop conditions.

Keywords-Component: *- Smart Farming; Robotics; Greenhouse; Environmental Monitoring; Auto Mation Optimization; Wi-Fi Camera; Sustainability.*

I. INTRODUCTION

Agricultural output is critical to both societal welfare and international economic trade [1][2]. As a result, food demand is steadily increasing; by 2050, farms will need to produce 70% more than they do today [3]. Nonetheless, some production estimates indicate that the agriculture sector can only produce 3% more since farmers have delayed planting numerous crops on their properties due to climate conditions (e.g., droughts and/or floods) [4]. Furthermore, it has reduced their profitability. To overcome poor weather circumstances and crop loss caused by bug infestations, farmers may employ fertilizers and insecticides to speed up crop sowing and harvesting. Unfortunately, in certain circumstances, they use drugs and materials without understanding how to manage them on a broad scale [5]. As a result of improper fertilizer and pesticide use, the quality of the land deteriorates, and the products grown on it (such as fruits and vegetables) lose key nutritional characteristics [6]. In this context, greenhouses are seen as an appropriate solution for keeping environmental conditions within a desirable range. This avoids crops from being subjected to uncontrolled environmental variables, resulting in significantly superior harvesting results [7]. However, inhomogeneous and unregulated conditions inside a greenhouse can lead to failure. Furthermore, maintaining climate homogeneity is critical, as greenhouses feature regions that are drier or more humid than others, as well as irregular soils. Worse, changes in irrigation type and geographical location, combined with the issues discussed above, can render the greenhouse unprofitable [8]. Furthermore, if the farmer lacks appropriate expertise, his job in carrying out the crop management procedure may be prone to errors [9]. As a result, accurate and effective monitoring and automation are critical to transforming a failed greenhouse into a lucrative one. Having said that, to address the aforementioned challenges, innovative technologies have been implemented in the agriculture sector to improve efficiency and management [10]. These technologies have provided unique options for reducing and optimizing the usage of fertilizers and pesticides [11]. Among these innovations, the Internet of Things (IoT) stands out. In short, IoT is highly worth employing since it enables communication between sensors, machines, and humans. The primary goal of this project is to create a robotic system that can automatically monitor and manage environmental conditions within a greenhouse.

➢ *Proposed System*

This research describes an autonomous robot that walks across greenhouse crop paths using pre-planned routes and can collect environmental data provided by a wireless sensor network in situations where the farmer has no prior knowledge of the crop[1]. Based on the study of environmental data, the robot will make autonomous decisions to optimize greenhouse conditions[2]. The use of video cameras to send a signal to a specific location via a limited number of displays[3].

II. SYSTEM DESIGN

➢ *The System Has Two Parts*

- Transmitter
- Receiver

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR2108

➢ *Transmitter:*

The transmitter serves as a vital component in the smart farming ecosystem, enabling seamless communication of environmental data for effective decision-making and automation in greenhouse management.

