IoT Based Smart Solar Atmospheric Water Harvesting System

Sudarshan E¹, Seena Naik Korra², Prof. Rajasekharaih KM³, S Venkatesulu⁴, A Harshavardhan⁵

¹Sumathi Reddy Institute of Technology for Women, Warangal, India.
², ³SR Engineering College, Warangal, India.
⁴Principal & Professor, Kshatriya College of Engineering, Armoor, Nizambad Dist., India.
⁵medasare@gmail.com  Orcid: 0000-0001-5682-1471

Abstract: Atmospheric Water Harvesting (AWH) is a device that extracts water droplets from a humid or fog ambient air. It can extract the water droplets by cooling the humid or fog vapours at its dew point or below, exposing or compressing air to desiccants. AWHs are very easy to get clean water here because small amounts of water can always be extracted from the air where water is almost impossible to get. The two main methods of cooling and desiccant can be solved with the Internet of Things (IoT) of solar power panel. If sufficient wind speed is not available to rotate the vertical-axis wind turbine (VAWT) the device receives power from solar panels, otherwise the VAWT will rotate with the help of wind speed and IoT devices will be used to monitor the situation. Here the enough power gets from the solar panel to IoT device and to the turbine. Here, this IoT device checks if the turbine is running, if not with the help of a built-in motor it will run. We have embedded an IoT device to monitor; if there is no air flow in the atmosphere, the IoT motor will intelligently run solar-powered spiral wind turbines. The IoT device collects data as needed, such as water availability, location, temperature and images of animals

Keywords: AWH, VAWT, IoT, Namib Desert Beetle principle, SSAWHS.

1. Introduction

In addition to food and air, the basic need of the people is water. Unlike energy sources and other important commodities, water is not a substitute. There is no life without water. According to the Central Water Commission, India needs an annual water requirement of 3,000 billion cubic meters and an average annual rainfall of 4,000 billion cubic meters. The country, with a population of 1.3 billion, has failed to use a third of the water it receives from the sky [1]. Many people suffer from water scarcity. According to the 1951 census only 5,177 cubic meters were available per capita, and according to the 2011 census there was a 70 per cent decline in 1,545 cubic meters in 60 years.

Many years’ later researchers were able to observe desert species and find a way to collect water. Many inventors have done so on fog water collection by inducing the Namib beetle species. The Namib Desert Beetles live in the arid forests of southwest Africa and collect water from the air for survival. The blueberry-sized, long-legged moth bends its bumpy body into the air, accumulating fog droplets and dropping its wing case into its mouth, shown in Fig.1. A few years later, scientists unlock the secret of how insects can survive in desert areas, a technology that can help supply clean drinking water to people in waterlogged areas. Now scientists have got complete information about how the body of insect helps to collect water from the surrounding air. The same Namib Desert Beetle principle

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was followed to cut off water from the air for isolated communities that could not obtain clean drinking water [2].

![Namib Desert beetle collecting water from fog](image)

Figure 1: Namib Desert beetle collecting water from fog

We propose an IoT based water harvesting method to overcome the problem of water scarcity in forest or hilly or desert areas. Many researchers have focused on producing water in such areas, which are discussed in the next section. Here, we have a lot of goals to have in it. Where there is a shortage of water, this device can be used for water collection or to cultivate water for thirsty animals in the forest or hill or desert. We proposed a solar-based water harvesting machine that works indefinitely and in which we embed an IoT device to monitor; if there is no air flow in the atmosphere, the IoT motor will intelligently run the spiral wind turbines with the solar-power. The IoT device collects data needed for water availability, location, temperature, and animal images. As far as we know, IoT applications have been developed together in various fields such as healthcare [3], agriculture, weather monitoring system [14] and spaceship, military; every IoT is the most useful platform. The proposed methodology is discussed in Section 3.

2. Literature Review

In 2002, Oliver J examined the area's fog water potential. Here some foggy or humid air properties (spatial and temporal) are investigated because the rate of collection of water droplets depends on them. Here they found that high humidity or fog was close to coastal areas. More than 2.5L / m2 of water were collected at Cape Columbine and this is the highest water droplet collection per day. 90% of water collection is deposited by fog and remains due to rainfall. This water is good and suitable for use by humans and animals [4] and the net is placed as shown in Figure 2.

![Fog water collector at Lepelfontein](image)

Figure 2: Fog water collector at Lepelfontein

In 2008, Marzol, Maria Victoria et.al proposed a method. The experiment was conducted in the Moroccan region to find water opportunities in the fog to provide water to small communities living in desert areas. June 2006, they set up 4 fog collection platforms to collect fog water in the Ifni area. The results showed that inland areas could receive an average of 7.1l/m2/day, while coastal areas could receive only 1.9l/m2 per day and the net is placed for experiment as shown in Figure 3. The Atlantic Ocean is a very suitable and ideal location for wet winds to collect water [5].
Presented by Abul-Hamayel et al in 2010, the Asir region is located in the southwestern part of Saudi Arabia at latitude 41 - 45° E and latitude 17 - 21° N. There is a high demand for water during the tourist season and alternative sources of drinking water need to be identified. Although fog events average three months to a year, it takes less time to establish a weather average, indicating a clear trend that fog is a viable resource in the Asir region of Saudi Arabia. The fog water at the glider club and hotel sites was recorded as LFCs 598L and 473L, respectively. The result indicates that the Glider Club site is more capable of collecting fog water than the hotel site. It is not useful in hot climates [6].

