IOT- Based Smart Plant Protection and Pest Control by Using Raspberry Pi

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Abstract: - In economies heavily dependent on agriculture, such as India, the farming sector plays a crucial role, yet it faces various challenges that hinder its profitability and, unfortunately, contribute to farmer suicides. Pest attacks stand out as a significant factor contributing to the agricultural woes, causing substantial harm to crops. This research proposes a solution leveraging Raspberry Pi technology, incorporating a mathematical model known as Beta regression analysis. The model utilizes farm humidity and temperature as inputs to predict environmental conditions conducive to pest formation and attacks. The resultant Beta regression factor serves as a risk indicator for environmental health. Based on this factor, the system forecasts the likelihood of pest occurrences. By offering advance predictions of pest activity, farmers can strategically apply the right amount of pesticides, effectively mitigating the impact of pests on their crops. This proactive approach allows farmers to manage potential damage before it occurs, fostering a more sustainable and profitable farming environment. The innovative system outlined in this paper aims to empower farmers with accurate pest control predictions, thus enhancing their ability to navigate and overcome challenges in the agricultural landscape.

Keywords: Internet of Things, Raspberry Pi, Beta regression analysis, DHT 11, Risk indicator.

I. INTRODUCTION & LITERATURE REVIEW

The Indian economy is predominantly characterized by Agro-based businesses, with seventy percent of its population relying on agriculture. Given the substantial dependence on agricultural enterprises, the nation's Gross Domestic Product (GDP) is intricately tied to the success and challenges faced by farmers. Of particular concern is the alarming rise in farmer suicides, prompting a need for comprehensive solutions. This paper addresses a significant factor contributing to harm in agricultural practices—pest formation on plants or farms. It's crucial to recognize that pest occurrences are primarily influenced by environmental changes, a concern that has been exacerbated by global warming. To tackle this issue, we propose a system integrated with an embedded server, utilizing controllers such as Raspberry Pi and Beagle Bone. These controllers offer the necessary ports for Ethernet

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or internet access, establishing a network to retrieve essential data. The selected controller, Raspberry Pi, stands out due to its advantages in terms of the number of ports, power consumption, and processing speed. Leveraging the embedded server system, the proposed framework employs a web-based approach, granting access to data collected from the field via various sensors. The system is bifurcated into two parts: the first involves light-dependent and LM35 temperature sensors as outer environmental sensors, while the second part employs the DHT11 sensor for humidity and temperature data collection to calculate the regression factor. The data collected by analog sensors in the first part is transmitted to the Raspberry Pi through an Analog-to-Digital Converter (ADC), specifically the MCP3008. On the other hand, the digital sensor, DHT11, in the second part does not require an analog-to-digital conversion. The transmitted data is then presented on a webpage through the web server system, providing accessible insights for effective pest management and environmental monitoring in agriculture.

Kale Mangesh et.al. focused on overseeing and controlling environmental conditions within poultry farms. They monitored crucial parameters such as humidity, temperature, brightness, and air quality. The system they developed includes features for remote management, empowering farmers to efficiently oversee and control their farms from distant locations. This remote accessibility results in cost savings, improved quality, and enhanced efficiency in managing poultry farming operations. The study's conclusions highlight the practical benefits of the proposed system for enhancing farm management, particularly in remote areas.

Balamurugan et.al. addresses the utilization of sensor networks in agricultural contexts, where field data is collected and stored in the cloud for monitoring through IoT. It allows for the observation of crop field areas without requiring direct human interaction. The current emphasis on smart security and monitoring systems in modern agriculture involves integrating the Internet of Things with Raspberry Pi and sensors to boost agricultural efficiency. The research outcome involves the monitoring of soil moisture, temperature, and humidity within the field.

Poornaiah Billa et.al. discussed on Protecting harvested crops from damage caused by diseases, pests, and animal attacks is essential. To address the challenges confronted by farmers, a method has been introduced to monitor weather and soil conditions. The proposed approach also offers suggestions for selecting the most suitable crop based on the prevailing climatic and soil conditions. By supplying images of plants, this method enables the detection of issues such as animal attacks, diseases, or pests. This system equips farmers with valuable insights to enhance crop yield, providing them with the means to optimize their agricultural output.

Rahman et.al. focused on real-time monitoring sensor data utilizing a soil moisture sensor to measure field moisture, a water level sensor for flood detection, a pH sensor to measure soil acidity, and a temperature and humidity sensor for tracking current atmospheric conditions, Live monitoring of sensor values through cloud integration and a user-friendly dashboard and also addressing farming security concerns through a combination of Laser shield and IP-Camera, connected via Wi-Fi and managed through an Android application.

From the above literature it has been observed that system can be implemented using raspberry pi and IoT is helpful for real time monitoring of environmental condition inside the farm as well as protection and pest controlling of crops.

