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AUTOMATIC GREENHOUSE SENSOR DESIGN

Abstract

The increasing in plantation productivity now becomes an urgent and important thing in human life. The population growth is unbalanced with the food production will cause the famine and later, of course, the sorrow ness in human life as Robert Malthus proposed: the population growth act as exponential sequence, while the food production is act as arithmetic sequence.

One solution to this problem is to improve the crop productivity with the use of greenhouse as a planting site. Greenhouse has been wide range use in many countries with a conventional technique that causing the inefficiency in time, since it requires more serious control and supervision.

The aim of this project is to construct a greenhouse model, which can automatically control light, the aeration and drainage process. This model is based on the sensory, which related to several factors in photosynthesis, i.e.: light and humidity (also, temperature is included).

Key words: Photosynthesis, greenhouse and sensory

I. PREFACE

The increasing in plantation productivity now becomes an urgent and important thing in human life. The population growth is unbalanced with the food production will cause the famine and later, of course, the sorrow ness in human life as Robert Malthus proposed: the population growth act as exponential sequence, while the food production is act as arithmetic sequence.

One solution to this problem is to improve the crop productivity with the use of greenhouse as a planting site. Greenhouse has been wide range use in many countries with a conventional technique that causing the inefficiency in time, since it requires more serious control and supervision.

The aim of this project is to construct a greenhouse model, which can automatically control light the aeration and drainage process. This model is based on the sensory, which related to several factors in photosynthesis, i.e.: light and humidity (also, temperature is included).

The benefit from this construction is emphasized on the crop productivity, especially to shorten the planting cycle so that it can give a maximum result and increase the planting cycle efficiency with the least number of workers.

II. AIM

To construct a greenhouse model that can automatically control the aeration and drainage process. This greenhouse can be used for increasing productivity of plants also, especially leaves part.

III. BASIC THEORY

A. PHOTOSYNTHESIS

Photosynthesis (*photo*=light, *synthesis*=putting together is the process of converting light energy to chemical energy and storing it in the bonds of sugar. It is affected by its surroundings and the rate of photosynthesis is affected by the concentration of CO_2, light intensity, and the temperature. This process occurs in plants and some algae. Plants need only light energy, CO_2, and H_2O to make sugar. The process of photosynthesis takes place in the chloroplasts, specifically using chlorophyll, the green pigment involved in photosynthesis.

Photosynthesis occurs in two stages.

1. **Light-dependent reaction** or **photosynthetic reaction** (also called the *Light Reaction*) capture the energy of light and use it to make high-energy molecules.

   $$\mathbf{2\ H_2O + ATP + 24\ NADP^+ \longrightarrow 6\ O_2 + ATP + 24\ NADPH}$$

2. **Light-independent reaction** (also called the *Dark Reaction*) uses the high-energy molecules to capture carbon dioxide and make the precursors of glucose.

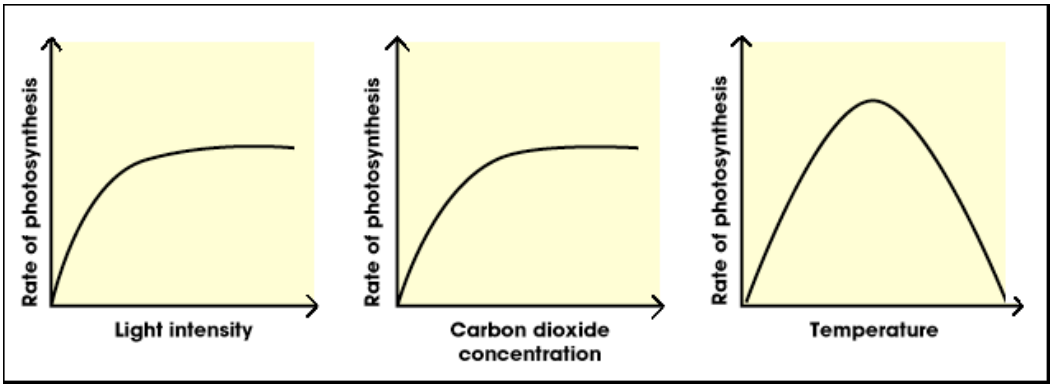
   $$\mathbf{6\ CO_2 + ATP + NADPH \longrightarrow (CH_2O) + 6\ H_2O}$$

If two reactions above are bundled, will be produced photosynthesis reaction.

$$\mathbf{6\ CO_2 + 12\ H_2O + energy \longrightarrow C_6H_{12}O_6 + 6\ H_2O + 6\ O_2}$$

There are three factors photosynthesis before going any further: light level, carbon dioxide, and temperature.

