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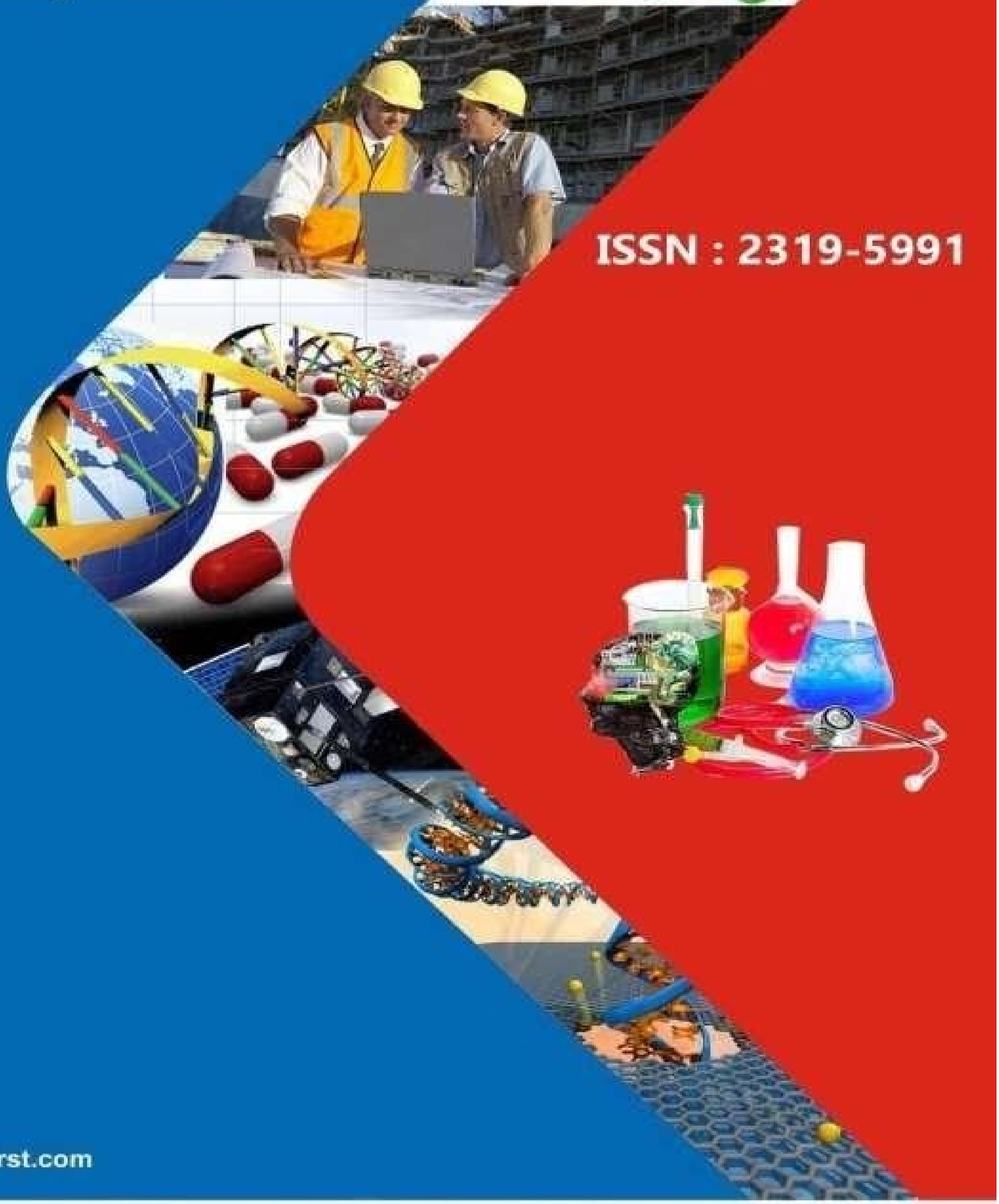

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IOT-Enabled Smart Greenhouse with ClimatePrediction and Autonomous Irregation using Raspberry Pi Pico

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Abstract:

This project presents an IoT-enabled Smart Greenhouse using Raspberry Pi Pico for automated climate control and irrigation. Sensors measure temperature, humidity, soil moisture, and pollution levels in real time. The system leverages IoT for remote monitoring and data analysis via a cloud platform. A machine learning model predicts climate conditions, enabling proactive adjustments. An autonomous irrigation system regulates water flow using an AC pump, optimizing water usage. A regulated power supply ensures reliable operation. The LCD monitor displays live data, while a buzzer alerts users to critical conditions. This system enhances crop yield, reduces manual intervention, and conserves resources. The integration of smart farming techniques promotes sustainable agriculture.