II. SYSTEM DEVELOPMENT –

A. Embedded Web Server

The utilization of an embedded web server holds significant importance, particularly in dedicated-purpose systems where applications are tailored to specific end-user tasks. In the context of the proposed system, an embedded web server is employed, with the implementation facilitated by the Apache server on the Raspberry Pi. Various servers are available for embedded web server implementation, and PHP is employed to create the web page for accessing it. Communication between the embedded web server and clients is established through internet protocol, specifically Serial Peripheral Protocol. The root location of the Raspberry Pi serves as the foundation for embedded web server access, restricted to authorized clients with dedicated IP addresses provided by the router.

B. Raspberry Pi

In the evolving landscape of embedded systems, controllers with the capability to install an operating system have gained popularity due to their faster speed, easy accessibility, and straightforward programming and operation compared to traditional controllers. Given the pivotal role of the internet and Ethernet in the embedded web server system, the Ethernet port of the Raspberry Pi plays a crucial role. With a GHz frequency, the Raspberry Pi exhibits minimal delay in data transmission and reception. Featuring an ARM Cortex and Ethernet IC, the Raspberry Pi enhances operational efficiency and control.

C. Beta Regression Analysis

The mathematical model of beta regression analysis is employed in the proposed system to calculate the regression factor, serving as a risk indicator for the environment. The regression factor is determined using Equation No.1, providing valuable insights into environmental risk in the context of plant protection and pest control using Raspberry Pi technology.

$$\log(y)=\log(\alpha)+\beta\log(t)+\gamma\log(1-t)+\delta\log(H) \text{ ------------------[1]}$$

Where, y = Regression factor

H= Humidity

The constants α, β, γ, and δ are specific to different crops, varying according to their respective ideal environmental conditions. The variable "t" represents temperature, as defined by equation number 2.

$$t = (T-T_{min}) / (T_{max} - T_{min}) \text{ ------------[2]}$$

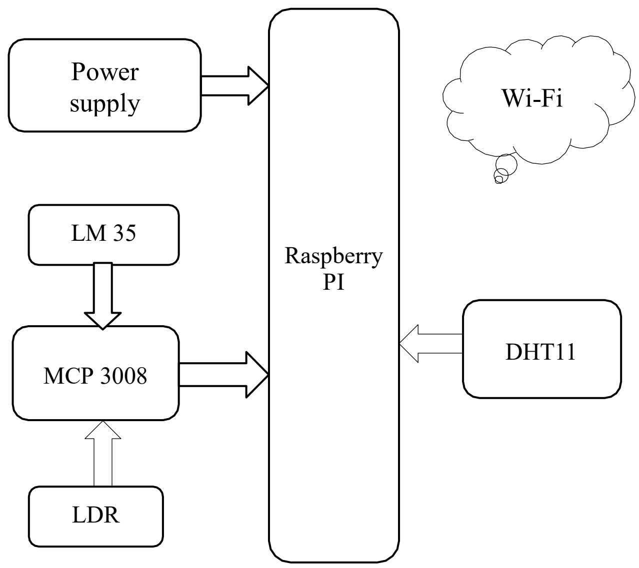
The severity index for pest formation is established based on the regression factor. Table 1 outlines the corresponding ranges for the severity index.

Table No 1 – Range of Severity Index

Sr. No.	Severity index	Range of Regression Factor
1	High Risk	>1
2	Moderate Risk	0.5<Y
3	Low Risk	< .0.5

D. Proposed System

a. Transmitter End



b. Receiver End

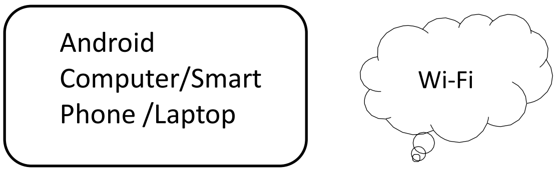


Figure. No. 1 Block Diagram of Proposed System

In Figure 1, the envisioned system comprises a transmitter and receiver. On the transmitter side, an embedded web server, powered by Raspberry Pi, is intricately designed alongside field-placed sensors. On the receiving end, users can employ various devices such as Android mobile phones, laptops, computers, and tablets. Access to the embedded web server is facilitated through a web page created using PHP. Python language is employed for sensor readings. The webpage displays all sensor parameters and the regression factor. The proposed system employs a DHCP server for IP address services.

