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Smart Atmospheric Water Generator Using Sensor Automation and Web-Based Monitoring

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Abstract - Water scarcity remains a world-wide problem, especially in arid areas where conventional resources are limited. Atmospheric Water Generation (AWG) technology offers the possibility of water harvesting from ambient air as an alternative. This paper provides the design, development, and testing of a hybrid AWG system combining thermoelectric cooling and desiccant adsorption. The system utilizes IoT-based monitoring using Arduino and NodeMCU for efficiency and automation. Experimental testing under varying humidity conditions confirms the efficiency of this system with decentralized, off-grid water harvesting application. Economic and environmental sustainability factors of AWG are considered in this research with regard to sustainable implementation.

Keywords- Atmospheric Water Generation, Arduino Automation, IoT-Based Water System, RESTful Web Service, Humidity Sensor, Water from Air.

1.INTRODUCTION

Water scarcity is arguably the most pressing problem of the 21st century, impacting over 2 billion people worldwide. Atmospheric Water Generation (AWG) technology has the potential to solve this issue by collecting water vapor from air and condensing it into drinking water. In this paper, we present a smart AWG system utilizing sensor-driven Arduino microcontrollers and data communication via RESTful web services. This enables not just the automation of water harvesting based on current humidity levels but also an open, remotely accessible solution suitable for remote and low-resource applications.

2. LITERATURE SURVEY

Some research has been conducted on the feasibility and efficiency of AWG technologies. Thermodynamic models
have been established to compare various AWG systems, with findings suggesting that absorption-based systems.
are the most energy efficient, followed by cooling condensation and adsorption-based
systems【15†source】. Experimental studies have proved that airflow, humidity, and cooling optimization have greatly enhanced water yield【17†source】. In addition, research on composite desiccant materials has
provided encouraging results in improving moisture absorption and regeneration cycles【18†source】.
Recent developments in AWG technology have involved the employment of hybrid cooling systems, enhanced
desiccant materials, and energy-efficient condensers. Research indicates that the incorporation of renewable
energy sources like solar or wind power will enhance the sustainability of AWG systems【19†source】. Research further emphasizes the optimization of system components to minimize energy consumption while achieving
maximum wateryield【21†source】.

3.METHODOLOGY

The system to be proposed will be able to capture water from atmospheric humidity through a sensor-based and internet-based hardware system. The system involves the integration of humidity and temperature sensing, automatic control of the condensing system, and real-time monitoring through RESTful web services. The steps to implement them are as follows:

Sensing Envirnomental Conditions

A DHT11 sensor is interfaced with an Arduino Uno to detect ambient relative humidity and temperature. These are crucial in determining if atmospheric conditions are conducive to water generation or not. Humidity value (typically >60%) is used as a threshold value to trigger the subsequent operation stage.

Activation of Water Generation Unit

After the humidity level goes beyond the threshold, the Arduino instructs the condensation system (in most cases, a thermoelectric cooler or a coil refrigerant system) to activate. The air moisture condenses upon contact with the chilled surface and is gathered into a water tank

Water Level Monitoring

A water level sensor is installed in the collection tank. It continues to monitor the amount of water collected at all times. When the tank is full, the microcontroller is caused to switch off the cooling system to conserve energy and prevent overflow.

RESTful Web Service Integration

Arduino is interfaced with a NodeMCU (ESP8266), which supports Wi-Fi. Sensor readings are sent to a web server via HTTP requests in the form of a RESTful API. Data sent includes temperature, humidity, water level, and system status.

Remote Monitoring and Control

Users can access a web or mobile dashboard with real-time data. Control commands (e.g., manual override, shut down, scheduling) can be sent to the system back via the same REST API, allowing two-way communication. 6. Data Logging and Analysis All the operational and environmental information is logged on a cloud platform to be analyzed later. This makes it easier to measure performance, perform predictive maintenance, and more**.**

4. FUTURE SCOPE

The system can also be upgraded by adding AI models to forecast optimal operating cycles from weather forecasts. High-performance desiccant materials and enhanced cooling systems can enhance water yield. Solar and wind energy input integration can render the system completely off-grid. Mobile app control, auto-cleaning systems, and water quality and environmental impact analytics dashboards can also be added in future versions.

