Air to Water Extraction Using Peltier Device and Ground Rover

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Abstract. Nowadays several countries such as India are facing a big problem that is not having enough water because of this growing population and various activities, particularly in desert regions and remote areas. This paper presents an innovative method to extract water from the air by utilizing Peltier effect technology. The system consists of Heat Sinks and ceramic plants. We have different methods to extract water like Atmospheric Water Generation, Refrigeration Systems, Dehumidification techniques, etc. By using all these methods we can't get more amount of water. So to maximize water production in our proposed system we are using Ground Rover which finds the locations with high moisture level content and a DHT11 sensor that will measure the humidity and temperature of the surrounding environments. Raspberry Pi can act as a central control unit for the entire system because by using this we can extract more amount water in a very short period.

Keywords: Peltier Device, Ground Rover, Solar Energy, Raspberry Pi, DHT11 sensor.

INTRODUCTION

Water scarcity is a pressing global challenge that arises from various interconnected factors like Growing Population, Pollution, and Over-extraction of Groundwater. Water is a fundamental requirement for the survival of all living organisms. It plays a critical role in various biological processes such as Hydration due to insufficient amount of water.

The atmosphere holds a vast reservoir of water vapor, particularly in humid conditions, creating a natural and untapped resource for addressing water shortages. This abundant water vapor, often overlooked, presents a promising solution to the global challenge of water scarcity.

By harnessing this atmospheric moisture, we can extract water naturally without causing harm to the environment. For this, we are using a device called the Peltier device, designed to naturally extract atmospheric air, which represents a cutting-edge solution to water scarcity. This innovative technology exploits the principles of thermoelectricity, inducing a temperature difference to condense water vapor from the air efficiently. Complementing this, integrating a ground rover adds a strategic dimension to the process. The ground rover, equipped with sensors and mobility features, traverses diverse terrains to pinpoint locations where the atmospheric water content consistently remains high. This dynamic approach enhances the scalability of the atmospheric water extraction system and ensures that the device is deployed in optimal conditions. By leveraging the Peltier device for extraction and the ground rover for precise location identification, this system maximizes the efficiency of water harvesting from the atmosphere.

LITERATURE SURVEY

Researchers dedicated their efforts to address the water scarcity problems.

Sachin P R et.al.,[1]. In this project, they used Arduino Uno, which consists of servo motors, and an LDR sensor and it controls and calculates the position of the servo motors. They also use solar tracking systems to help these systems to track the sun's rays. The goal is to collect as much solar energy as possible. Additionally, researchers are looking at ways to make clean water using technologies like external purification systems. To manage the water, they use ultrasonic sensors that can measure water levels accurately. The system will not off if the water level is less than 1 cm from the sensor; otherwise, it will continue to function. One important aspect highlighted in the literature is the need for a continuous supply of solar energy, often stored in batteries during the day. This stored energy can then be used to keep the system running at night, making it independent and sustainable. In 4.3 hours, this system generates one liter of water during the daylight.

Vandana, P. Pandya, Dhruv [2]. During this one, they use the Water Generator to extract water and to cool the air around the Atmospheric Water Generator they use evaporator coils and Atmospheric generator used for cooling condensation will not operate effectively if the temperature below 18.3°C. They are also using some purification systems externally to purify the water to make water drinkable.

Ramya M et.al, [3]. While researchers extract water using a Peltier device. They used two Peltier devices to implement the project and to move the heat generated by the hot side of the Peltier device to the cold side, the authors used the Conductor compound.

K. Nitheesh, S. Saravanan, A. Ashik Ahamed. In this project, they can extract a one-liter quantity of water per hour.

METHODOLOGY

The methodology for water extraction using a Peltier device and ground rover begins with the careful assembly and calibration of the Peltier device onto the rover chassis. It's crucial to ensure that the device is securely mounted and properly connected to a power source suitable for its specifications. Calibration involves fine-tuning the system to accurately control and monitor temperature variations during operation.

To equip the ground rover with environmental sensors for data collection, the DHT11 sensors will be utilized. These sensors are capable of measuring temperature and relative humidity, providing essential inputs for calculating the dew point temperature. Implementing the robust mobility and navigation capabilities in the ground rover, allowing it to traverse diverse terrains and access different areas for water extraction. This may involve integrating sensors and algorithms for autonomous or remote-controlled navigation.