Keywords: IOT, Smart Greenhouse, Climate Prediction, Autonomous Irregation, Raspberry Pi Pico, Water Conservation, Microcontroller-based System, Precision Agriculture.

1. INTRODUCTION

Technology is advancing quickly today and has taken over humankind's way of life entirely. Even though technology plays a significant role in our daily lives, some people have totally different lifestyles from those associated with the term. Therefore, it is our duty to create a few trustworthy systems that farmers can employ effectively. The farmer who labours and works hard to produce the crop ultimately endures great suffering. Unexpected rains that fall during the drying process before selling the crop can completely ruin the yield or reduce it to second-rate quality. Automatic rain-protected drying shelters must be built to prevent this situation. In this project, we suggest a system that automatically detects rain and wraps a shield around the rooftop sensor using an intelligent microprocessor and a DC motor. The crop is protected from rain and getting wet by the drying shed's rain sensor. A rain sensor monitors the rain and transmits information to the microcontroller to automate this job. The data is processed by the microcontroller, which also turns on the DC motor control circuit and wraps a protective cover around the roof.
Crops are not protected in the current system from natural calamities like floods, rain, or excessive solar heat. which in turn slows plant growth, which in turn lowers production. After their crops were ruined by natural weather disasters, the formers committed themselves. Through the media, only weather updates or alerts are provided to the public. However, there is no precise timing notice or system in place to safeguard previous crops.

Unexpected and out-of-season rains are still occurring today, harming crops. If a hurricane or flood strikes, crops will be lost, as will obligations to the government in the form of relief contributions. We lost 20 chores of land for just one cyclone because HudHUd destroyed 9 chores of agricultural land and the government spent 11 chores of money as a relief fund. Unexpected showers are frequent in India. By putting in place an automated system that can cover agricultural land and collect rainfall for use in farming, we may overcome this loss. The primary functions of this system are to measure the amount of rainfall and the percentage of moisture in the field. The system should be turned on to safeguard the crops if there is more water than is necessary. If the water storage capacity is exceeded, the water should flow to the drainage system without affecting other regions. We will build a roofing structure that can allow the water to flow in a predesigned way.

Crops are not protected in the current system from natural calamities like floods, rain, or excessive solar heat. which in turn slows plant growth, which in turn lowers production. In this study, we suggest a method that guards against crop spoilage brought on by prolonged periods of rain. The design of embedded systems makes this possible. The main idea behind this project is to automatically cover the field in order to protect the crops from severe rain and to also conserve the water that is gathered.

Crops are not protected in the current system from natural calamities like floods, rain, or excessive solar heat. which in turn slows plant growth, which in turn lowers production. Following the destruction of their crops by natural weather disasters, farmers commit suicide. Through the media, only weather updates or alerts are provided to the public. However, there is no precise time notice or system in place to safeguard farmer crops. To safeguard farmer crops from natural calamities like excessive rain, floods, and even excessive sun heat, an intelligent system has been developed. An agricultural field is protected by a moveable panel.

This intelligent rain protection system incorporates multiple sensors and actuators to ensure seamless operation. The rain sensor continuously monitors weather conditions and sends signals to the microcontroller when rainfall is detected. The microcontroller then activates the DC motor, which moves a protective sheet or rooftop covering over the drying area. Once the rain stops, the system automatically retracts the cover, allowing crops to dry naturally under the sun.

To enhance efficiency, the system can be integrated with a moisture sensor that monitors soil conditions. If the soil moisture level is already high, the system will ensure that additional rainwater is diverted to drainage instead of soaking the crops. The collected rainwater can be stored in underground reservoirs or tanks and used for irrigation during dry spells, promoting water conservation.