5.APPLICATIONS

Remote and Rural Areas:
Provides stand-alone water harvesting where there is no infrastructure.

Military and Relief Camus:
Autonomous and mobile facilities that are appropriate for transient settlements.

Smart Homes and Cities:
Integrates into smart resource management platforms.

Agriculture and Irrigation:
Offers sustainable irrigation services in arid regions.

6. PROPOSED SYSTEM

The suggested system is an Arduino-based smart atmospheric water generator with humidity sensors and a condensation unit to harvest water from air. It possesses real-time monitoring through a RESTful web service and NodeMCU-based automatic control. Energy efficiency and remote access are achieved in the system, and it provides a green, IoT-based solution to generate water in any environment.

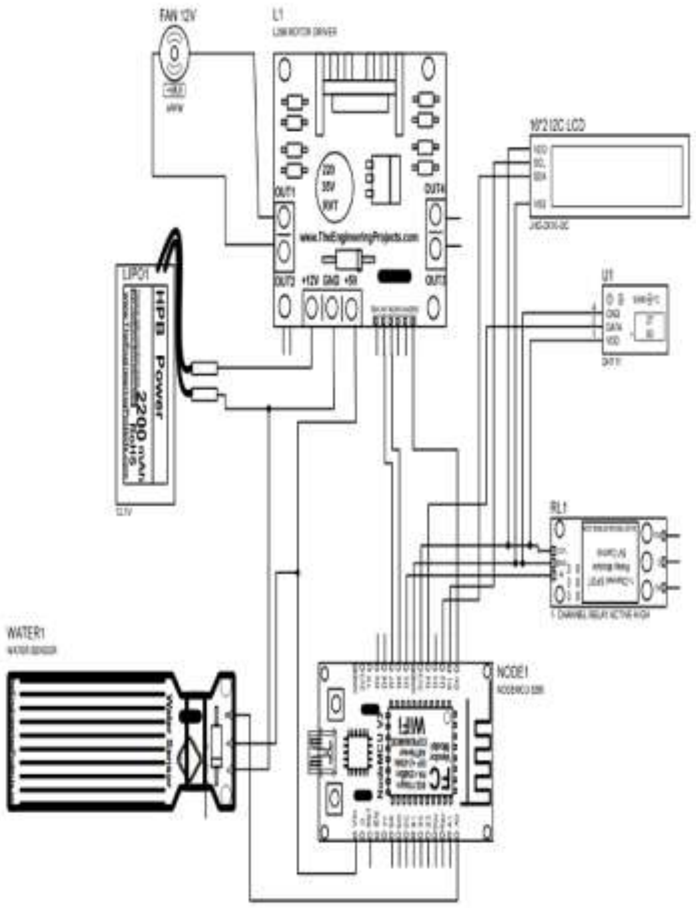

Figure 1. Circuit Diagram of Project

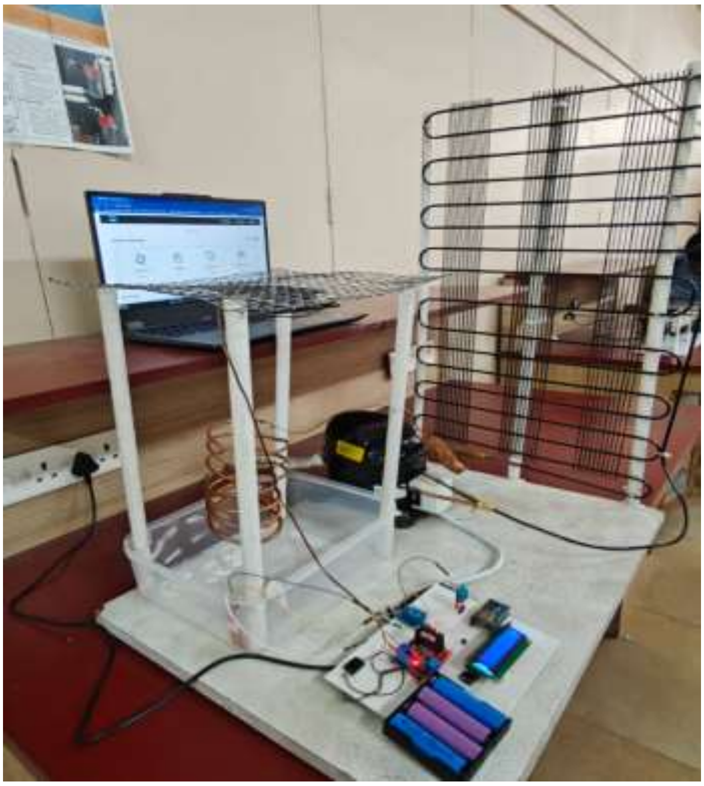

Figure 2. Hardware Implementation of Project

7. COMPONENTS

1] **DHT 11 Sensor -**It is a Low-cost digital temperature and humidity sensor that provides reliable data over a range of environmental conditions. It is widely used in hobbyist projects, home automation systems, and environmental monitoring devices.

Figure 3: DHT 11 Sensor

2] 16*2 I2C LCD – It is a liquid crystal display that can show 16 characters in each of its two rows, providing a total of 32 characters of information.

Figure 4: 16*2 I2C LCD

4] Node-MCU 8266 – It is an open-source IoT platform that integrates the ESP8266 Wi-Fi module, providing both microcontroller capabilities and Wi-Fi connectivity. It enables developers to create network-connected projects with ease, using the Lua scripting language or the Arduino IDE.

Figure 5: Node-MCU 8266

5] Water level sensor - is a device that detects and measures the level of water in a container or system in real-time.