Here's how to integrate the DHT11 sensors with the ground rover:

Mount the DHT11 sensors onto the ground rover's chassis at strategic locations to ensure accurate measurement of ambient conditions. Position the sensors in areas where they can capture representative environmental data without obstruction.

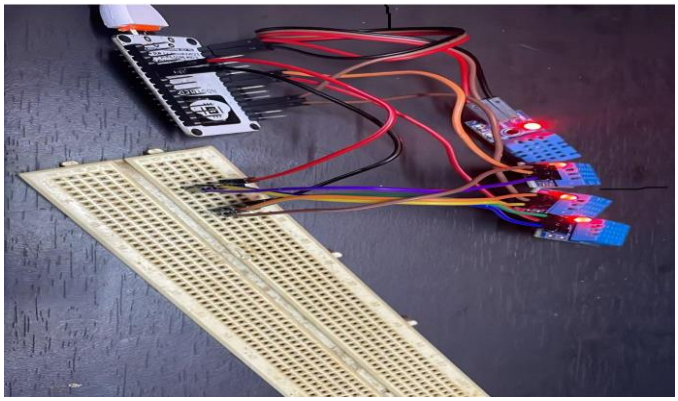


FIGURE 1: Block diagram for suggested approach

Figure 1 shows the connection between DHt11 sensors with ESP8266 and here is the description that how to connect:

- Attach the VCC pin from the DHT11 sensor to a 3.3V power source on ESP8266.
- Attach the GND pin from the DHT11 sensor to the ground pin on ESP8266.
- Attach the DATA pin from the DHT11 sensor to one of the GPIO pins on the ESP8266 (e.g., GPIO2 or GPIO4).

Implementing software routines to read data from the DHT11 sensors at regular intervals. Using some libraries or APIs compatible with the Raspberry Pi as a microcontroller or single-board computer to facilitate data acquisition and communication

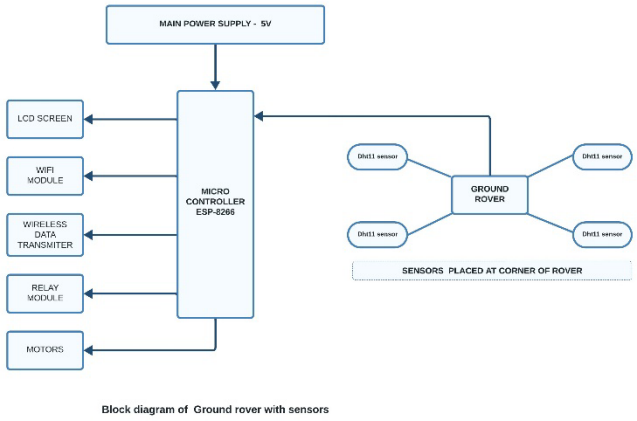


FIGURE 2. Block diagram of Ground Rover with DHT11 sensors.

Ground Rover is equipped with a variety of sensors to measure atmospheric conditions such as humidity, temperature, and air pressure. This rover traverses different terrains, allowing for comprehensive data collection. Utilize meteorological data and climate models to pinpoint areas where atmospheric water content is consistently high.

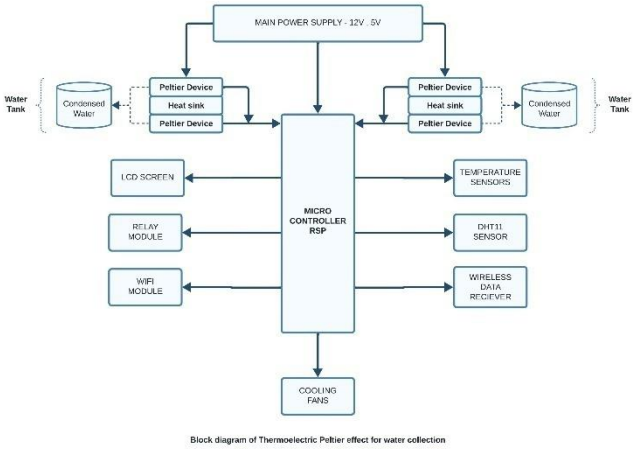


FIGURE 3. Block Diagram of Thermoelectric Peltier Effect for Water Collection

The Peltier device, also known as a thermoelectric cooler, can be utilized for water extraction. It takes the location given by the Ground Rover to extract the maximum amount of water. When one side of the device is heated and the other cooled, it creates a temperature differential that can cause condensation of water vapor. The capacity of air to hold water vapor fluctuates based on temperature and humidity; warmer air has a greater capacity to hold moisture. Here, we're utilizing a device known as a Peltier device, which has a hot side and a cold side. First, open air is directed toward the cold side of the Peltier element, assisting in lowering air temperature, causing the air to cool, lose some of its water-holding ability, and begin to condense with moisture. The temperature of the hot side is subsequently lowered by passing this air through the Peltier device's hotter side. The Peltier device begins to run as soon as it is attached to the power source, and it must continue to run to maintain the temperature at the recent side.

