Cloud-based Internet of Things Approach for Smart Irrigation System

Pandimadevi Ganesan, Thushara Hameed, Maheswari Maruthakutti

Abstract: ***The agriculture sector is facing numerous challenges such as water scarcity, climate change, and low productivity due to outdated farming practices. In most countries, approximately 75% of their GDP is dependent on agricultural products. Hence, utmost care has to be taken to introduce modern technology in the agricultural sector to enhance its productivity and efficiency. This paper presents an IoT-based Smart Agriculture Monitoring System designed to improve agricultural productivity by automating and optimising crop management. The primary objective of the proposed system is to supply water to crops based on soil moisture and surrounding temperature. This can be achieved by using a soil moisture sensor, a DHT11 sensor, a light-sensitive module, and a NodeMCU. All sensors are interfaced with Node MCU. The processor will process the data collected through the sensor. Whenever the soil moisture is low and the temperature is high, the pump will automatically switch on for irrigation. Apart from this, the collected data from the sensor is also transmitted to the cloud through ThingSpeak. Farmers can access the same information to monitor crops remotely and improve productivity. By providing farmers with real-time data on their crops, the system enables them to make informed decisions regarding water and fertiliser usage, pest control, and optimal harvesting times. This, in turn, can lead to increased crop yields, reduced costs, and improved profitability. With the increasing demand for food production and the need to address the challenges of climate change and food security, this project serves as a promising solution for sustainable agriculture.***

Keywords: ***Agriculture, DHT11, IOT, NodeMCU, Sensor.***

I. INTRODUCTION

Cultivation is one of the most important things a man can do, as many people see it as having significant benefits. The use of technology can have a big impact on irrigation advancement. An irrigation system that determines the amount of water required by the plant and supplies it by using artificial intelligence, cloud computing, and remote sensing techniques. Smart devices can be used to remotely regulate and operate the irrigation system, saving time, labour, and water.

It is a system that relies on the use of soil moisture sensors to schedule an electronic irrigation system automatically. This allows one to determine how much water the soil requires based on the percentage of moisture in the soil, and it can also be used to determine the irrigation requirements of crops based on the type of crop and the agricultural seasons. As a result. Additionally, by providing plants with the right amount of water, intelligent irrigation systems can increase crop yield and improve crop quality. Because less water and energy are required when using this method, irrigation costs are also reduced. As a result, it is crucial to maintain continuous water flow and manage it according to the plant's needs. Furthermore, to oversee and control the irrigation process, as well as agricultural lands.

II. LITERATURE SURVEY

Sukriti et al. have developed an IoT-based Smart Irrigation and Tank Monitoring System designed to minimise water wastage through intelligent irrigation practices. It discusses how the Internet of Things (IoT) can be utilised to monitor water levels, enabling continuous and efficient irrigation. It also goes over how to use the suggested mobile application to maintain the water supply [1].

To aid farmers, novelist Joaquín Gutiérrez suggested introducing an automated watering system. To sense the information in this, a wireless network of temperature and moisture sensors is used. To schedule irrigation, the gateway device starts the actuators and sends data between the farmer and the web application. The system's power supply comes from the photovoltaic panels [2].

A novel GSM-Bluetooth-based remote-controlled embedded irrigation system was proposed by Indu Gautam and S.R.N. Reddy (2012) in the International Journal of Computer Applications. It depends on crop type and sensor data to determine the irrigation schedule in advance. Through SMS, the system communicates with the user. The message transformation process utilises GSM technology. The use of Bluetooth technology inside the specific meters will prevent SMS charging [3].

To assist farmers in applying the appropriate amount of water to their lands, N.V. Gowtham Deepshikha et al. proposed a design for an irrigation system based on a soil moisture sensor and microprocessor.

The 8051 microprocessors Sensors are used in conjunction with Keil Vision 3 software. The pump will shut off when the land reaches 70% moisture, and it will continue to run

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until the land reaches a specific moisture level below 70%. With a solenoid valve, the water pump is adjusted [4].