B. Algorithm

1. Start:
2. Initialize Raspberry Pi.
3. Check input signals from DHT11 and ADC.
4. Proceed to step 11 if there is no signal from DHT11 and ADC.
5. Execute the Beta Regression Model.
6. Transmit sensor parameters and disease forecast (Risk Factor) to the web page.
7. Display sensor parameters and forecasts on the web page.
8. If the Risk Factor is HIGH, proceed to step 9; otherwise, go to step 10.
9. Activate Relay 1 and Relay 3.
10. Activate Relay 2 and deactivate Relay 1 and Relay 3.
11. Wait for 5 seconds, then return to step 3.

C. Flow chart

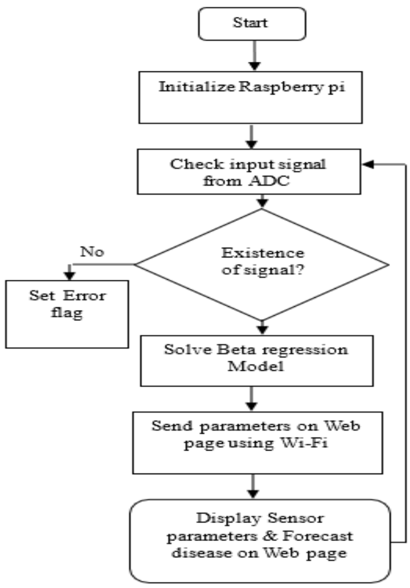


Figure. No. 2 Flow Chart of System

III. RESULTS AND DISCUSSION

The implementation of the proposed system using Raspberry Pi and various sensors has been successful. Figure 3 demonstrates the effective functionality of the IoT-based monitoring web page.

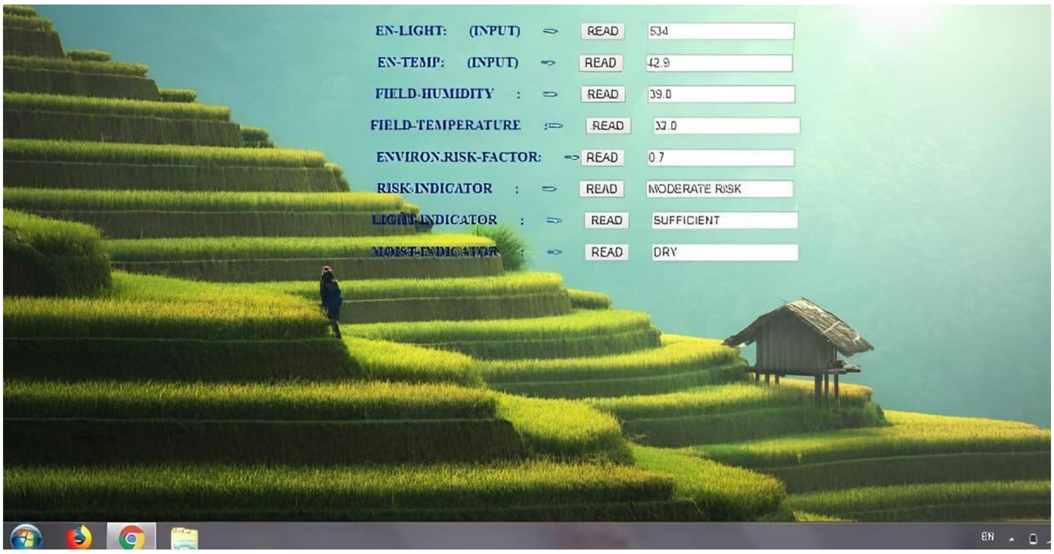


Figure No. 3 Screen Shot of Web Page

The real-time test reveals the results outlined in Table 2.

Table No. 2 Real Time Test Result

Sr. No.	Risk Indicator	Regression Factor
1	High	1.1
2	Moderate	0.9
3	Moderate	0.6
4	Low	0.4

During real-time testing, it was observed that the proposed system exhibits minimal time lag, making it significantly faster compared to other controllers and existing systems. The predictive capability of pest occurrence using the regression factor proves to be a valuable tool for farmers, aiding in the prevention of crop loss.

IV. CONCLUSION

- In conclusion, the implementation of the proposed system, utilizing Raspberry Pi and a range of sensors, has demonstrated commendable performance during real-time testing. The system showcases remarkable speed with minimal time lag, surpassing the efficiency of other controllers and existing systems.
- The incorporation of a predictive model based on the regression factor for pest occurrence is a noteworthy aspect. This predictive capability offers farmers a valuable tool to proactively address potential pest threats, thereby minimizing the risk of crop loss. The successful deployment of an IoT-based monitoring web page further enhances the system's effectiveness in providing real-time insights to users.
- The outcomes of this study underscore the potential of integrating advanced technologies, such as Raspberry Pi and IoT, in agriculture for enhanced monitoring and control. As the proposed system proves its efficacy, it holds promise for contributing to sustainable and efficient farming practices, ultimately benefitting farmers and the agricultural sector as a whole.

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