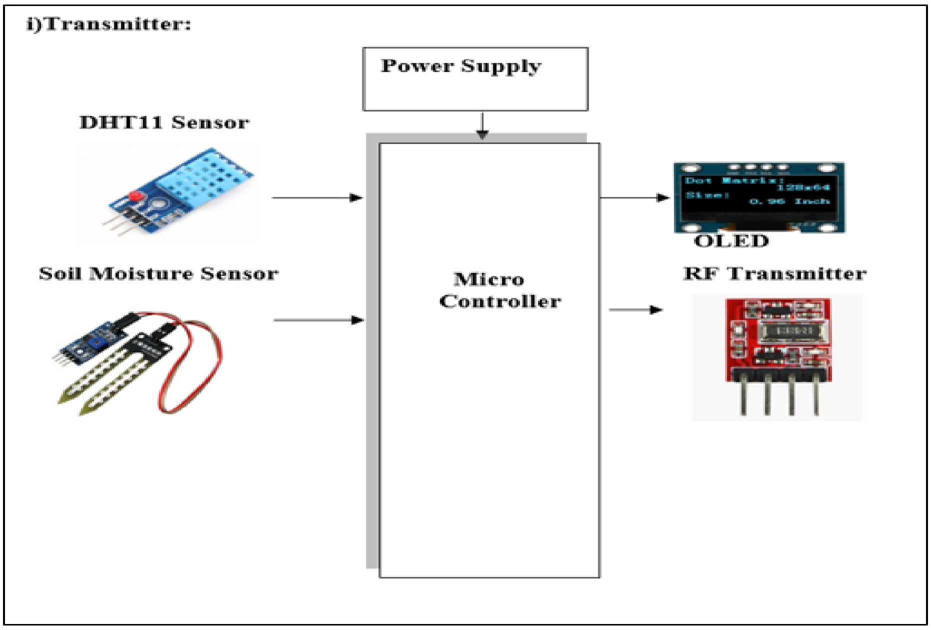

Fig 1 Block Diagram of Transmitter [1]

➢ *Main Components Description*

- *Dht11 Sensor*


Fig 2 DHT11 Sensor

The DHT11 is a simple, low-cost digital temperature and humidity sensor. It monitors the ambient air using a capacitive humidity sensor and a thermistor and delivers a digital signal via the data pin.

- *Soil Moisture Sensor*

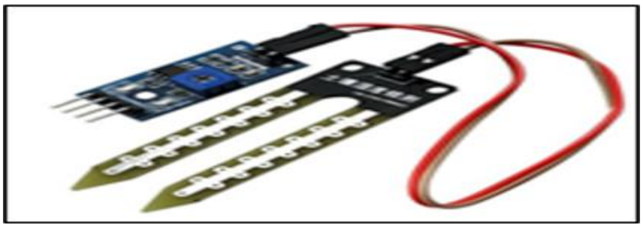
Fig 3 Soil Moisture Sensor

Soil moisture sensor measures or estimate the amount of water in the soil [1]. These sensors can be stationary or portables such as handheld probes [2]. Stationary sensors are placed at the predetermined locations and depths in the field, whereas portable soil moisture probes can measure soil moisture at several locations [3].

- *RF Transmitter*


Fig 4 RF Transmitter

It converts electrical signals into radio waves that can be transmitted across the air and received by suitable devices. RF transmitters are used in a variety of applications, including radio broadcasting, remote control systems, and data transmission.

- *Microcontroller*

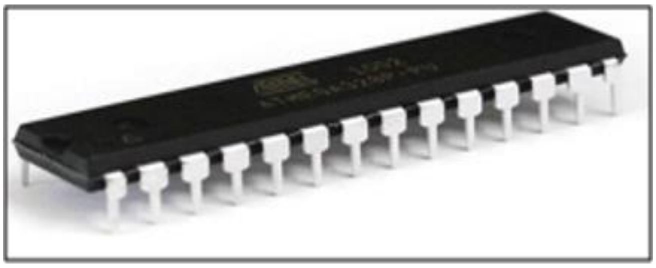
Fig 5 Microcontroller

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A microcontroller is indeed a compact integrated circuit intended to oversee specific operations within an embedded system [1]. It typically incorporates a processor, memory, and input/output peripherals all within a single chip [2]. This compact design makes microcontrollers ideal for controlling various devices and systems across numerous applications, ranging from simple consumer electronics to complex industrial automation [3].

- *OLED*

Fig 6 OLED

An OLED is a solid-state device made up of a thin, carbon-based semiconductor layer that produces light when charged by nearby electrodes. To allow light to escape from the gadget, at least one of the electrodes must be transparent.

- *Receiver*

The receiver plays a crucial role in the smart farming ecosystem by facilitating wireless communication and data reception from environmental sensors, enabling real-time monitoring, analysis, and management of greenhouse conditions.