Hardware Description

Esp-8266 WiFi Module

FIGURE 4. ESP-8266

Manufacturers are utilizing the inexpensive ESP8266 Wi-Fi module to create microcontroller modules capable of wireless networking. The ESP8266 WiFi module functions as a system-on-a-chip, offering 2.4GHz capabilities range. An 80 MHz 32-bit RISC CPU is employed for computational operations. It operates on TCP/IP protocol suite. Performing the IoT operation, it stands as the pivotal component within the system.

LCD Display

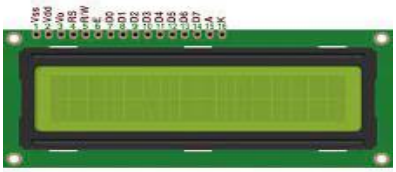


FIGURE 5. LCD Screen

The necessary pins for an LCD interface (Liquid Crystal Display) are those that allow for communication with the LCD controller. The Register Select (RS) pin determines whether data or instructions are being sent by distinguishing between writing updates to the screen content (data register) and sending operational directives (instruction register). The Read/Write (R/W) pin allows for the distinction between read and write processes and facilitates data store and retrieval. The Enable pin begins the processing of the given data and starts the execution of commands or data transfer by going from high to low. Finally, eight bits of data can be transferred during write operations or when reading data that has been received thanks to the eight data pins (D0 through D7). This parallel interface design is necessary for microcontroller or microprocessor-driven devices to interact with and control LCDs.

Relay

FIGURE 6. Relay

An electrically controlled switch known as a relay comprises input terminals designed to receive one or multiple control signals, alongside a collection of utilising contact terminals. Different contact forms, such as make and break connections, or combinations of them, with an arbitrary number of contacts, may be included in the switch.

DHT11 Sensor

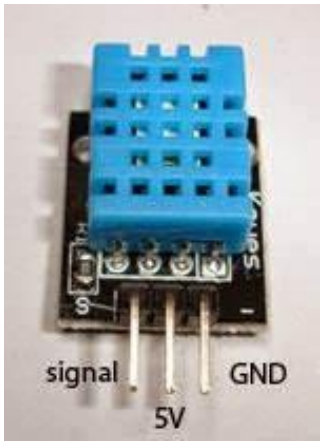


FIGURE 7. DHT11 Sensor

The DHT11 is an inexpensive digital sensor designed to measure humidity and temperature. It is compatible with a wide range of microcontrollers like Arduino, Raspberry Pi, etc., facilitating humidity and temperature measurement effortlessly. DHT11 module has three pins: the GND pin, the VCC pin, and the DATA pin.

Raspberry Pi

FIGURE 8. Raspberry Pi

The Raspberry Pi series is a collection of compact, reasonably priced single-board computers created by the Raspberry Pi Foundation. It typically features a system-on-a-chip containing CPU, GPU, RAM, USB ports, HDMI ports, GPIO pins, and various other peripherals.

RESULTS & DISCUSSION

This section presents the outcomes of simulation studies, hardware testing, and a comprehensive performance analysis of the “Air to Water Extraction Using Ground Rover”.

