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Automatic Solar Powered Fan for Regulation of Temperatures in a Green House

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***Abstract*— *Green houses are designed to support growth of crops under a variety of regulated environmental conditions such as temperature, humidity, light etc. Temperature being among them should be maintained at levels suitable for growth of a specific crop. Given that it may be costly to regulate the temperatures using electricity, energy cost can be reduced by use of automatic solar system because it is renewable. During the day the glass traps solar energy. The energy heats up the air which is then stored by the rock pebbles. During the night when the temperatures are low in the green house, the valve on the delivery duct is opened to allow warm air into the green house while at daytime temperatures is regulated by use of an automatic fan. The fan runs once the set temperature is reached and cools the greenhouse up to a certain point. The set point will be in accordance to the crop requirements. The design is cost effective, uses readily available materials and simple to construct which makes it ideal for small scale farmers.*
***Keywords*— Green house, temperature, solar, fan.**

I. INTRODUCTION

Green houses play a crucial role in the agriculture sector especially in the production of vegetables and horticultural products. Higher yields are realized in crops grown under regulated climatic conditions as in the case of green houses [1]. However, these temperatures may rise or fall to extreme levels affecting normal growth of plants. The majority of crops that are grown in greenhouses are usually warm-season species which are adaptable to temperatures in the range of 17–27 °C, with approximate limits of lower and upper values of 10 and 35°C [2]. According to Hugang Li, H.G. and Wang, [3] reduction of air temperature inside the greenhouse or the regulation of temperature close to the ambient temperature during summer is necessary for successful crop production. In the growth of tomatoes for example, flowering is affected when the night temperatures fall below 13℃ and during the day when temperatures rise beyond 32℃, scorching and development of immature fruits is experienced.

Therefore, it is important to device a way of regulating the inside temperature to a level that is optimum for maximum crop yields during the day and night. It sometimes proves expensive to maintain the temperature at required levels through use of methods like conventional energy to drive electric fans used in circulating air [4]. However with the use of an automatic solar system expenses are greatly reduced in terms of power and convenience is guaranteed [5]. During the day solar energy is tapped and stored. It is released at night into the green house when temperatures fall below a certain level warming the green house. During the day when temperatures rise beyond a certain level the fan automatically runs cooling the green house. By construction of a solar regulation system that is cost effective and reliable, problems associated with overheating and excess cold in the green house will be averted and ensure there is uniform distribution of temperatures inside the green house for maximum production.

Many different kinds of equipment are available for this conversion of solar energy. Flat plate collectors have been in service for a long time without any significant changes in their design and operational principles. Presently most thermal storage devices use sensible heat storage and a good technology is developed for the design of such systems.[6] However, above 100ºC, the storage tank must be able to contain water at its vapor pressure and the storage tank cost rises sharply for temperatures above this point. Organic oils molten salts and liquid metals do not exhibit the same pressure problems but their use is limited because of their handling, containment, storage capacities and cost. Between liquid materials, water appears to be the most convenient because it is inexpensive and has a high specific heat. The difficulties and limitations relative to liquids can be avoided by using solid materials for storing thermal energy as sensible heat. But larger amounts of solids are needed than using water, due to the fact that solids, in general, exhibit a lower storing capacity than water. The cost of the storage media per unit energy stored is, however, still acceptable for rocks [7]. .

II. MATERIALS AND METHODS

Materials for greenhouse model were: Polythene, Metal rods, Arduino board, Solar panel, Fan, Battery, thermometer

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A gable type greenhouse measuring 1m × 1m × 0.8m was constructed from metal. A polythene material was then fixed on the metal frames to cover the structure.

A centrifugal fan was used in the greenhouse to regulate the temperatures during the day. The fan is solar operated and automatically controlled by an Arduino board. When the temperatures go beyond a certain point the fan runs and cools the greenhouse up to the set point depending on the plant requirement. The fan also distributes heat during the night when the temperatures fall below the optimum.

A thermometer was used to measure the temperature of the greenhouse during the day and night and the response of the solar regulation system at different temperatures was then determined.

III. DESIGN AND OPERATION

3.1 Design

The circuit for solar powered fan was developed as shown in figure 1.

A program code for solar powered fan was developed to assist in controlling the temperatures automatically by either closing or opening regulator as well as giving a signal in form of a colored light.