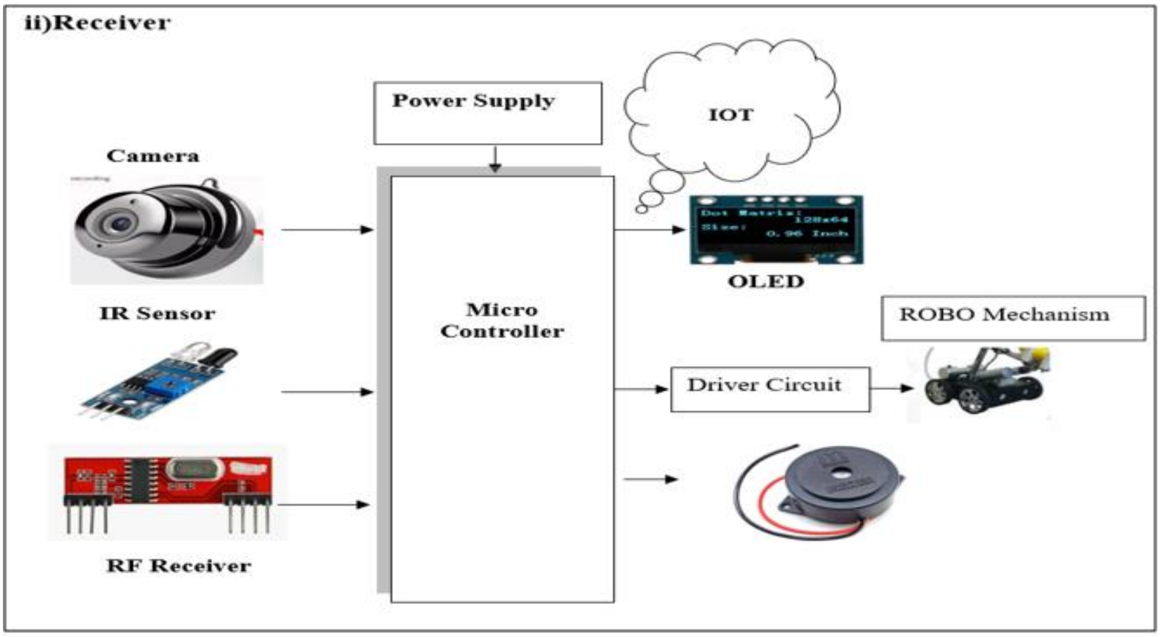

Fig 7 Block Diagram of Receiver [1]

- *Main Components Description*

- *Wi-Fi Camera*

Fig 8 Wi-Fi Camera

Wi-Fi Cameras play a crucial role in smart farming by providing visual monitoring capabilities, enhancing situational awareness, and facilitating data-driven decision-making for greenhouse management.

- *IR Sensor*

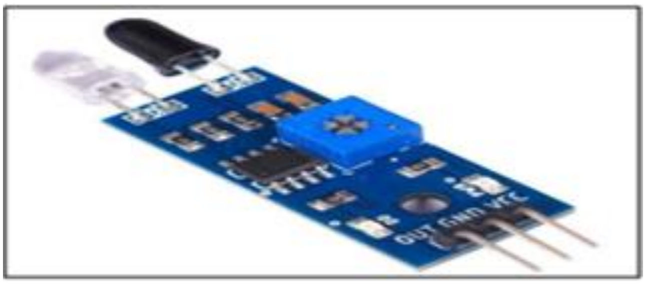

Fig 9 IR Sensor

An infrared sensor is an electronic gadget that produces light in order to detect something in its surroundings [1]. An infrared sensor can measure an object's heat while also detecting motion [2]. Usually, in the infrared spectrum, all objects emit some type of thermal radiation [3]. These radiations are undetectable to human eyes, but an infrared sensor can detect them [4].

- *RF Receiver*

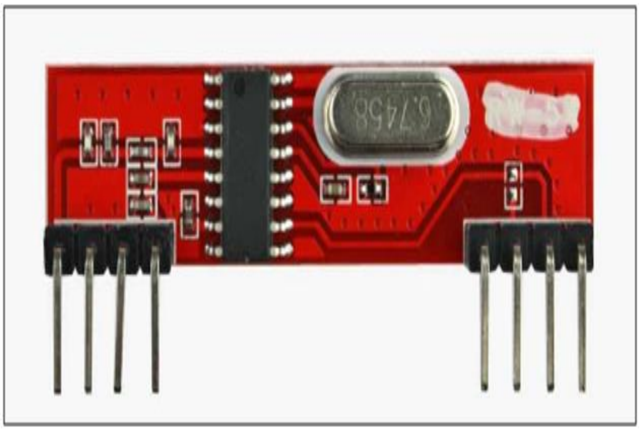

Fig 10 RF Receiver

RF receivers are electronic devices that isolate radio signals and transform them to audio, video, or data formats. RF receivers employ an antenna to receive transmitted radio signals and a tuner to distinguish a specific signal from the other signals received by the antenna.