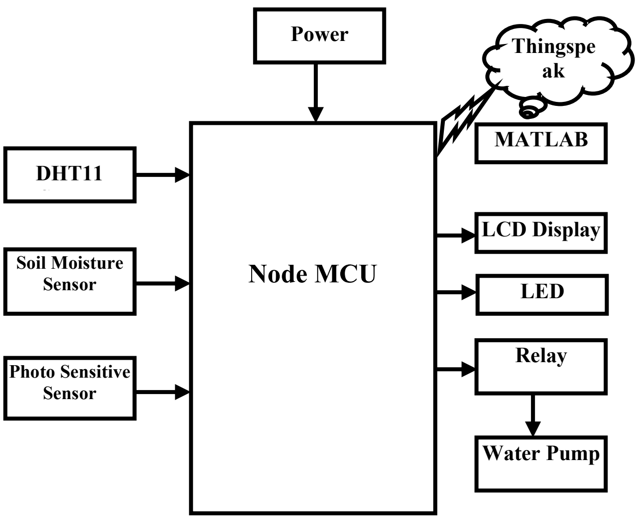
The authors, Supravi, AP, and Saraswathi R. Devadiga, proposed an IoT-based method that works in conjunction with sensors and analogue-to-digital converters to process data. They measured the soil conditions, such as pH, moisture, and temperature, and utilised IoT systems to enable more efficient water usage and reduce crop damage risks. The implementation typically involves an Arduino Uno controller connected to soil moisture and temperature sensors, allowing for real-time monitoring and management of agricultural processes [5].

M. Jagadesh (2018) submitted a wireless sensor network-based agricultural monitoring system to the International Journal of Creative Research Thoughts (IJCRT), which utilises sensors to measure temperature, moisture, pH, and water levels. Zigbee technology will be used to transfer the data from those sensors to the Arduino. The Raspberry Pi also processed data to control the water pump. The live status of the field will send over the webpage received from the predefined IP address in the module [6].

S.R.N. Reddy Purnima (2012) presented a design for a remote monitoring and Control System with an automatic irrigation system utilising GSM-Bluetooth in the International Journal of Computer Applications. This design offers a low-cost, low-power remote irrigation monitoring and control system. To eliminate SMS charges, the system is built using a sensor and a microcontroller that are interfaced with Bluetooth to transform data within a limited range of the device. Data such as CO_2 concentration, low moisture content, and excessive temperature are sent to farmers via SMS using GSM technology [7].

A. Block Diagram

The innovative irrigation System consists of a DHT11 sensor, One Moisture sensor, a light sensor, a water pump, a light and a 16x2 LCD I2C (Fig. 1).



[Fig.1: Block Diagram]

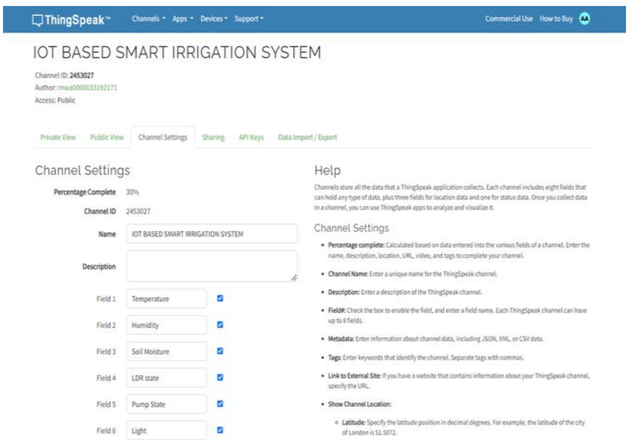
Here, ESP8266 will control the entire process and send the soil status information to the display unit. The Moisture sensor will detect the moisture level in the soil or recognize when you need to water your plants. Humidity and Temperature Sensor (DHT11). Which traces the temperature change. And the light sensor, which works as an alternative to the sun when it sets. All these sensors are connected to the Node MCU ESP8266, which not only automatically irrigates the water based on the soil's moisture level but also sends data to the Data Server to track the land's condition. The System will consist of a water pump used to sprinkle water on the land, depending on the land and environmental conditions, such as Moisture, Temperature, and Humidity.

III. RESULT AND DISCUSSION

This section focuses on the project's implementation. The first component is about our Thingspeak channel development, followed by Matlab analysis. The testing results for all components are explained, followed by the analysis, and the project deliverables are provided in the final section.