1. Without enough **light**, a plant cannot photosynthesize very fast, even if there is plenty of water and carbon dioxide. Increasing the light intensity will make the photosynthesis faster. Light intensity or quality of light affects the rate of photosynthesis. When light intensity is low, the rate of photosynthesis is proportional to light intensity. This is because the light supplies energy for photosynthesis.
2. Sometimes photosynthesis is limited by the level of **carbon dioxide**. Even if there is plenty of light of plant cannot photosynthesize if it has run out of carbon dioxide. If carbon dioxide concentration is increased to 0.4%, the rate of photosynthesis will be increased a few times.
3. **Temperature** can be a limiting factor too. If it gets too cold, the rate of photosynthesis will slow right down. Equally, plants cease to be able to photosynthesize if it gets too hot. At the optimum temperature, which may between 25^{o}C to 40^{o}C, the rate of photosynthesis is maximum. When temperature is increased further, there is a rapid decrease in the rate of photosynthesis. This is because enzymes are denatured by high temperature.



Understanding the factors, that limiting photosynthesis enables greenhouse farmers to maximize the conditions for plant growth. They often use lamps inside the greenhouse because burning paraffin produces carbon dioxide as well as heat, and so makes photosynthesis proceed faster. They may also use artificial light to enable photosynthesis to continue beyond daylight hours.

B. GREENHOUSE

1. Greenhouse Structure

A greenhouse (also called *glasshouse* or *hothouse*) is a structure with a glass or plastic roof and frequently glass or plastic walls. It heats up because incoming solar radiation from the sun warms plants, soil, and other things inside the building. Air warmed by the heat from hot interior surfaces is retained in the building by the roof and wall. These structure range ion size from small sheds to very large buildings.

The glass used for a greenhouse works as a selective transmission medium for different spectral frequencies, and its effect to trap energy within the greenhouse, which heats both the plants and the ground inside it. This warms the air near the ground, and this air is prevented from rising and flowing away, in addition to the fact that infrared radiation cannot pass through the greenhouse glass. This can be demonstrated by opening a small window near the roof of a greenhouse, the temperature drops considerably.

The most basic aspects of greenhouse design are:

First, to thermodynamically isolate the system to stop convection and conduction from equalizing the temperature with the ambient temperature;

And second, to provide a covering with a controlled difference between the transparency in the solar radiation band and the terrestrial thermal radiation band.

2. The Use of Greenhouse

Greenhouse effects are often used for growing flowers, vegetables, and fruits. Many vegetables and flowers are grown in greenhouses in late winter and early springs, and then transplanted outside as

the weather warms. Started plants are usually available for gardeners in farmers' markets at transplanting time.

The closed environment of a greenhouse has its own unique requirements, compared with outdoor production. Pests and diseases, and extremes of heat and humidity, have to be controlled, and irrigation is necessary to provide water. Significant inputs of heat and light may be required, particularly with winter production of warm-weather vegetables. Special greenhouse varieties of certain crops, like tomatoes, are generally used for commercial production.

Greenhouses are increasingly important in the food supply of high latitude countries. The largest greenhouse complex in the world is at Lamington, Ontario (close to Canada's most southern point) where about 200 acres (0,8 km^2) of tomatoes are entirely grown under glass.

Greenhouses protect crops from too much heat or cold, shield plants from dust storms and blizzards, and help to keep out pests. Light and temperature control allows greenhouses to turn non-arable land into arable land. Greenhouse can feed starving nations where crops cannot survive in the harsh desert and arctic wastes.

3. Humidity in Greenhouse

If we want to have a greenhouse, we do need to check into the best type of greenhouse humidification to use. Humidity in a greenhouse helps keep the plants thriving and prevents disease and decay. With such a system, we can monitor and control all the factors of the environment that can affect the growth of plants. We need to have the optimum levels of humidity as well as the correct levels of light, and temperature.

One of the systems you can use to control all these factors. From the greenhouse owner, there are several benefits can be gained by using this system:

a. Improving the uniformity of the plants.

b. Eliminates excesses of humidity and temperature.

c. Plants germinate much faster.

d. Productivity increases with using seedlings.

With humidification system, there is very little condensation. This enables you to control the humidity inside the greenhouse when the temperatures outside are below freezing. At the same time, this system will prevent the plants from dehydration when the heat is turned on.