- *OLED*

Fig 11 Arduino Uno

An Organic Light Emitting Diode (OLED), also known as an organic electroluminescent (organic EL) diode, is a form of light-emitting diode (LED) whose emissive electroluminescent layer is an organic compound film that produces light in response to an electric current.

- *Robo Mechanism*

The purpose of robot mechanisms varies depending on their design and intended application[1]. Generally, robot mechanisms are developed to automate tasks that are either too dangerous, too repetitive, or too precise for humans to perform efficiently[2]. These mechanisms can be found in industries such as manufacturing, healthcare, agriculture, and space exploration, among others[3]. Their goals may include increasing productivity, improving safety, reducing labor costs, enhancing precision, and expanding the capabilities of human operators[4].

Fig 12 Robo Mechanism

- *Driver Circuit*

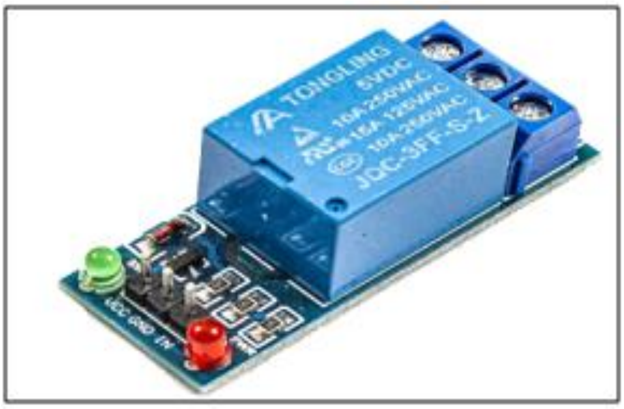

Fig 13 Driver Circuit

In electronics, a driver is a circuit or component used to control another circuit or component, such as a high-power transistor, liquid crystal display (LCD), stepper motors, SRAM memory, and numerous others.

- *Buzzer*

Fig 14 Buzzer

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- A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric.

- *Micro controller*

Fig 15 Micro Controller

Microcontrollers serve as the brains behind various electronic devices, providing them with intelligence and control. They are purpose-built integrated circuits designed to execute specific tasks within a given application.

III. IMPLEMENTATION

The robot collects real-time data on various environmental parameters within the greenhouse, such as temperature, humidity and soil moisture. It processes the collected data to make it meaningful and actionable. Based on the processed data, the robot makes intelligent decisions to optimize environmental conditions within the greenhouse. For example, it may decide to adjust irrigation systems based on soil moisture levels or control ventilation systems based on temperature and humidity.

➢ *Transmitter*

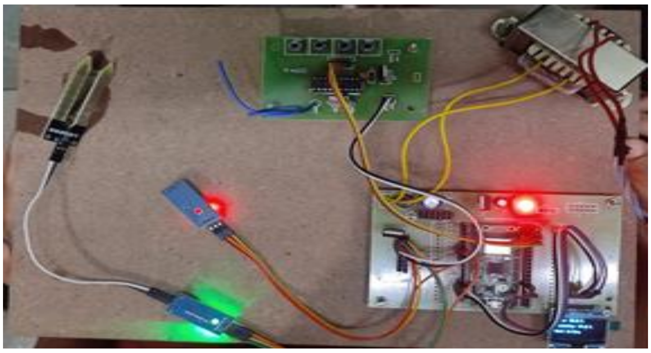

Fig 16 Circuit Diagram of Transmitter

The transmitter collects data from the DHT11 sensor and the soil moisture sensor. The DHT11 sensor measures temperature and humidity levels in the greenhouse environment, while the soil moisture sensor measures the moisture content of the soil.

It processes the collected data to ensure accuracy and reliability. This may involve filtering out noise, calibrating sensor readings, and converting analog signals from the sensors into digital data that can be transmitted.

