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IOT Based Smart Irrigation System with Water Generator

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Abstract: India is the country where agriculture plays an important role in the growth of the economy. Due to the advancement of lifestyle and economic need, farmers are fond of performing some other work along with farming. The present work has suggested an economic model to farmers for helping them to balance their agricultural work and other duties. CATIA and Solid Works are used to design the model of an agricultural field where sufficient amount of water can be generated by the help of condenser and then, pesticide can be mixed with the water and will be sprayed throughout the land with the help of sprinkler. The sprinkler will move in a closed loop and it is rotated by the help of a motor. The sprinkler is modeled by 3D Printing. The concept of Internet of Things (IOT) is used for monitoring and controlling various parameters of the plant with the help of a mobile application.

Keywords: IoT, CATIA, Solid Works, 3D Printing.

I. INTRODUCTION

Irrigation is that the appliance of controlled amounts of water to plants at needed intervals. There are numerous IoT applications in farming [1] like collecting data on temperature, rainfall, humidity, wind speed, pest infestation, and soil content. This data is accustomed to automate farming techniques, take informed decisions to enhance quality and quantity, minimize risk and waste, and reduce effort required to manage crops. The Internet of things (IOT) could be a system of interrelated computing devices, mechanical and digital machines supplied with unique identifiers and also the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.[2][3][4][5] New smart farming applications supported IoT technologies will enable the agriculture industry to scale back waste and enhance productivity from optimizing fertilizer use to increasing the efficiency of farm vehicles' routes. Over or under-watering makes a plant over stress, leaving it unhealthy, and this reduces crop yield. These unhealthy plants also are more susceptible to disease, weeds, and pests. In agriculture, there are two things that are vital, first to induce information about fertility of soil and second is to live moisture content in soil. Atmosphere contains a large amount of water in the form of vapour, moisture etc. Within those amounts almost 30% of water is wasted. This amount of water can be used by implementing a device like Atmospheric Water Generator. This device is capable of converting atmospheric moisture directly into usable water. In many countries like India, there are many places which are situated in temperate regions. There are deserts, rain forest areas and even flooded areas where atmospheric humidity is eminent. But resources of water are limited. In the past few years some papers have already been done to establish the concept of air condensation as well as generation of water with the help of peltier devices, such as harvesting water for trees using Peltier plates that are powered by solar energy etc. According to previous knowledge, we know that the temperature required to condense water is known as dew point temperature. Here, the goal is to obtain that specific temperature (dew point temperature) practically or experimentally to condense water with the help of some electronics devices. This paper consists of a thermoelectric peltier (TEC) couple, which is used to create the environment of water condensing temperature or dew point; the condensed water will be collected for any usable applications. Pesticides are chemical substances that are meant to kill pests. Depending upon the size of land the pesticide concentrate is added to the water and spraying is done.

A. Principle of Peltier Device

The thermoelectric effect is the direct conversion of temperature differences to electric voltage and vice versa. A thermoelectric device creates voltage when there is a different temperature on each side. Conversely, when a voltage is applied to it, it creates a temperature difference. At the atomic scale, an applied temperature gradient causes charge carriers in the material to diffuse from the hot side to the cold side. A Peltier cooler is a solid-state active heat pump which transfers heat from one side of the device to the other, with consumption of electrical energy, depending on the direction of the current. Such an instrument is also called a Peltier device.