In summer, with rising temperatures outside, it is often hard to keep humidity levels where they should be. With a system installed, you do not have this worry and the plants will continue to thrive. Although the expense of installation may be a bit costly, it is will save you money over the long term by preserving your plants.

C. SENSOR

1. Sensory Function

Sensor is a device that is used to convert energy from physics stimulus to electric current in order to measure, control and giving information.

2. Light Sensor

This sensor is sensitive to light which able to respond change of light and measure of resistant value. The resistance variable that caused by light change use as dark and shining condition. This sensor can be use as automatic switch.

If the light is given to the sensor, so the resistance value of LDR will decrease, and the contrary also. Thus, LDR can detect light and dark condition. The reaction's result of this sensor is used to switch

on/off the lamp. The lamp will be turned off when the condition of the environment is shining, and the contrary also.

3. Humidity and Temperature Sensor

This sensor is used to detect the relative humidity (RH) and the change of temperature. The information that is received by the sensor will be functioned to measure level of humidity and condition of area's temperature. Output results of humidity and temperature sensor will be proceeding by a specified program.

IV. AUTOMATIC GREENHOUSE SENSOR DESIGN

As the aim of this project, three sensors will use in order to make a hospitalization for light source, water sources, and humidity. These three factors will control automatically by each sensor.