A. Thingspeak Channel

We've set up our ThingSpeak channel and entered the channel configuration information. We can provide up to 8 fields, but for our project, we only needed 6: soil moisture, LDR state, pump state, light, temperature, and humidity. (Fig. 2)



[Fig.2: Thingspeak Channel Setup]

B. Matlab Analysis Tool

MATLAB Analysis can be used to investigate data contained in ThingSpeak channels. Time Control can be used to activate our code at specified times, while the React app can be used to trigger an action when a predefined condition is fulfilled. The software provides templates with sample code for performing analysis and sending emails.

We constructed four MATLAB analysis templates for soil moisture, temperature, humidity, and light status, as shown in Figure 3.

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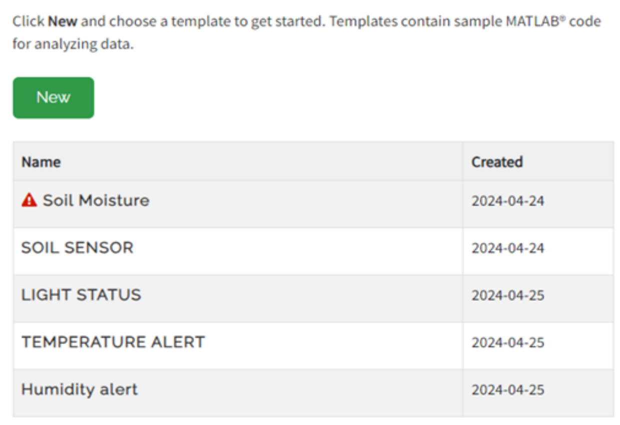

Click **New** and choose a template to get started. Templates contain sample MATLAB® code for analyzing data.

New

Name	Created
Soil Moisture	2024-04-24
SOIL SENSOR	2024-04-24
LIGHT STATUS	2024-04-25
TEMPERATURE ALERT	2024-04-25
Humidity alert	2024-04-25

[Fig.3: Matlab analysis Templates]

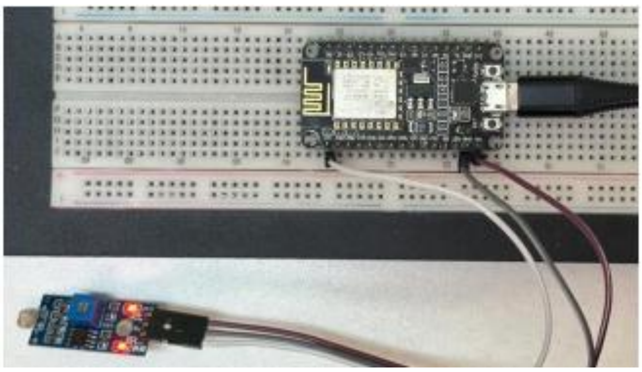
C. NodeMCU Testing

We connect the NodeMCU to the laptop (Fig. 4). Next, we launch the Arduino software and select the Blink application from the Arduino IDE (File > Examples > ESP8266). Select 'Blink'. After verification, the software is uploaded to the Node MCU. The NodeMCU board's built-in LED is now blinking.

[Fig.4: NodeMCU Testing]

D. Photosensitive Sensor

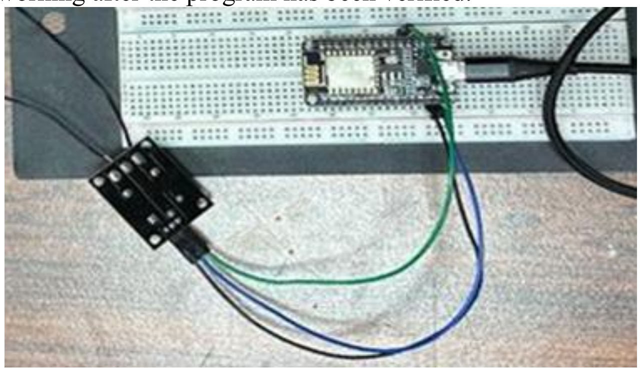
Figure 5 illustrates the connection of the photosensitive sensor to the Node MCU (Vin> Vic, GND > GND, DO > D5), followed by the connection of the Node MCU to the laptop. After that, we accessed the Arduino software and uploaded the application. After checking the software, open the serial monitor and check the output. It will show "light" or "dark".