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II. LITERATURE REVIEW

Kalyan et.al[6] proposed that in the past few years, the need for systems that make agriculture easier and sustainability has increased. The ability to conserve two of the most important resources of a farmer, water and time, has been the latest challenge. A system that provides this ability - through the use of efficient and reliable methods such as wireless sensor networking, sprinkler irrigation, GSM, SMS technologies and readily available mobile phone devices help the agricultural and economic growth of the country. Anbarasu et.al.[7] Inferred that even though dehumidifying units using vapour compression refrigeration systems is more effective than the Peltier system but it lacks in the sense that it is not portable and it generates a lot of sound. And also this system is more costly. Chetana et.al.[8] reported that Automated Wireless Watering System is a user friendly system, which notifies the user about its status. The 2 modes of operations provide the user with the option of automatic and manual process. The system also provides the log file of the events carried out. Karan kansara et.al.[9] proposed an automated irrigation system where the humidity and temperature sensors are used to sense the soil conditions and based on that microcontroller will control the water flow. Farmers will be intimated through GSM. This system doesn't monitor the nutrient content in the soil. Kabeela et.al.[10] said that they can in no way refuse to accept the fact that dehumidification units using Peltier devices are very portable and environment friendly. It has a simple design and has high endurance capability. So, this type of Atmospheric Water Generator is the device which can be implemented in extreme situations like during floods or in desert and rural areas. It has great advantages as it works like a renewable source of atmosphere water and doesn't need a heavy power source. Applying this system in a highly humid region almost 1 litre of condensed water can be produced per hour during the day light, which is a very promising result. Joaquín Gutiérrez et.al[11] published a paper mentioning optimized use of water in the agriculture field. An algorithm was developed with threshold values of temperature and soil moisture that was programmed into a microcontroller-based gateway to control water quantity. The system was powered by photovoltaic panels and had a duplex communication link based on a cellular-Internet interface that allowed for data inspection and irrigation scheduling to be programmed through a web page. The issue is that the investment in electric power supply would be expensive. Sakthipriya.N et.al.[12]worked on the system and says that, based on the value of soil moisture sensor the water sprinkler works during the period of water scarcity. Once the field is sprinkled with adequate water, the water sprinkler is switched off. Hereby water can be conserved. Also the value of soil pH sensor is sent to the farmer via SMS using GSM modem. The issue is that it provides only precision values that are not accurate and are not cost efficient. Hemlata Channel et.al.[13] studied the use of modernized techniques such as Internet-of-Things (IOT), Sensors, Cloud-Computing, Mobile Computing, Big-Data analysis in the agricultural sector . Soil and environment properties are sensed and periodically sent to Agro Cloud through IOT (Beagle Black Bone). Big Data analysis on Agro Cloud data is done for fertilizer requirements, best crop sequences analysis, total production, and current stock and market requirements. It is beneficial for increase in agricultural production and for cost control of Agro products.

III. MODELING

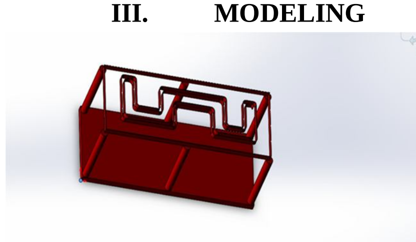

Fig 1: Model of the plant

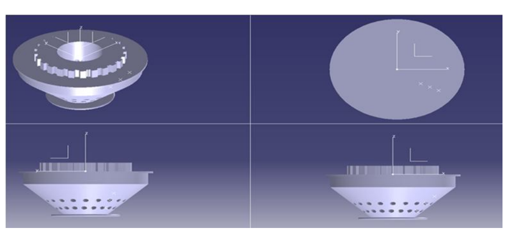

Fig 2: Model of sprinkler

Firstly a model of plant is prepared by solid modeling as shown in fig 1. Similarly CATIA is used to model the sprinkler (as shown in fig 2) which is used to spray pesticide in the plant.