A. GREENHOUSE CONSTRUCTION

1. Material Construction: Fiberglass (Mica)

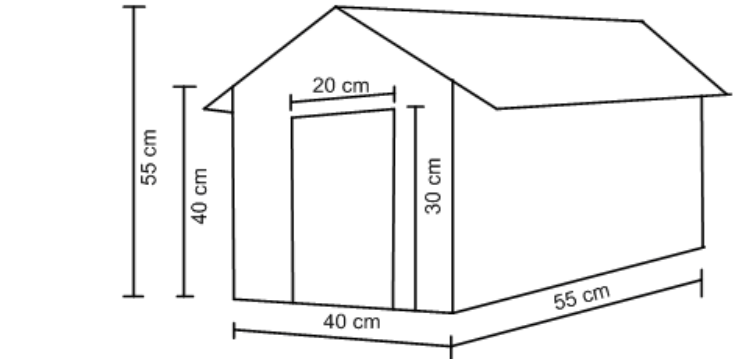
2. Dimension of Volume

L (Length) = 55 cm

W (Width) = 40 cm

H (Height) = 55 cm

Side View



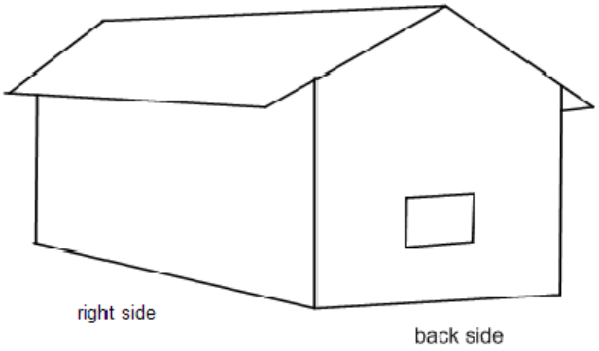
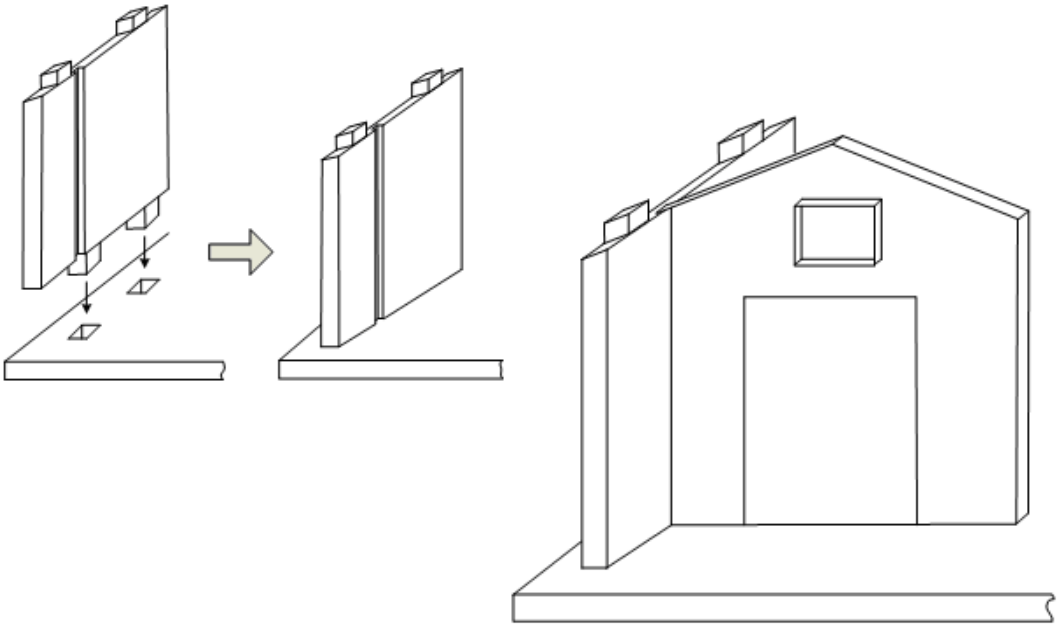
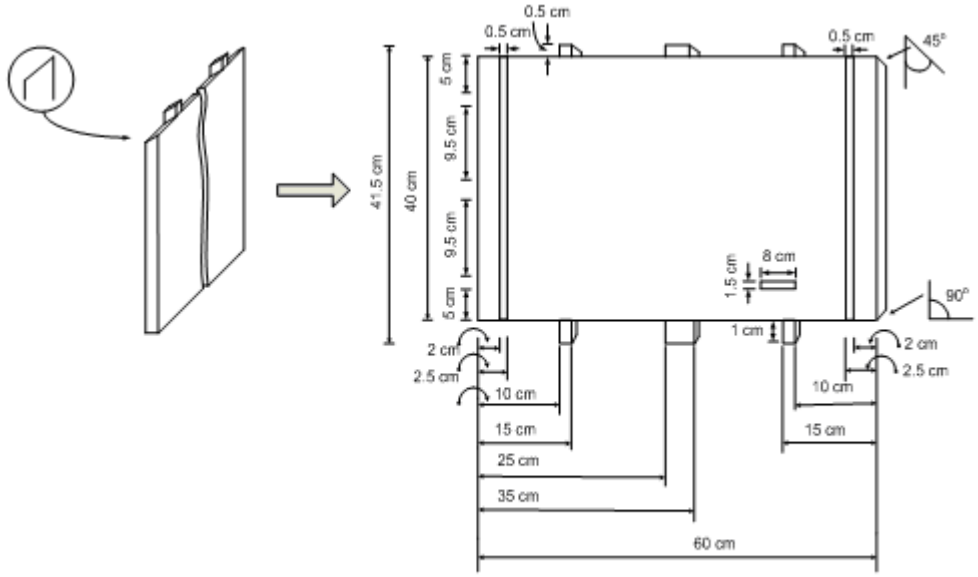
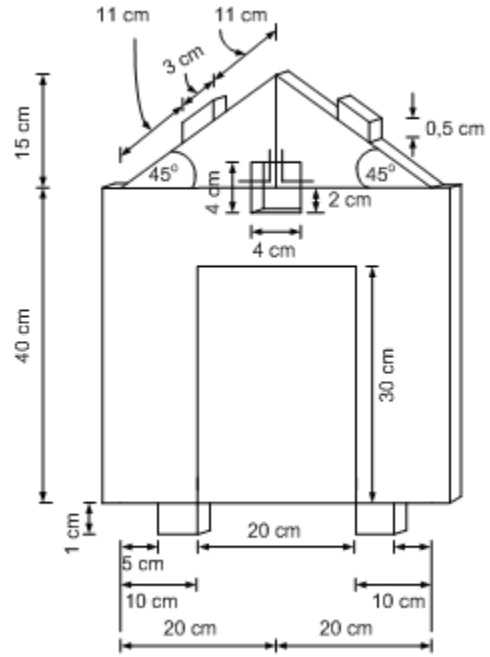


