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Developing The Solar Tracking System for Trough Solar Concentrator

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***Abstract*— The efficiency of the trough solar concentrator strongly depends on the position of its absorber surface with the sun. Controlling the solar radiation concentrated collectors automatically tracking with the sun plays as the key factor to enhance the energy absorption. An automatic controlling device that can rotating the parabolic trough solar concentrator to the sun is calculated, designed, manufactured, and testing successfully. The experimental results show that the device tracks the sun during the day very well. The sensor has adjusted position of collector good when the intensity of solar radiation changes due to weather.**

***Keywords*— trough solar concentrator; solar energy; automatic control; solar absorber.**

I. INTRODUCTION

Energy shortage is one of ten problem and will be major challenges that humanity faces in the coming years. Renewable energy in general and solar energy in particular is increasingly widely used in many areas such as lighting, power generation, water heating, cooling, and heat recovery for agricultural products drying. There are many methods of collecting heat from solar thermal in which the trough solar concentrator might create the temperature reach 1200^0C, collection efficiency up to 75%, and the ratio of concentrate can be from 30 to 1000 [1] . However a difficult problem and a major obstacle in collecting solar thermal is the movement of the earth around the sun and spins around its axis tilted resulting in the change spacing Earth and sun, as well as change the intensity of solar radiation on the earth's surface by time of day, month and season of the year. These changes require the absorber surface of the trough solar concentrator has to automatically rotate towards the sun during the day in order to get high collection efficiency. Therefore, a study for designing and manufacturing a device can automatically rotate the solar absorber surface to the direction of the sun is necessary.

II. DESIGNING, CALCULATIONS AND FABRICATION

A. Calculate the rotational speed of collector

Basing on the experimental testing, the solar radiation absorber is tested in between 8 am and 4 pm or the total time of solar radiation received about 8 hours per day. Therefore, the rotation angle to the sun is 120^0 equivalent with 1/3 round. As a result, the round per minutes (rpm) of the rotary device to the sun is:

$$n_{sun} = \frac{1}{3*8*60} = \frac{1}{1440} = 0{,}000694\ (rpm)$$

B. Calculate and design the transmission system

To optimize the amount of heat absorbed from solar, the collector is always required to locate at the perpendicular with the sun direction. Naturally, the sun would move from east in the morning to west in the afternoon. Therefore, the transmission system must determine the direction of the sun in order to automatically adjust the solar collector following the sun direction as Figure 1.

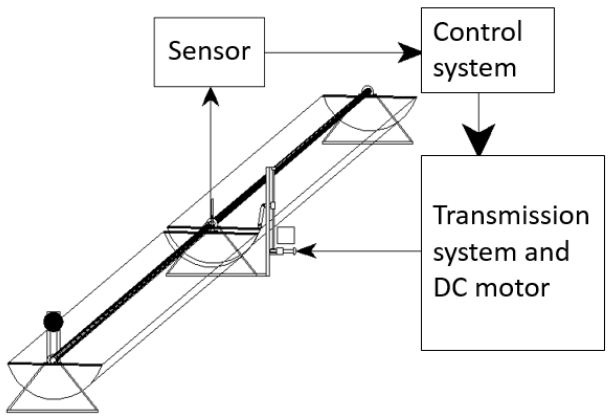
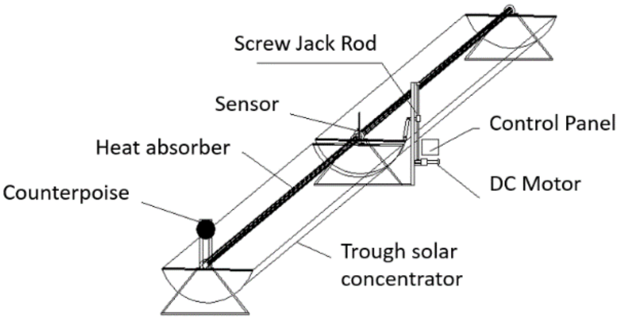


Fig 1. The solar tracking control system

III. Results and Discussion

A. Results of design and manufacturing

Figure 2 shows the principle diagram (Fig.2(a)) and the trough solar concentrator automatically rounds to the direction of the solar direction was manufactured (Fig.2(b)).



(a)

(b)

Fig 2. The principle diagram (a) and the automatic solar tracking equipment manufactured (b)

One of the most important problem is how the sensors work towards the sun direction automatically. This study, the solar direction capture devices run comply with the principle as shown in Figure 3.