The transmitter sends the processed data wirelessly to a central control unit or a remote monitoring system. This allows greenhouse operators to monitor environmental conditions in real-time from a distance without physically accessing the Greenhouse.It utilizes a communication protocol, such as Wi-Fi. The whole data is transmitted through the RF Transmitter.

➢ *Receiver*

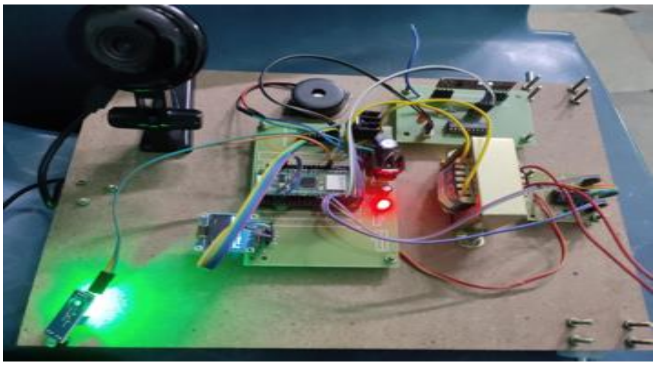

Fig 17 Circuit Diagram of Receiver

RF receiver receives data wirelessly transmitted by the RF transmitter component containing information about environmental conditions measured by sensors such as the DHT11 and soil moisture sensor.

It processes the received data to extract relevant information about environmental conditions, such as temperature, humidity, and soil moisture levels. This data can then be used to make decisions or trigger actions related to greenhouse management.

The receiver utilizes the data from the IR sensor to enable path following capabilities in the greenhouse. The IR sensor detects infrared signals emitted by markers or beacons placed along predefined paths, allowing the robot to follow these paths autonomously. This is particularly useful for navigation within the greenhouse environment, ensuring efficient movement without colliding with obstacles or damaging crops.

The camera component in the receiver helps in detecting obstacles or obstructions within the greenhouse environment. It captures images or video footage of the surroundings, which can be processed using computer vision algorithms to identify obstacles in the robot's path. This information is crucial for ensuring safe navigation and avoiding collisions.

IV. RESULT

The output of the implementation will display the values of humidity, temperature values and determines whether the soil is wet or dry.Based on these values the Robo will make autonomous decisions to increase efficiency, productivity, and sustainability in greenhouse agriculture.

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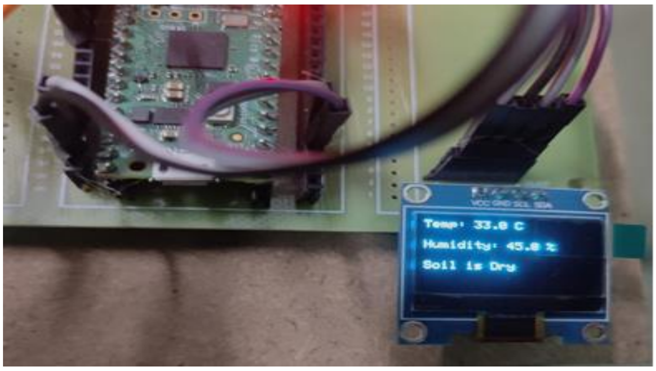

Fig 18 Transmitter Output

Fig 19 Receiver Output

Fig 20 picture taken by camera

V. CONCLUSION

The smart farming robot creates optimal growing conditions by accurately monitoring and controlling factors such as temperature, humidity, and soil moisture. This leads to improved crop yields and enhanced crop quality. Automation of tasks such as irrigation and ventilation control reduces resource wastage and promotes efficient use of water, energy, and other inputs. This contributes to cost savings and environmental sustainability. It employs IR sensor which is used for the path following condition in greenhouse as well as camera which captures the images and videos.

FUTURE SCOPE

The future scope is characterized by continued advancements in sensor technology, AI integration, multi-robot collaboration, navigation and mapping, energy harvesting, IoT integration, and customization. These developments hold the potential to revolutionize greenhouse agriculture, enabling growers to achieve higher levels of efficiency, productivity, and sustainability in crop cultivation.

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