Figure wall construction

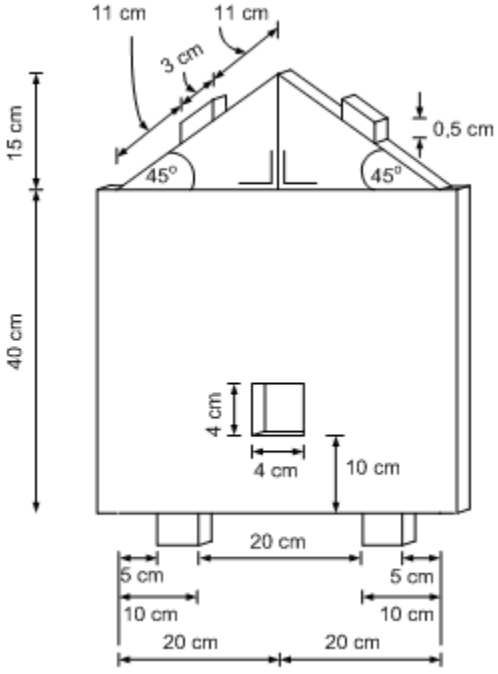




Front wall section

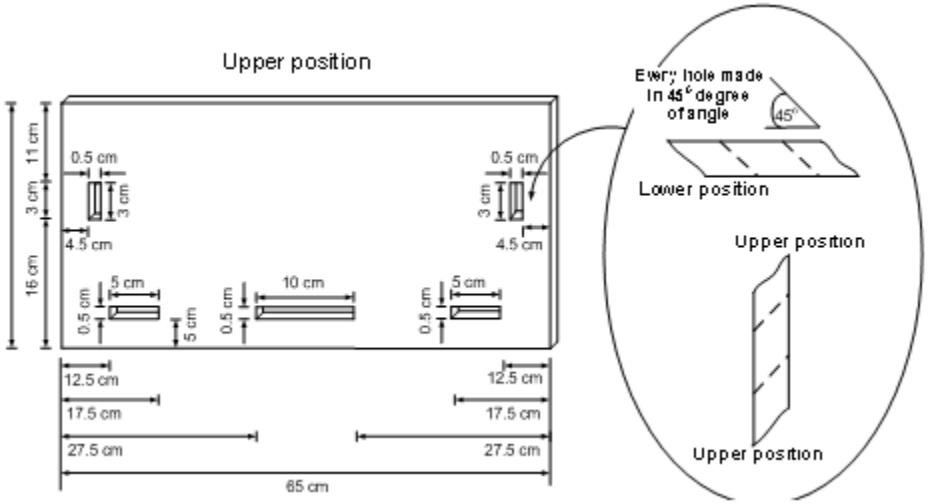


Back wall section



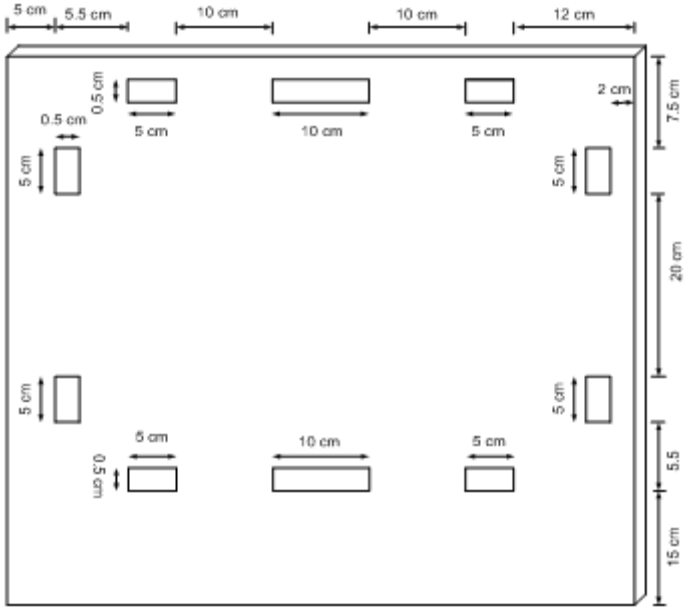
Upper section

Left and right roof section



Bottom section

Ground section



B. DESCRIPTION OF AUTOMATIC SENSOR

There are three conditions for arranging automatically by sensor. First, to control light for photosynthesis. Second, humidity and temperature, for controlling area condition from humidity and temperature extreme. Sensor will detect the environment's humidity and temperature.

Humidity sensor will detect environment's humidity condition. If humidity low and temperature high, water pump and blower turn on to pour water and to blow the wind. If the humidity high, only blower turn on. Moreover, if humidity low and temperature low, only water pump turn on. To help photosynthesis process in night, LDR sensor turns on to active lamp, and if there is sunshine, LDR turn off and the lamp off too.

1. Material Sensor

a. Humidity sensor (type series: Parallax 28018)

b. Temperature sensor

c. LDR (Light Dependent Resistor)

2. Controlled Output

a. Aquarium water pump (AC, 220 V)

For giving more water to plants if the water intensity is low.

b. Fan / blower (DC ,12 V)

For decreasing the temperature by make a flowing air out of the greenhouse.

c. Lamp ($\leq$ 7 W)

For keeping the photosynthesis process going on.

d. Timer

There are two options to control the lamp:

- Lamps are controlled by using timer that the time has already set.