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A solar panel system can be added to power the automatic shelter, making it self-sufficient and sustainable. Solar energy will provide electricity to the microcontroller, motor, and sensors, ensuring uninterrupted operation even in remote farming areas. This reduces the dependence on external power sources, lowering operational costs for farmers.

2. LITERATURE SURVEY

The agricultural issues that farmers currently confront in society are explained in this chapter. This project offers autonomous watering equipment that operates using a temperature and humidity sensor. Rain sensors are used to gather information on rainfall so that crops can be covered, depending on whether it is wanted or not. Weather conditions can change from place to place, crops require different amounts of water, and crops can be damaged by drought or heavy rain. Drip lines can be installed to ensure that water reaches roots directly and increase the system's effectiveness. According to a programme created in the Python environment, this design will sense when motion is detected, and the controller will command the camera to snap a photo and communicate the image to the farmer. The process of sensing changes in relation to objects and the surrounding environment is included in motion detection systems. When animals or people enter an agricultural area, the video-based surveillance system is generally beneficial for identifying them and sounding an alarm. To identify and analyse the duration of motion as detected from both a static camera and a moving camera, a new approach is applied. Motion detection reduces the need for and expense of monitoring. The objects will be periodically detected and classified by a real-time gadget. Frequency analyses can be used to find the regular motion. We can also take pictures and categorise them using algorithms for image processing.

We have reviewed earlier studies on projects of this nature. The Indian economy is based on agriculture, which can be compared in several ways. Because agriculture produces our primary source of food, life would be impossible without it. However, it is uncommon to find labour available nowadays to carry out agricultural tasks. Industrial expansion is a result of automation in many types of industries. Agriculture is automated at this place. A single person is sufficient to check if everything is operating normally in the proposed system, where all equipment operates on its own with the aid of inputs from sensors that continuously monitor agricultural land. A programmable logic controller regulates and keeps an eye on the entire process [1]. Seeding, irrigation, planting, fertilising, weeding, and harvesting are all part of the agricultural process. Three processes can be used in this situation. The primary goal is to show that anyone, including professionals, can work in agriculture. Due to this methodology, the cost of manual cultivation for one acre of land is reduced to roughly Rs. 9000 to 10,000, and the yield is higher than it would be with a typical method [2].

A substantial amount of water can be conserved by using the RainGun Irrigation System, which was proposed by Sanjay Kumawat, Ashwini Kapadnis, and others [1]. This system uses an automatic microcontroller and only irrigates when there is a serious need for water. The of field resources can be improved because of this system's creation of the Android software stack, which is used for mobile devices and includes an operating system, middleware, and important administration applications. The Java programming language is supported by the Android SDK, which offers the tools and APIs required to start creating applications for the Android platform. Mobile phones play a crucial role in meeting people's many demands. The solution for the irrigation control system is to employ the GPRS feature on a mobile device. These methods weren't economically feasible and only covered lower-quality agricultural land. When there is a significant amount of water on the land, the GSM is used to relay messages. An Android app is used to prevent soil contents that affect nutrient availability from being washed away. The Microcontroller extends the life of the system and reduces power consumption. This system only supports automatic irrigation and lacks other unique features. The advantages include time savings, careful water use, and earlier knowledge of the crops that may be produced in a field thanks to the autonomous irrigation system installation and PH value determination. The drawback is that this technology only functions in locations with intermittent electrical supplies. Proteus software has been suggested for use in system design and simulation by Naveen K.B., Sagar G.H., et al. [2]. The soil moisture sensor and the rain sensor are the two sensors. The moisture sensor measures the moisture content, while the rain sensor calculates the amount of precipitation, both of which are displayed on the LCD. The car roof is employed. The automatic system for conserving rainwater and crops shields crops from heavy downpours and reduces water waste. Utilising an auto roof minimises human work while saving electricity and increasing production in both sunny and wet weather. Since the advent of agriculture, irrigation has been the foundation of human civilization. In the current situation, it is important to save water and protect the earth's natural resources. We can manage the water flow and reduce wastage by regularly monitoring the condition of the soil and employing soil moisture sensors. Low power usage and simplicity of installation are advantages. From the field to the farmer's house, remote monitoring is feasible. We can save power by automating DC motor control. Water waste can be minimised. Temperature and high humidity levels can be sensed and managed. controlling soil moisture. The expense of applying the demerit is high. According to A. Pederi and H.S. Cheporniuk et al. [3], this work combines innovative agricultural techniques and technologies.