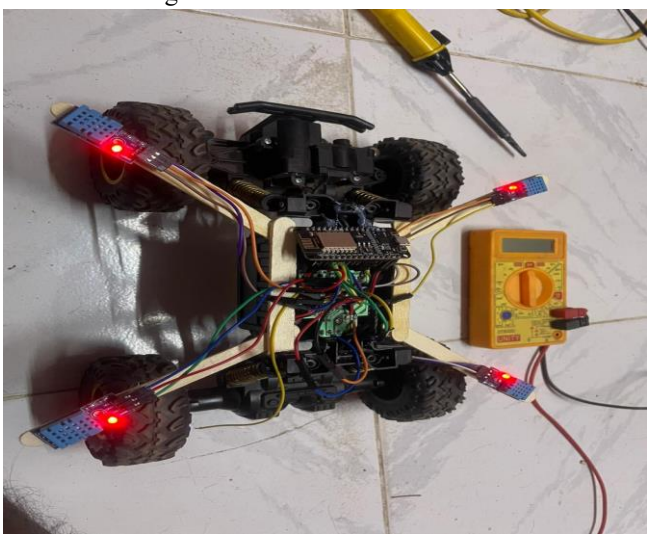


FIGURE 9. Hardware Connections of DHT11 sensor with ESP8266 on Ground Rover

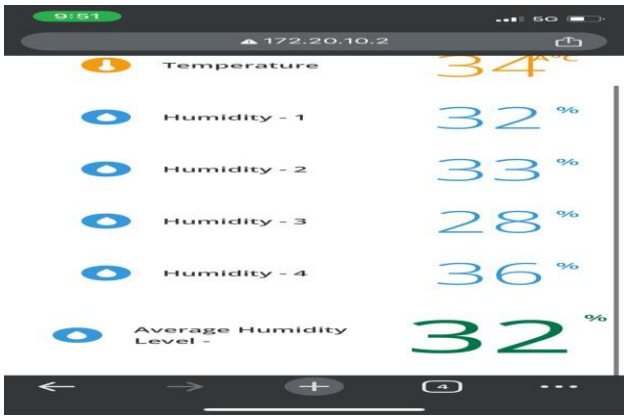


FIGURE 10. Output Image of Ground Rover

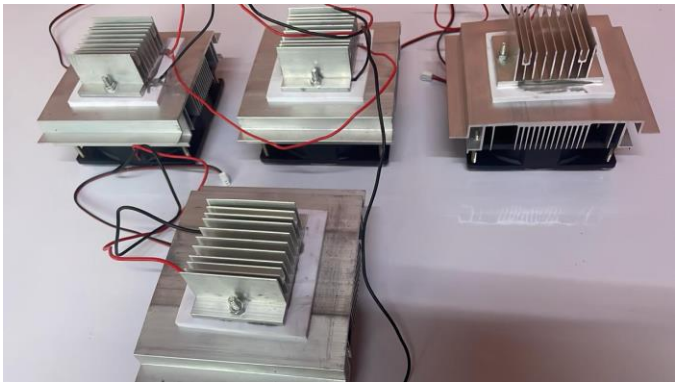


FIGURE 11. Hardware Arrangements of Peltier Devices

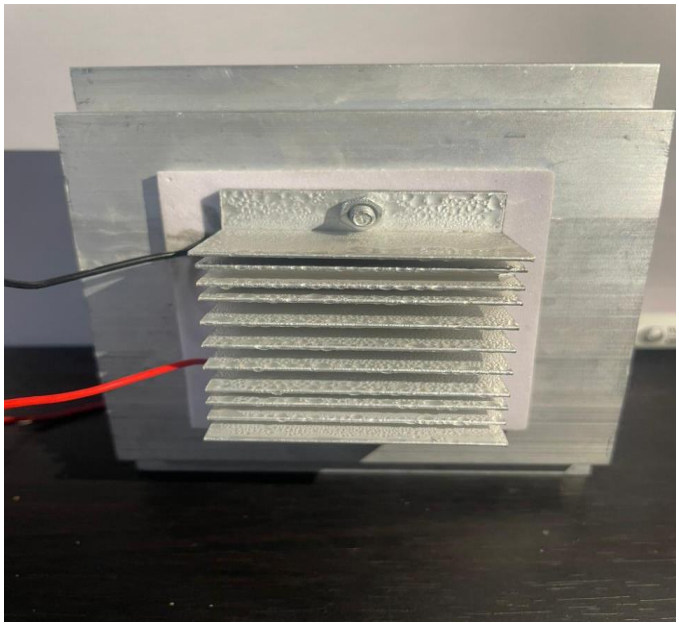
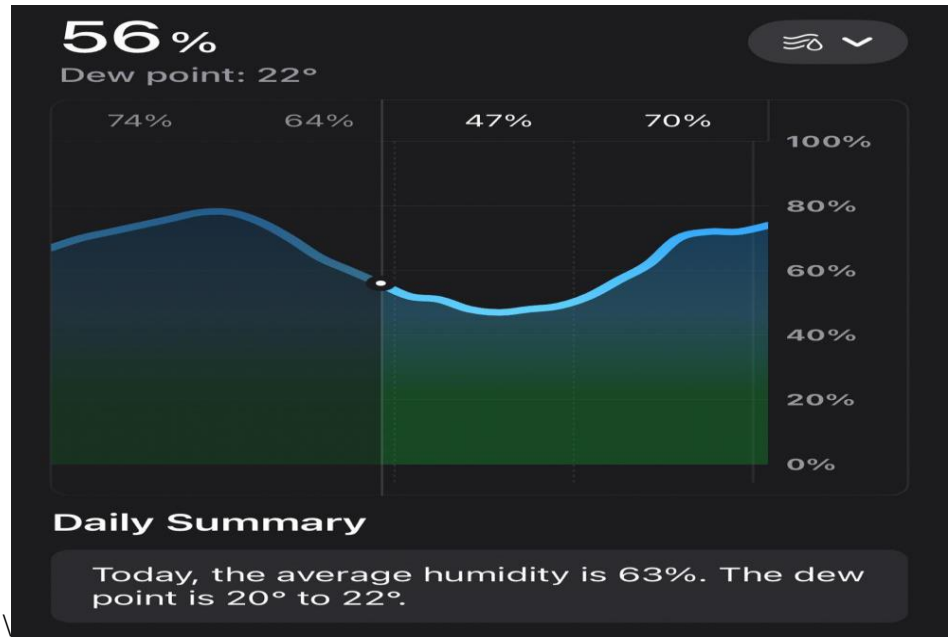