- Lamps are controlled by LDR sensor.

e. Power supply

The circuit block gives current electricity supply to whole system of greenhouse. It consists of:

- 5 V, to supply the minimum system

- ± 18 V, to supply IC op-amp (operational amplifier)

- 12 V, to direct DC blower

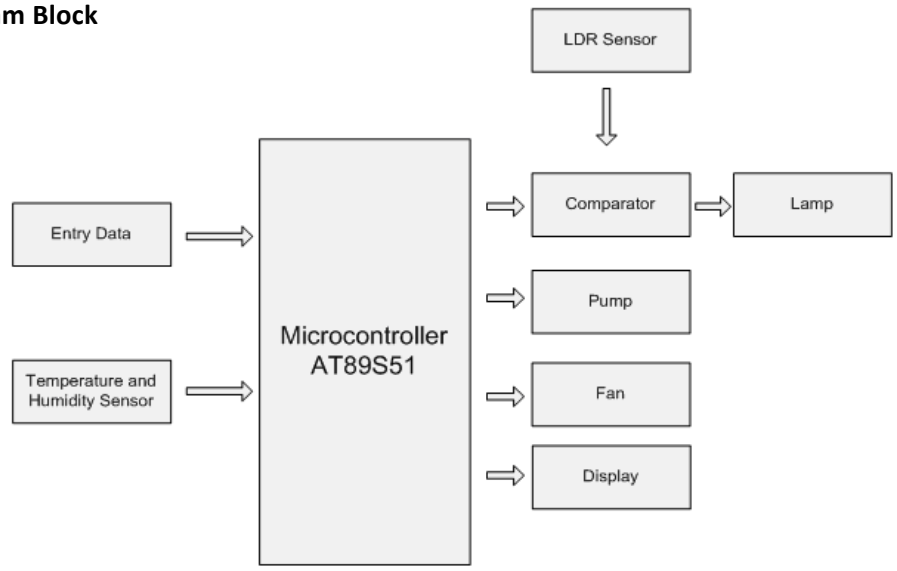
- Alternate Current (AC) 220 V, to supply electricity for lamp and water pump.

f. Hosepipe

For watering the plants when the humidity inside the greenhouse is low.