Two sensors have been used in which one called left sensor and the other is right. When the radiation of the sun come, the left sensor (Figure 3 (a)) and right sensor (Figure 3 (b)) will activate (ON) or deactivate (OFF). In case of the sun is at the left side of the concentrator, the left sensor would receive the solar radiation intensity is stronger than the one in the right due to it is hide by a shield (Figure 3 (a)). As a result, the left sensor is in ON. In opposite, when the sun is at the right device (Figure 3 (b)), the rule happen is similarly so that the right sensor is in ON. The received signal will be transmitted to the control circuit to analyze in order sending command for control the solar collector via DC motor works as actuator. Depending on the signal obtained, the control circuit will create the order to collector rotation following the clock direction or in the opposite direction. The controller is continually adjusted until the sun collector locates perpendicular with the sun direction.

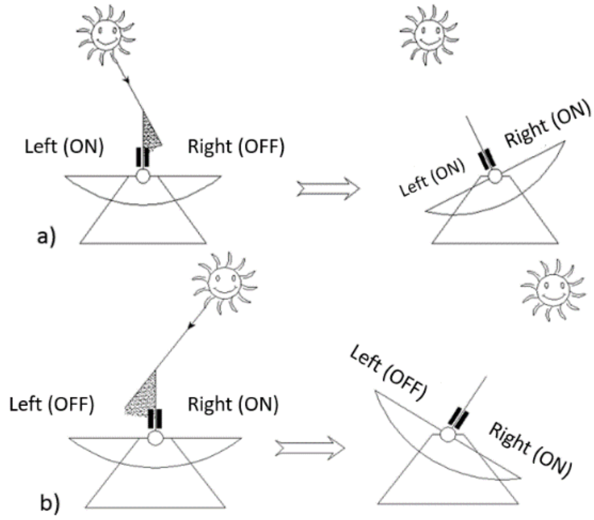


Fig. 3. Principle of the solar direction capture sensor

Figure 4 presents the light sensor circuit has been designed and manufactured successful. Sensor works on the principal of a light sensor circuit which uses 5mm optical resistance for receiving light. The circuit returns to the close / open digital (LOW / HIGH) or analog values from 0 to 1023 corresponds to the potential from 0 to 5 voltages. The light sensitivity is adjusted by a 10 KΩ potentiometer.

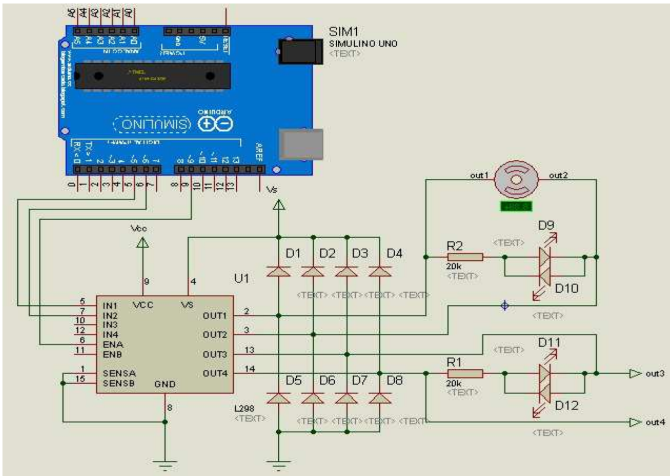


Fig. 4. The light sensor circuit

B. Testing results

The experiment was conducted at the Heat and Refrigeration Center, Nong Lam University Ho Chi Minh city, Viet Nam from 8:00 am until 15:00 pm at the same day (Fig.5). The trough solar concentrator is arranged along the North – South axis. The position between the absorber surface and horizontal direction (α) was measured and recorded every hour during the testing day. The data recorded are shown in Table 1.