FIGURE 12. Water Droplets Collection in Peltier

TABLE 1. Values of Temperature & Humidity Readings

S. No	Temperature	Humidity	Absolute Humidity
1.	38°C	52%	9.6 g/kg
2.	27°C	56%	12.8 g/kg
3.	27°C	58%	13.2 g/kg
4.	27°C	46%	10.5 g/kg
5.	23°C	52%	9.3 g/kg
6.	26°C	52%	11.1 g/kg
7.	23°C	52%	10.2 g/kg
8.	24°C	47%	8.4 g/kg
9.	24°C	41%	7.8 g/kg
10.	34°C	41%	14.2 g/kg



. FIGURE 13. Graph between Due point and relative humidity

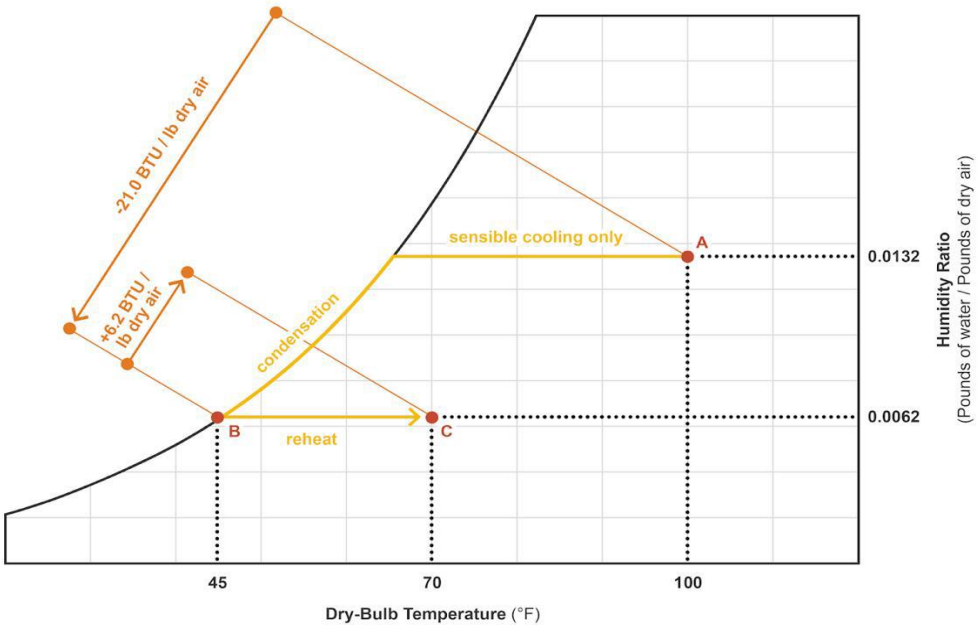


FIGURE 14. Psychrometric Chart

CONCLUSION

In this project, we used four Peltier devices to extract more amount of water. The design of the device is very easy and we can carry it anywhere because of this simple structure. Our project resolves the problems of water scarcity. This system can generate a one-liter quantity of water in an hour. With further improvements, this method could play a key role in ensuring a more secure and abundant water supply for the world. Our upcoming work on this project aims to design a system that can yield large volumes of water while operating with minimal power consumption.

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