[Fig.5: Photosensitive Sensor Testing]

E. Relay Testing

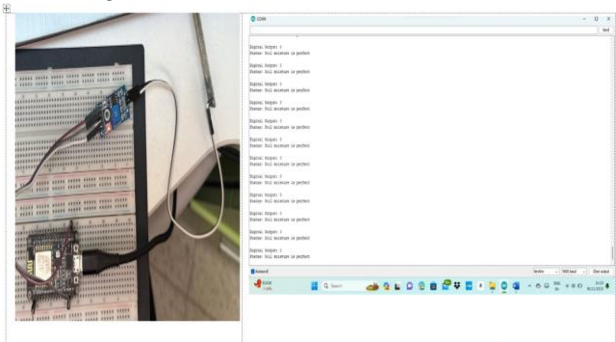
The relay is connected to the Node MCU via Vcc to Vcc, ground to ground, and the relay input to Node MCU pin D8.Additionally, the COM port is connected to the -12 V supply, and the on relay is connected to the pump's positive terminal. (Fig. 6) After that, we accessed the Arduino software and uploaded the application. The pump starts working after the program has been verified.



[Fig.6: Relay Testing]

F. Soil Moisture Sensor

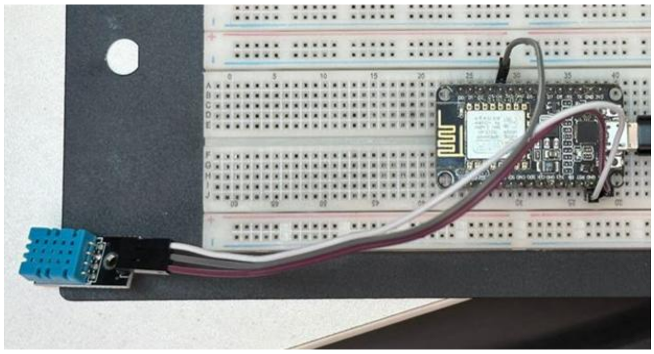
As its name suggests, a soil moisture sensor measures the amount of moisture in the soil. This can be especially useful if you want to gauge how quickly water is draining at a particular spot or precisely identify when plants need to be watered. The connection and output of the serial monitor are shown in Figure 7.



[Fig.7: Soil Sensor Output]

G. DHT 11 Sensor

The circuit below (Fig. 8) shows how to connect the DH11 sensor to NodeMCU.



[Fig.8: DHT 11]

The data output pin of the DHT11 can be connected to digital pin 3 (D3) of the NodeMCU. The VCC pin of the sensor is connected to the Vin pin of the NodeMCU.

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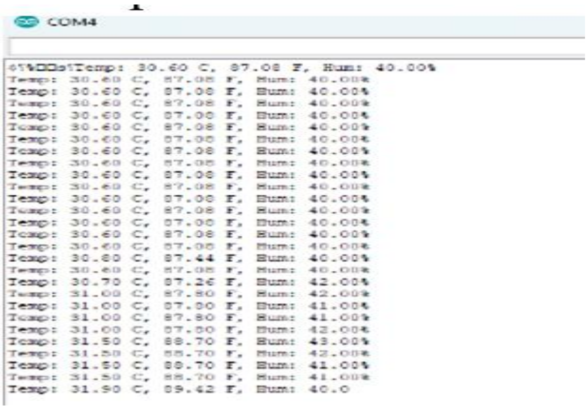
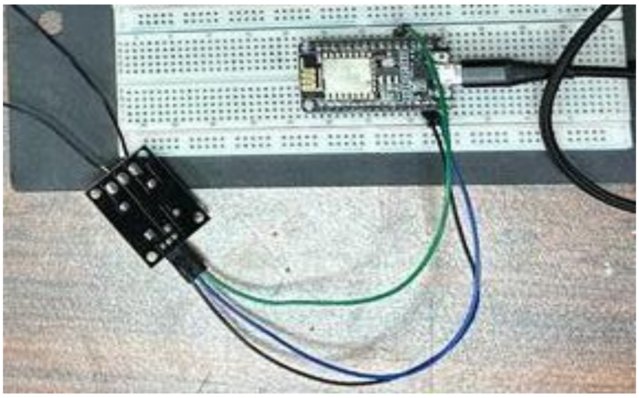
The GND of the DH11 sensor can be connected to the GND of the NodeMCU. Finally, the program was run in Arduino software by pressing the upload button to test the DHT11 sensor's functionality. The output is shown in Figure 9.