3. PROPOSED METHODOLOGY

The proposed system integrates Raspberry Pi Pico with IoT to enable real-time monitoring and automation in greenhouse environments. Sensors continuously track temperature, humidity, soil moisture, and pollution levels, ensuring accurate climate control. The system utilizes a regulated power supply for stable operation, reducing energy fluctuations. An LCD monitor displays real-time sensor readings for on-site monitoring. IoT connectivity enables remote access and control via cloud-based platforms. A machine learning algorithm predicts climate variations, allowing proactive adjustments to greenhouse conditions. The autonomous irrigation system operates an AC pump based on real-time soil moisture data, optimizing water usage. A buzzer alerts users to critical environmental changes, enhancing system responsiveness. The integration of pollution sensors ensures air quality regulation within the greenhouse. Automated logging of data reduces human errors and improves precision in decision-making. The system reduces labor costs by minimizing manual intervention. Predictive analytics enhance crop yield by maintaining optimal growing conditions. The smart greenhouse promotes sustainability by conserving water and energy. Advanced monitoring ensures early detection of potential issues, preventing crop damage. The system supports scalability, allowing future enhancements for increased efficiency.

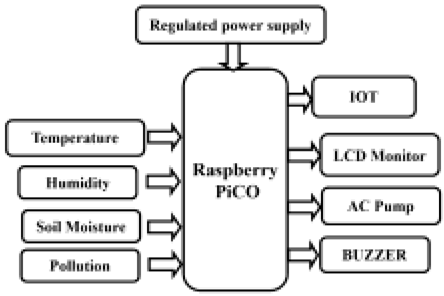

Fig. 4.1: Proposed Block diagram

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Vol. 21, Issue 2, 2025

It is absolutely essential to detect any excess moisture or rain throughout the drying process of the crop yield because if not, the hard-yarned crop yield will be destroyed, which would be a huge loss for the former. Sensing the parameters with a moisture sensor or rain sensor helps prevent this situation. The microcontroller receives the sensed information. A microcontroller is an intelligent controller that has already been pre-programmed to meet its needs. The sensor's data is processed, and appropriate action is then performed.

The DHT11 sensor will track the current humidity and temperature. This device has a mode button that allows it to operate the fan and shed manually or automatically according to the temperature and humidity. The existing fan will automatically turn on to regulate the room's temperature if the temperature exceeds the threshold voltage, and everything will warn us via an IOT server.