Figure 6: Water level sensor

6] Relay – It is an electrically operated switch used to control a high-power circuit using a low-power signal.

Figure 7: Relay

7] L298N motor driver – It is a dual H-bridge module used to control the speed and direction of two DC motors or one stepper motor.

Figure 8: L298N motor driver

8] Condenser – It is a device that converts vapor (such as water vapor) into liquid by cooling it.

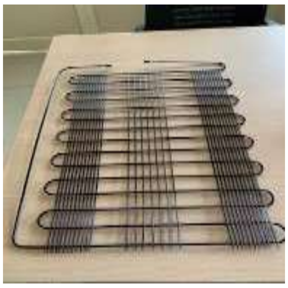

Figure 9 : Condenser

9] Copper pipe – This is used for making humidity grabbed and changing into ice form.

Figure 10: Copper Pipe

10] Compressor - A compressor is a mechanical system that compresses a gas by decreasing its volume. An air compressor is one type of gas compressor.

Figure 11: Compressor

8.WORKING

The system runs in real time, starting with environmental monitoring via sensors. The Arduino, upon sensing favorable humidity, triggers the cooling process, condensing water vapor onto the cooled surface. As water builds up in the collection tank, sensors monitor the water level and send status notifications through the RESTful service. This configuration enables system behavior (ON/OFF, sensor alerts) to be remotely controlled, allowing for efficient and responsive system operation.

9. CONCLUSION

This study succeeds in demonstrating a functional and scalable proof of concept of an intelligent atmospheric water harvester using Arduino-based sensors and RESTful web service integration. The platform not only simplifies harvesting water from air economically but also enhances the transparency and control of such systems using IoT-based automation. With water scarcity challenges on the rise, this model is a viable step toward sustainable water access, especially in underdeveloped and climate-risky regions.

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