[Fig.9: DHT 11 Output]

H. Relay

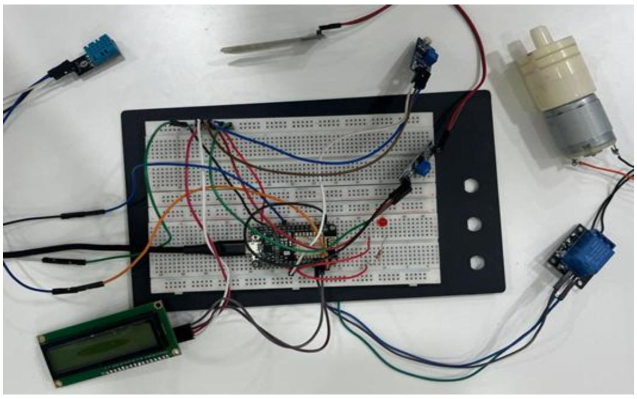
The diagram (Fig. 10) illustrates how to connect the relay to the Node MCU (Vin > Vcc, GND > GND, IN > D8) and the laptop (COM > "– "12V battery, ON>> "+" of pump). Next, we launched the upload program and Arduino software. The pump will start up after the software has been verified.



[Fig.10: Relay]

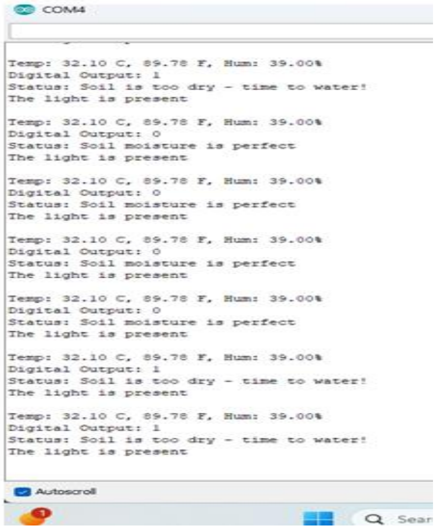
I. Final Circuit Assembly

All the components are connected to create the final circuit once the testing of the individual components has been completed successfully. (Fig. 11)



[Fig.11: Final Circuit Assembly]

The required coding for each component is combined to create a new version of the application. After being checked, the written software is uploaded to the Node MCU. Additionally, we installed a soil moisture sensor to gauge the plant's moisture content. When the moisture content drops, the MCU signals the relay to activate the water pump. When there is no light coming from the sun, the photosensitive sensor detects this and signals the NodeMCU to turn on the LED, which serves as a substitute for sunlight. The serial monitor (Fig. 12) and LCD show all the values.



[Fig.12: Serial Monitor Result]

J. Final Prototype

The final prototype of the project is shown in Figure 13.

[Fig.13: Final Prototype]

Both the Thingspeak channel and the serial monitor display the findings. Figure 14 shows the conclusions of the serial monitor, and Figure 15 displays the Thingspeak channel output. The user will receive an email from the MATLAB Analysis app if the parameter values surpass the predetermined values. In Figure 16, a sample of received emails is displayed.