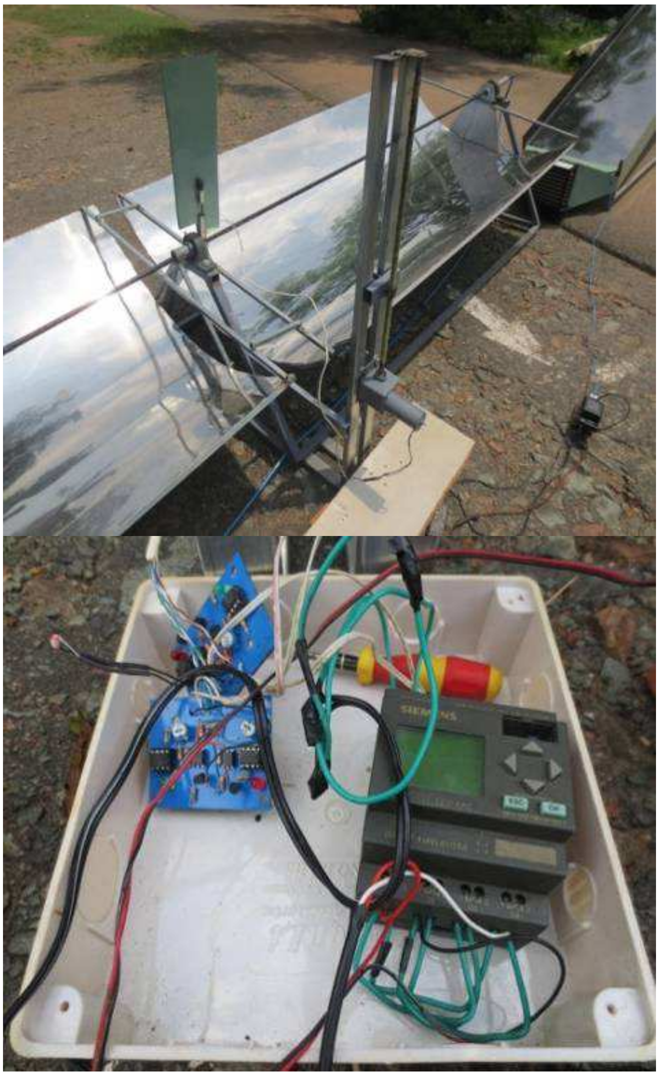


Fig. 5. Experimental testing

TABLE I
LOCATION OF THE CORRELATION BETWEEN SOLAR ABSORBER SURFACE AND THE HORIZONTAL DIRECTION (α).

No	1	2	3	4	5	6	7	8
Time	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00
Angle (degree) (date 15/10/ 2014)	39	26	17	9	1	-11	-25	-44
Angle (degree) (date 16/11/ 2014)	42	22	18	9	3	3	-30	-42
Angle (degree) (date 12/11/ 2014)	39	29	29	9	9	-19	-25	-48

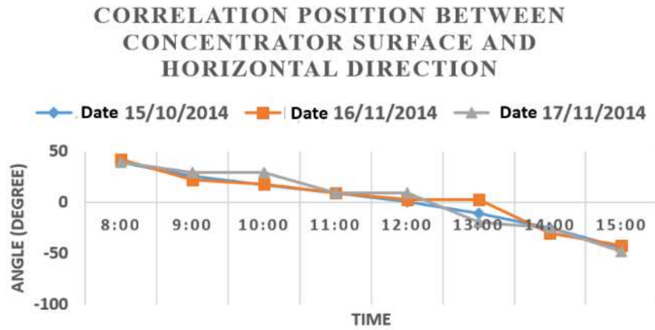


Fig. 6. Correlation position between solar concentrator surface and horizontal direction (α angle) in different time on each testing day

According to Table 1 and Figure 6, it can be seen that the collector surface has been turned to the sun direction during the day well. Looking at the chart we see the angle of the collector moving towards the sun regularly in date of Oct.15, 2014 due to sunlight enough for sensor operation. However, from 13:00 to 14:00 on Nov.16, 2014 the collector angles are almost no change at this time due to cloudy weather, both left and right sensor have not get enough light as signal control to active the actuator. Similar results occur in two intervals from 9:00 to 10:00 and from 13:00 to 14:00 on Nov.17, 2014 due to it was cloudy so that the angles were almost unchanged. The results indicate that the sensor and device works well suitable for trough solar concentrator.

IV. CONCLUSIONS

Automatic control for the heat absorber from solar radiation plays a very important role in improving the efficiency of the trough solar concentrator and great contribute significance in the use of solar energy. A device that automatically controls focus of parabolic trough solar concentrator to the sun direction was calculated, designed and manufactured successfully. The results show that the device responsive rotates to the sun direction during the day very good. The rotation angle sensor adjusts well when solar radiation changes due to weather. It demonstrates the precision turning in accordance with the change of the intensity of solar radiation.

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