Programming code:

```
bytefanPin        = 3;
bytesensorPin     = A1;
byteblueLED       = 0;
byteredLED        = 1;
byteCurrentTemp = 0;
void setup()
{ pinMode(fanPin, OUTPUT);
pinMode(sensorPin, INPUT);
analogReference(INTERNAL);
pinMode(blueLED, OUTPUT);
pinMode(redLED, OUTPUT);}
void loop()
{  CurrentTemp = analogRead(sensorPin) / 10;
if (CurrentTemp>= 30) {
digitalWrite(fanPin, HIGH);
digitalWrite(redLED, HIGH);
digitalWrite(blueLED, LOW);
  } else if (CurrentTemp<= 13) {
digitalWrite(fanPin, HIGH);
igitalWrite(1, LOW);
digitalWrite(0, HIGH);
  }
else {
digitalWrite(blueLED, LOW);
digitalWrite(redLED, LOW);
digitalWrite(fanPin, LOW); }
delay(100);}
```

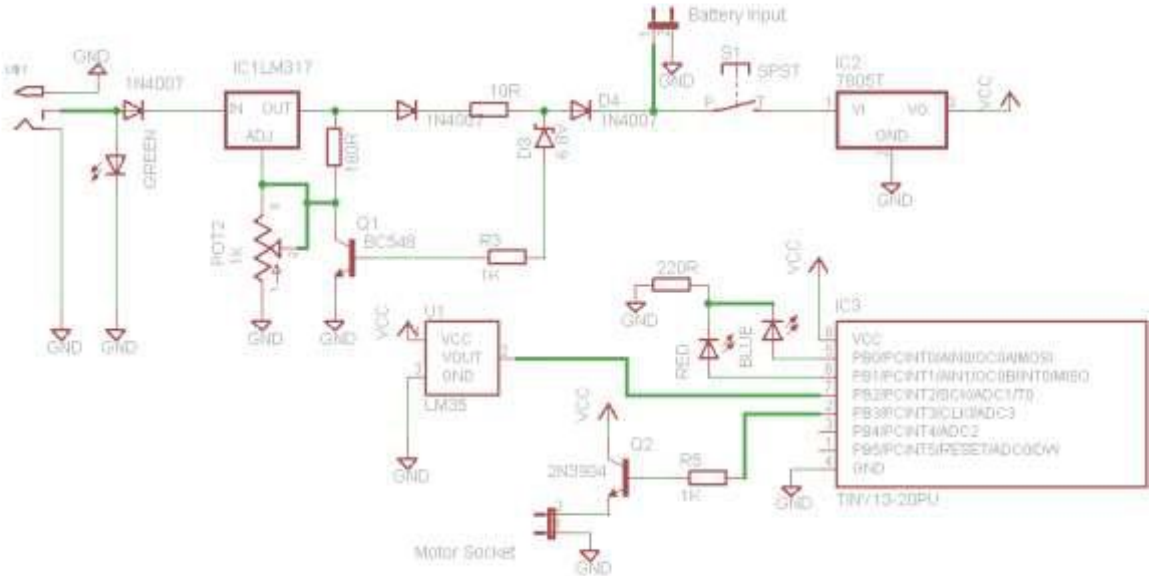

Fig.1: Skematic diagram of the automatic solar powered fan

3.2 Fan operation

The fan runs when there is power supply and once the set temperatures are obtained. When the temperature goes beyond 30^0C the fan runs with a red indicator on. When the temperature cools and falls below 13^0C the fan runs with a blue indicator on. Plates 1, 2 and 3 shows the various components of automatic solar powered fan, tests done on low as well as high temperatures. Therefore when temperature exceeds 30^0C inside the green house and the fan turns on, there is a reduction of temperature which falls within the recommended range. When temperature inside the greenhouse also tends to lower ranges of less than 13^0C, the fan is also turned on and subsequently the warm air trapped in pebbles or any other source can be circulated to the entire area of greenhouse. The highest and lowest temperatures for operating the fan can be adjusted depending on crop temperature requirements. The air flow in the fan is <500 cubic feet per metres and also depends on the size of greenhouse.

Plate 1: Photo of components of the automatic solar powered fan

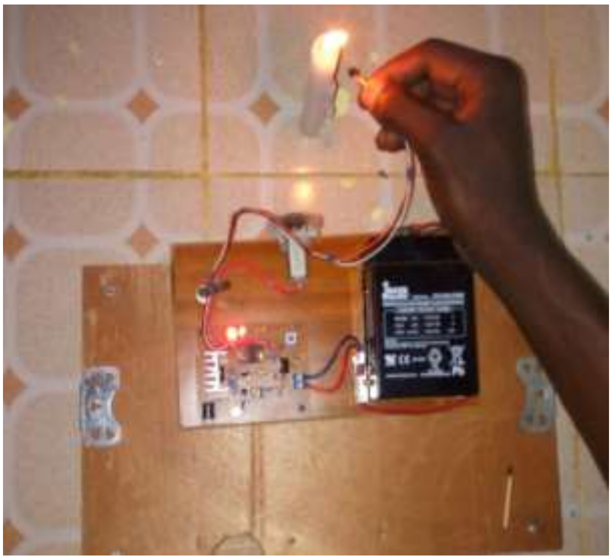

Plate 2: Testing the response of the solar powered fan at elevated temperatures

Plate 3: Testing the response of the solar powered fan at low temperature

IV. CONCLUSION

The automatic operation of fan at high and low temperatures inside the greenhouse assists in maintaining the required range of temperatures required in crop production. The design of solar powered fan is simple in construction and can be easily used.

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