In 2012, Klemmet et al proposed a method. Fog water collection is a simple and sustainable technology for deforestation, gardening and obtaining fresh water as a source of drinking water for human and animal use. It is possible to harvest water where fog often occurs and supply clean water to water-scarce communities. The mesh is exposed to the atmosphere, so foggy air passes through the mesh. All the mist drops caught on the mesh are collected and deposited in the storage tank and this collection was different location to location and from time to time. They harvested 3 to 10 liters per day. This article is about reviewing mist collection projects worldwide, analyzing triumph factors and evaluating these technical capabilities. It is useful in hot climates [7]. For this experiment a big net is placed as shown in Figure 5 and with different types of meshes have been used in it Figure 6.
In 2014, Jeremy K. Domen et al. proposed as a mist of water supply to farming communities to the low annual rainfall has great potential, but mist is the alternative source for collect the drinking water. Fog water collection is the only alternative source to supply clean water to desert villages. In the absence of natural resources, fog water collection is the best alternative to provide water to a group of isolated villages that depend on external water supply, scarcity or irregular rainfall. The mist used for deforestation is good for the aquaculture surroundings. This rainfall rate increases over time so it recharges the land with water so the fog is a source for forest expansion. It is useful in areas with high fog but not hot weather [8]. The inventor designed the fog collection mesh (Fig. 6) by inspiring nature plants shown in Fig. 7.

![Three different types of mesh for fog collection](image1)

**Figure 6: Three different types of mesh for fog collection**

In 2016, Wikramanayake has come up with a new solution for the societal natural resource wastage. The combustible gas-based AWH system [9] was developed and produced 11% of the water in Eagleford and 65% in the Buckenheals area. The water harvested by the system is enough to dig 22,000 bore wells in these two states and remove 7 million trucks of round trip. This AWH system cultivates water well in humid places such as the Middle East, Africa and Central America and is shown in Figure 8.

![Gas engine based AWH system](image2)

**Figure 8: Gas engine based AWH system**

In 2018, Tu, Yadong et al. introduced this method. Moisture in the air is a potential source of abundant pure water, which is ubiquitous and is like a renewable energy source. It provides an acatalectic and complex analysis of cutting-edge research on aquaculture. We focus on how much water can be produced from the atmosphere and what range we can produce under certain weather conditions. Therefore, different methods are discussed in this work, including radioactive cooling and sorption-based water extraction with different materials and the system has shown in Fig. 9. This work reviews the performance of different AWHs and also addresses 4 crucial issues that limit cost effectiveness and prescribe some solutions [10].
In 2018, Bodamyalazade and Dosu et al presented a water collection system. In this proposed facade model will meet the water consumption needs of the residents. It produces 420 liter water per day using solar energy. Application with this system uses solar energy to extract water from the air, with turbine systems collecting water through moisture so it is capable of being used for multifunctional purposes, collecting up to 396 liters at temperatures between 86 degrees 104 degrees (30 to 40 degrees Celsius) and 80% and humidity between 90% [1] and is designed as shown in Fig. 10 and the UC Berkeley designed Fig.11 model.

3. Design and implementation of Smart Solar Atmospheric Water Harvesting System
Smart Solar Atmospheric Water Harvesting System (SSAWHS) is simple and effective. The system was designed and implemented with the intention of providing water for animals. Hence the system was placed in desert or hilly areas. The SSAWH system made up of solar panel, rechargeable battery, spiral wind turbine, Raspberry Pi, webcam, GPS, GSM, airflow sensor, copper condenser, DC motor. The system is planted in the ground to a depth of 3 meters. In the system the Raspberry Pi works after receiving power from the battery and which is recharged with a solar panel [12,13]. This Raspberry Pi board is equipped with airflow sensor, GPS, GSM.

The spiral wind turbine runs through the air flow and that air is pushed into the copper condenser by the fan. There it dehumidifies and turns into water droplets. If there is not enough air flow, the IoT system automatically drives the DC motor to rotate the turbine [16, 17]. This system not only produces water from fog or high humidity air, but also monitors the surrounding animals. We have to keep as many as possible, it is very difficult to detect if any system is damaged, so here we have GPS and GSM devices, locate them by getting the location of the system and let us know via GSM. Of course we can transfer images via this GSM connection.
4. Results Discussion

The experiment yielded results after placing the system on a 500ft high hill in the Yerragattugutta area of Warangal as shown in Fig.13a. The experiments were used for analysis from 1 June 2019 to 31 May 2020. During the experimental period above 365 days, 97 days there was no fog, but 66 days there was fog with rain and fog water was collected every day. Here we observed in this experiment that we were able to produce a minimum of 3.39 liters and a maximum of 11.2 liters of water is given in Fig. 13b. Experimental results show that the Warangal region here has a very high percentage of water in the air from August to January, while it is very low from February to July. Water collection is very low, especially in May, and very high in December.

The quantity and quality of water depends on the environment or surroundings. Heavy water can be harvested if we install multiple systems in the serial and it will be more useful for wildlife if we keep it in a water scarce forest or hilly area.

5. Conclusion

This work addresses water scarcity problems as an alternative where natural resources are depleted. The IoT based AWH system with solar panel has great ability to extract water from fog or high humidity air. It provides drinking water to organisms whose water is severely contaminated or scarce. In the proposed system implemented for multipurpose it’s not only cultivate the water from fog or from high humidity air but also able to capture the animal pictures. IoT, Solar panel and spiral wind turbine have been work coordinative. This IoT system has powered with Raspberry Pi. In this
experiment we successfully harvested 3.39 litres to 11.2 litres of water per day and this varies according to the climate or region.

Further development of this concept poses significant challenges; the system should be able to identify and count animals for further use, the system should notify to the headquarters if any repairs are required.

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