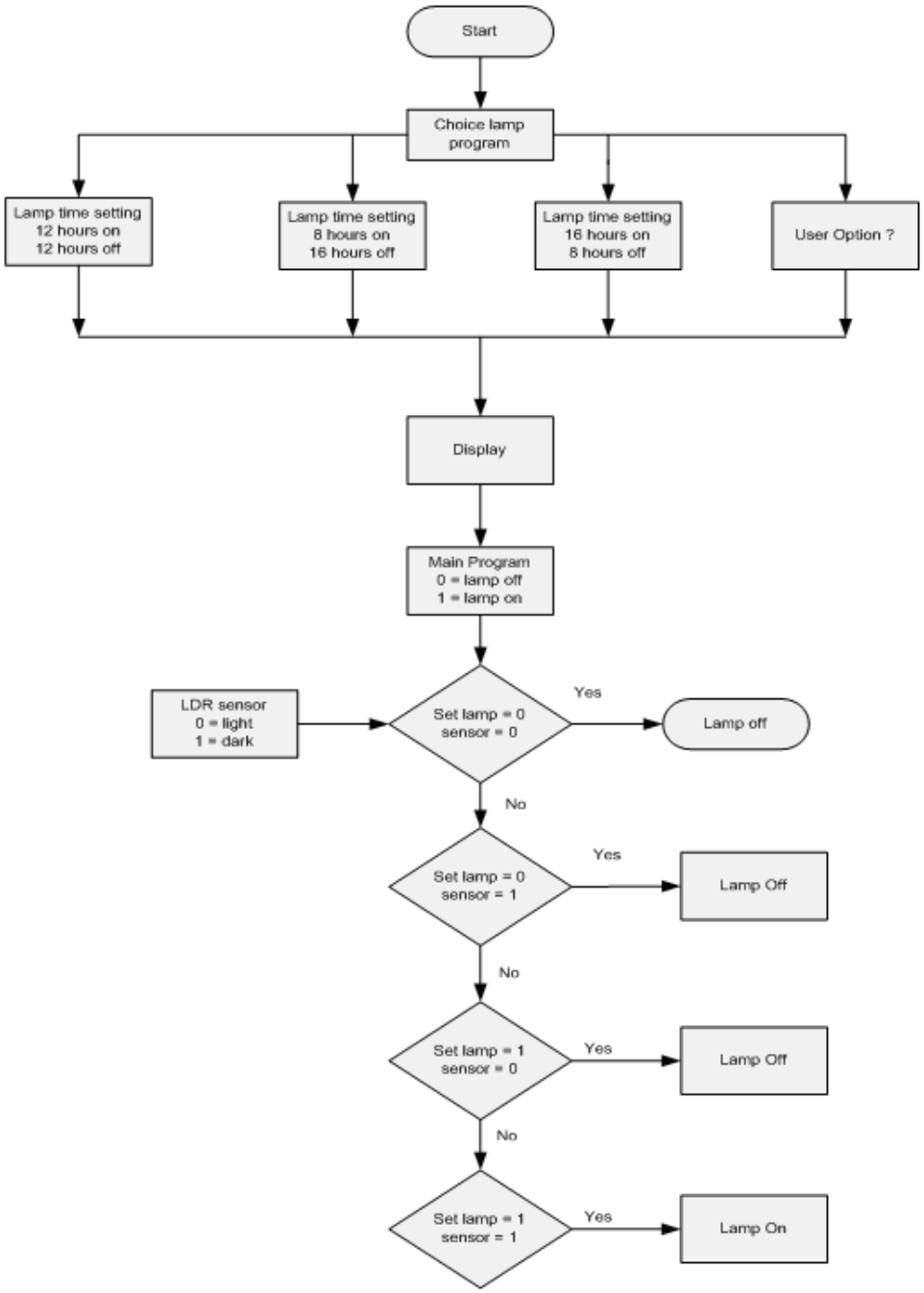
3. Sensory System

a. **Diagram Block**

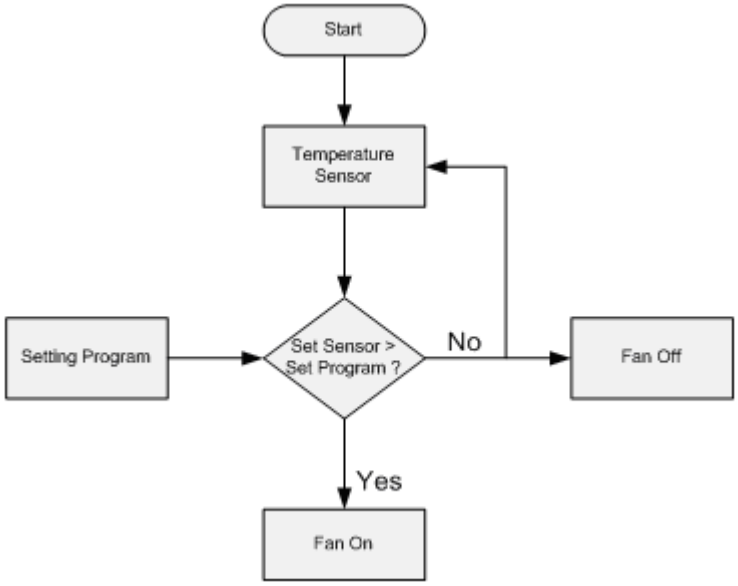


b. **Flowchart**

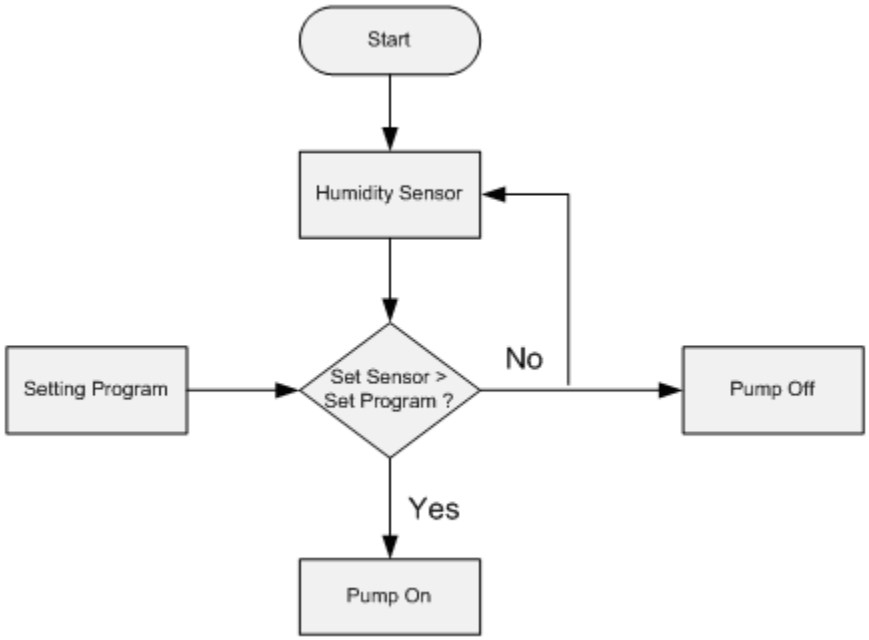
1) Timing of emitting light



2) Temperature control



3) Humidity control



c. **Schematic Electronic**