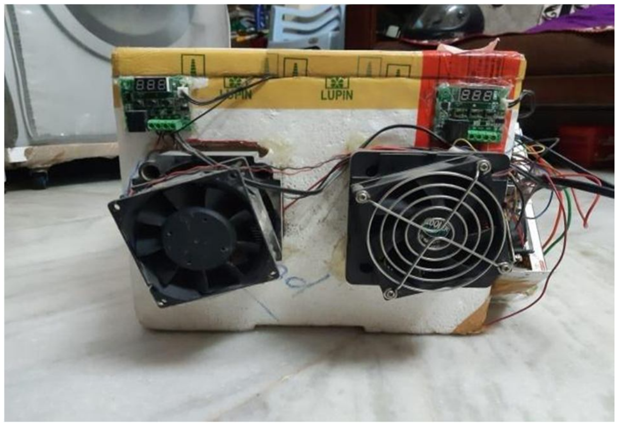

Fig 3: Condenser model

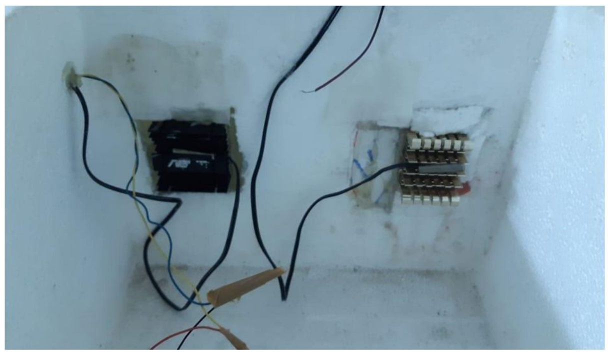
Fig 4: Interior of Condenser model

Then, a box-like structure of thermocol material with dimensions (33*28.5*24.5) is constructed as shown in the fig 3. The hotter side of the peltier element is attached to the fan driven by brushless motor (CPU Fan). On the other side (colder side) of the peltier, dielectric paste is applied and attached with a heat sink. One Thermostat is then connected to the peltier and fan. One more setup by following the above mentioned lines is modeled. On one side of the thermocol box the setups is attached and properly fixed. The positive terminal of the fan is connected to the positive terminal of peltier and similarly negative terminal of fan is connected to the negative terminal of peltier. Then, positive and negative terminals are connected to the SMPS. From the fig 4, the interior condenser model is shown and the ice formed on the fins is slowly changing into water by the aid of an external fan which is connected to the SMPS. The plant area is constructed by wood with a dimension of (5*4 Feet). Physically, wood is strong and stiff but, compared to a material like steel, it's also light and flexible. It has another interesting property too. Metals, plastics, and ceramics tend to have a fairly uniform inner structure and that makes them isotropic i.e. they behave exactly the same way in all directions. With the above dimensions the layout is constructed with wood, also the pillars that are needed to place inside the plant for the sprinkler fixture is also made with wooden blocks. For the two mounted pillars for each a motor is fixed vertically such that both the pillars and the motion are in a linear path.

A gear like wheel is fixed on each motor and then a belt with the tooth will be mounted around the wheels which are on the pillars. This system is fixed by arranging the motor and belt mechanism between the pillar and belt. Now the sprinkler is attached to the belt and fixed.

IV. RESULTS AND DISCUSSION

A. Dew Point Temperature Calculation

$(T, RH) = ln\,(RH/100) + bT/c + T$ …….equ(1)

$Tdp = c*(T, RH)/b - (T, RH)$ …….equ(2)

[b=17.67 & c=243.50C, T is in degree]

Above formulas are used to calculate the dew point temperature for different atmospheric conditions at which the device may be subjected to operate.

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B. Sample Calculations

For DBT=30^{0}C and RH=45%

(30,45) = ln (45/100) + (17.67 × 30) / (243.5 + 30) = 1.139

Tdp = (243.5 × 1.139) / (17.67 − 1.139)

Tdp = 16.77735769

C. Dew Point Calculations For Different Atmospheric Conditions Theoretically

Table 1:- Dew point temperature calculations at 30^{0}Cand at different relative humidity

Dry bulb temperature (°C)	Relative Humidity (in %)	Required dew point temperature(in C)
30	35	12.89
30	40	14.95
30	45	16.77
30	50	18.46

Table 2:-Dew point temperature calculations at 35^{0}Cand at different relative humidity

Dry bulb temperature (°C)	Relative Humidity (in %)	Required dew point temperature(in C)
35	35	17.27
35	40	19.4
35	45	21.36
35	50	23.090

Table 3:-Dew point temperature calculations at 40^{0}Cand at different relative humidity

Dry bulb temperature (°C)	Relative Humidity (in %)	Required dew point temperature(in C)
40	35	21.65
40	40	23.85
40	45	25.94
40	50	27.71

Table 4:-Dew point temperature calculations at 45^0C and at different relative humidity:

Dry bulb temperature (°C)	Relative Humidity (in %)	Required dew point temperature(in C)
45	35	26.02
45	40	28.29
45	45	30.51
45	50	32.33

D. Equations on Saturation Pressure (Ps)

Relative Humidity (RH) is the ratio of partial pressure of water (Pw) to that of saturation pressure (Ps).

$RH = Pw/\ Ps \times 100$…...equ(3)

Thus from saturation pressure (Ps) and relative humidity (RH) data partial pressure of water (Pw) can be obtained as

Pw= RH/100 *Ps

R.H gives the volume of the water in $1m^3$ of air. It can be expressed as

Humidity ratio= 0.622* Pw/(Pa-Pw)

where Pa = atm. pressure

i.e. Pa = 1.013 bar

Humidity ratio gives the amount of water (in ml) present in $1m^3$ of air, also we know that $1m^3$ is equal to 1000 litres. Thus multiplying the humidity ratio by 1000 gives the maximum amount of water that is present in $1m^3$ of air.

E. Sample Calculations

For atm 25^0C,R.H= 35%Saturation pressure of water vapour(Pw) at 25^0C from steam tables (ps)=0.03167 bar

Thus Partial pressure of water, $Pw = RH\ /100 \times Ps$

$Pw = 35\ /100 \times 0.03167 = 0.0110845$ bar

Humidity Ratio = $0.622 \times Pw/(Pa{-}Pw)$

By Calculating we get, Humidity Ratio =

$0.622 \times 0.0110845\ /(1.01325{-}0.0110845) = 0.006879661$.

Therefore the amount of water present in $1m^3$ of atmospheric air = Humidity ratio × 1000 = 0.006879661 × 1000 = 6.879661 ml.