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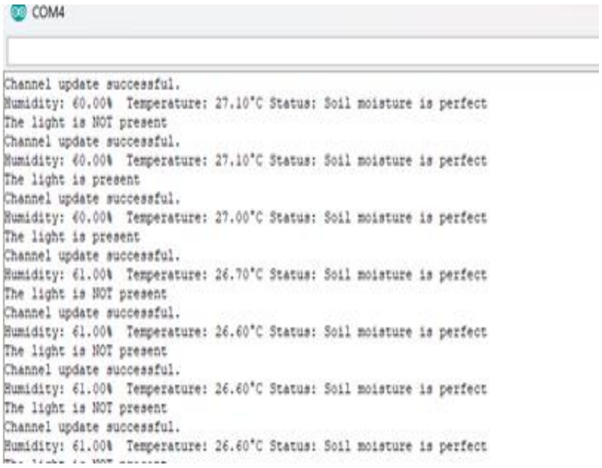
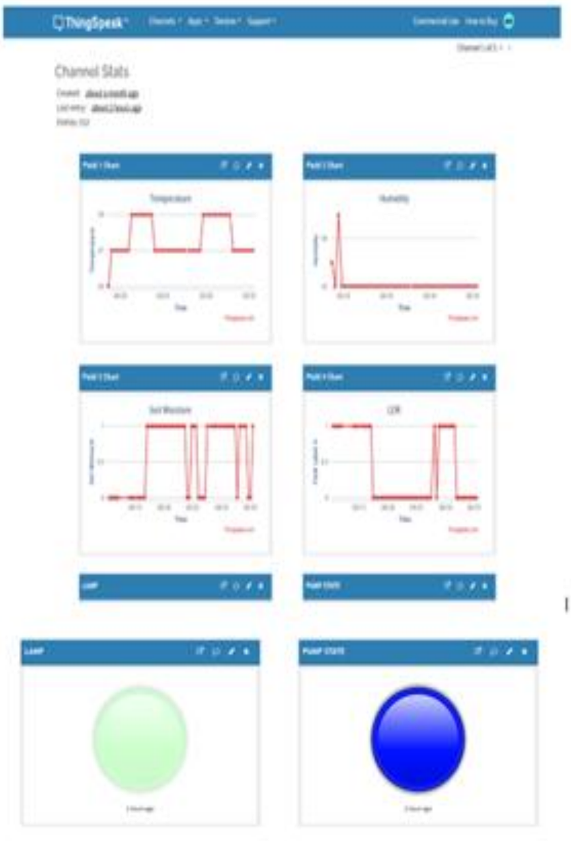
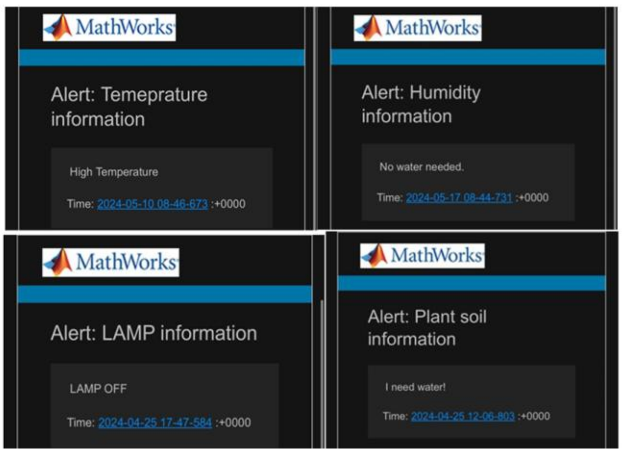


[Fig.14: Final Prototype Serial Monitor Output]



[Fig.15: Thingspeak Output]



[Fig.16: Email Alert]

IV. CONCLUSION

This research presents a practical method for identifying an intelligent irrigation system that enhances performance, offering a cutting-edge approach to water conservation and irrigation system automation. The study demonstrates how to employ accurate soil moisture sensors, which makes it easier to track and document changes in soil moisture. The temperature is measured and evaluated using the NodeMCU microcontroller in conjunction with a moisture sensor, a temperature sensor, and a light-dependent resistor sensor. Information regarding the soil's moisture status can be obtained by monitoring the soil for a specified period of time. The data received from the sensors will be gathered and processed by the NodeMCU. Water will flow through the soil when the soil's threshold moisture level is reached. This is crucial since a healthy yield depends on the plant receiving water at a specific time. The project's elimination of manual or traditional irrigation system methods is beneficial to farmers and nursery specialists.

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DECLARATION STATEMENT

After aggregating input from all authors, I must verify the accuracy of the following information as the article's author.

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- **Funding Support:** This article has not been sponsored or funded by any organization or agency. The independence of this research is a crucial factor in affirming its impartiality, as it was conducted without any external influence.
- **Ethical Approval and Consent to Participate:** The data provided in this article is exempt from the requirement for ethical approval or participant consent.
- **Data Access Statement and Material Availability:** The adequate resources of this article are publicly accessible.
- **Author's Contributions:** The authorship of this article is contributed equally to all participating individuals.

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