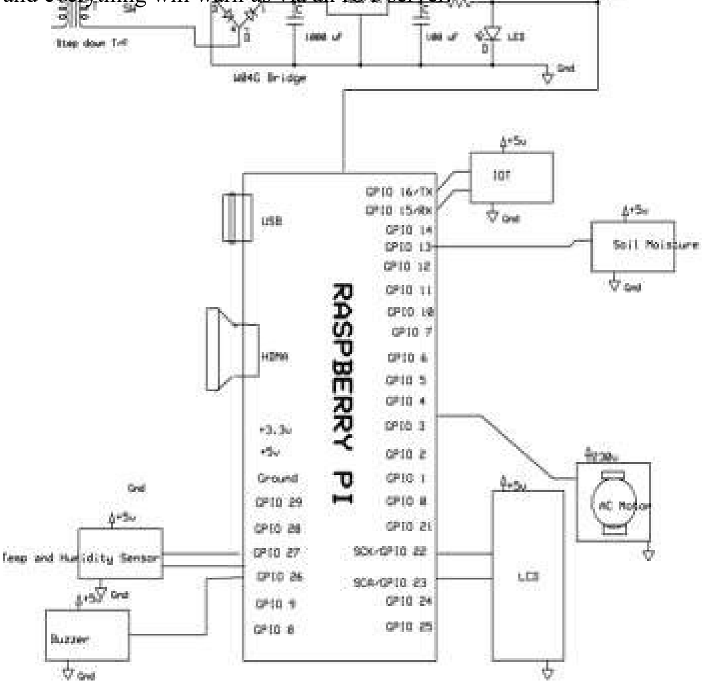

Fig. 4.2: Schematic diagram

- DHT11 is connected to GPIO 27,28 pins of RPi PICO.
- BUZZER is connected to GPIO 26 pin of RPi PICO.
- LCD is connected to GPIO 22,23 pins of RPi PICO.
- AC MOTORis connected to GPIO 3 pins of RPi PICO.
- soil moisture is connected to GPIO 13 pins of RPi PICO.
- IOT is connected to GPIO 15,16 pins of RPi PICO.

Additionally, we are monitoring the temperature and humidity of agricultural fields (using temperature and humidity sensors), and the same information will be sent to the IoT server. Sensors will monitor the moisture content in the soil, and depending on the moisture level, water pumps will turn on or off. In the suggested system, temperature and humidity are continuously monitored using DHT11 sensors, and depending on the temperature and humidity, fans are opened and closed to protect the crop's grain. The rain status will be updated by a rain sensor. The pH and conductivity of the sail are provided by a pH sensor. Using a Raspberry Pi Pico controller, a soil moisture sensor can automatically regulate an irrigation pump and send out an IoT signal.

4. EXPERIMENTAL ANALYSIS

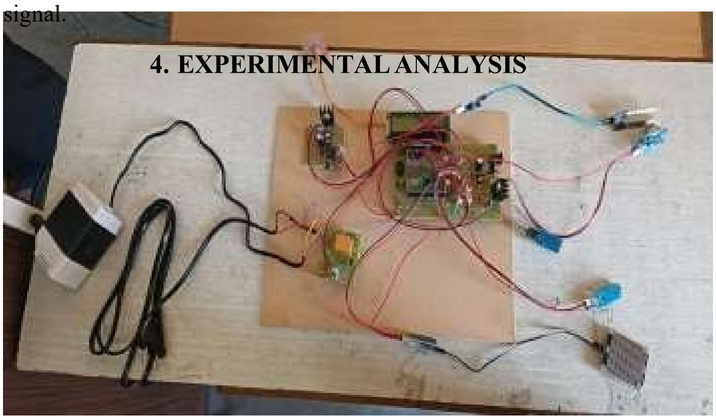

Fig1. Trainer Kit with Component Integrated

Fig2. LCD Screen Showing "Smart Green House Irrigation".

Fig3. Display Showing "Ready to Connect".

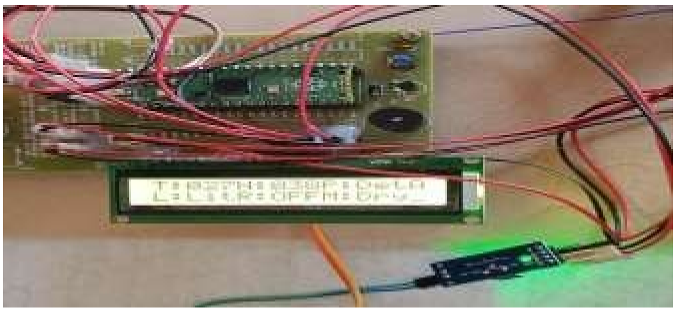

Fig4. LCD Screen Showing the Temperature, Humidity, Light, Pollution and Moisture Levels.

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5. CONCLUSION

The IoT-enabled Smart Greenhouse using Raspberry Pi Pico successfully automates climate control and irrigation, optimizing plant growth while conserving resources. By integrating humidity, temperature, soil moisture, and pollution sensors, the system enables real-time monitoring and predictive climate adjustments. The IoT connectivity ensures remote access and data-driven decision-making, while the autonomous irrigation system efficiently manages water usage through the AC pump. Features like the LCD display, buzzer alerts, and regulated power supply enhance usability and reliability. This project demonstrates a sustainable approach to smart farming, reducing manual effort, improving yield, and promoting eco-friendly agricultural practices. Future enhancements could include AI-driven analytics and expanded sensor networks for even greater efficiency.

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