Table 5:- Amount of water which can be obtained by processing $1m^3$ of air at 35% relative humidity for different temperatures

Temp(° C)	Relative Humidity (in %)	Humidity Ratio (Amt of water in $1m^3$ of air)	Amount of water (in ml)
30	35	0.009247393	9.24739272
35	35	0.012322732	12.3227324
40	35	0.016261899	16.26189902
45	35	0.024461212	24.4612118
50	35	0.02771848	27.184841

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Table 6:- Amount of water which can be obtained by processing $1m^3$ of air at 40% relative humidity for different temperatures

Temp(°C)	Relative Humidity (in %)	Humidity Ratio (Amt of water in $1m^3$ of air)	Amount of water (in ml)
30	40	0.010590943	10.59094276
35	40	0.014123094	14.12309413
40	40	0.018654702	18.65470152
45	40	0.024461212	24.4612118
50	40	0.031921436	31.921436

Table 7:- Amount of water which can be obtained by processing $1m^3$ of air at 45% relative humidity for different temperatures

Temp(°C)	Relative Humidity (in %)	Humidity Ratio (Amt of water in $1m^3$ of air)	Amount of water (in ml)
30	45	0.011940224	11.94022424
35	45	0.015933705	15.93370461
40	45	0.021065512	21.06551245
45	45	0.02765481	27.65480986
50	45	0.036094937	36.094937

Table 8:- Amount of water which can be obtained by processing $1m^3$ of air at 50% relative humidity for different temperatures

Temp (°C)	Relative Humidity (in %)	Humidity Ratio (Amt of water in $1m^3$ of air)	Amount of water (in ml)
30	50	0.013295274	13.2952739
35	50	0.017754652	17.7546516
40	50	0.023494536	23.49453588
45	50	0.030880118	30.88011809
50	50	0.040376872	40.376872

Table 9:- Practical calculations

TIME DURATION	Temp (in ^{0}C)and Relative Humidity(in %)	Amount of water (in ml)
9 AM TO 12 PM = 3 hours	Temp=30^{0}C	9 ml
1 PM TO 4 PM = 3 hours	Temp=40^{0}C	7 ml
5 PM TO 8 PM = 3 hours	Temp=34^{0}C	8 ml

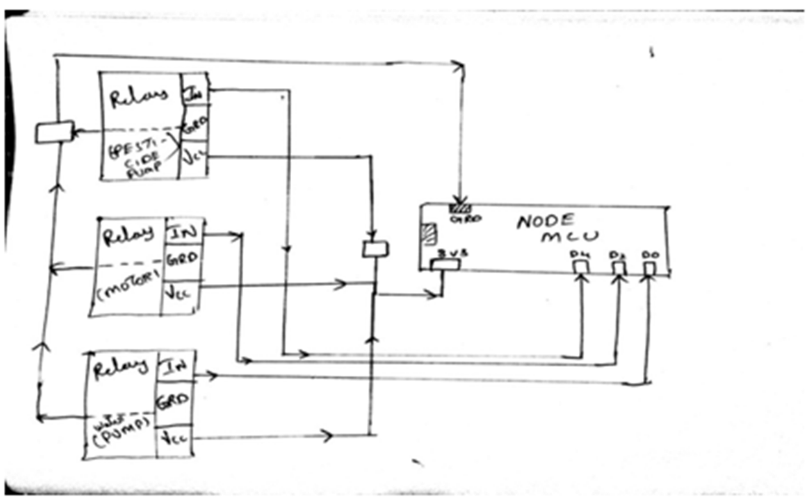

Fig 6: Electrical Connections and program code

F. Program fed to Microcontroller

```
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h> // You should get Auth Token in the Blynk App.
                                      // Go to the Project Settings (nut icon).
char auth[] = "  ";          // Your WiFi credentials.   // Set password to "" for open networks.
char ssid[] = " ";
char pass[] = "";
void setup()
{                                     // Debug console
  Serial.begin(9600);
  Blynk.begin(auth, ssid, pass);
}void loop()    {
 Blynk.run();   }
```

V. CONCLUSION

Smart irrigation system can be easily adaptable and controlled manually and automatically by a smart phone.

Here, the inlet ambient temperature of air is dropped after entering into the condenser fan. In order to start the condensation process the obtained dew point temperature should be greater than the dropped temperature. From all the above inferences it is concluded that if ambient temperature is 35^0C or higher and if relative humidity is greater than 50%, the device will function well and it will start condensing sufficient water.

The farm is controlled from any corner of the world with our smart phone just with the help of blink app as used here.

The smart irrigation system implemented here is practical and cost effective for optimizing water resources for agricultural production.

Based on the calculation it is observed that, the humidity of a region must remain above 50% and temperature should be more than 30 degrees for proper functioning of the device.

The proposed system can be used to switch on/off the submersible motor depending on the soil moisture levels thereby making the process simpler to use.

A. Future Scope

In the future, the prototype may include another two Peltier devices so as to increase the water output.

Adding an ecofriendly flavour may include a solar power source (solar panel) in place of the present AC power source without much modification in the circuitry.

A backup can be maintained for soil moisture, temperature, rainfall in a database. This backup is used for weather forecasting and directs the farmers regarding the type of crop to be cultivated in future.

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