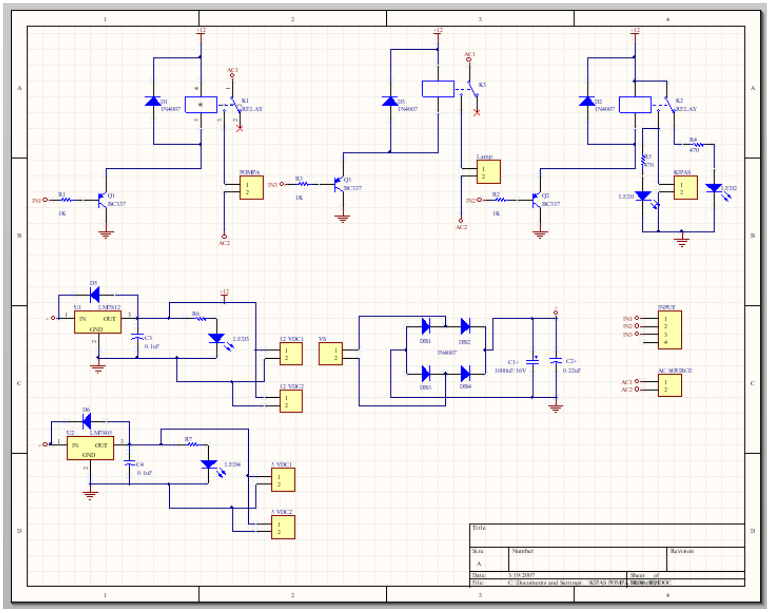


Fig.1 Driver Electronic Circuit of Fan, Pump and Lamp

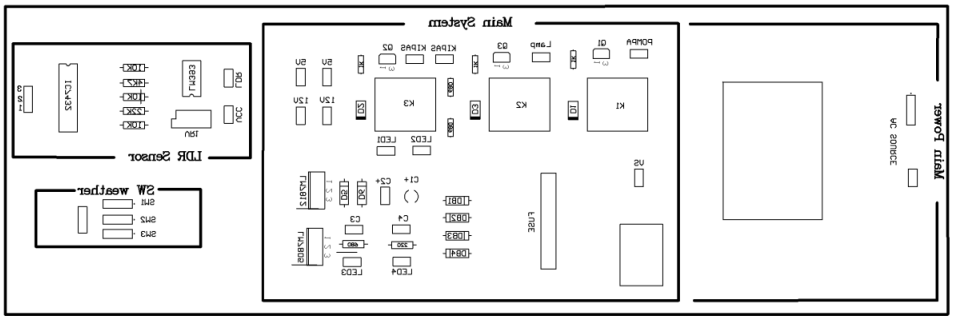
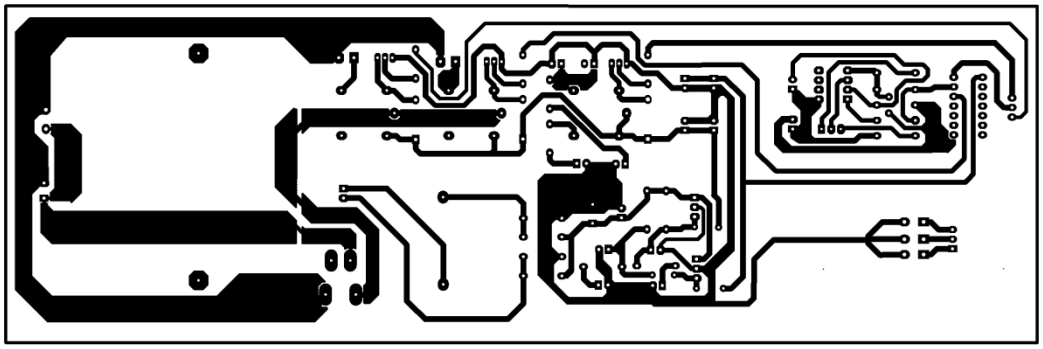


Fig.2 Driver Component Layout of Fan, Pump and Lamp

Fig.3 Driver Layout PCB of Fan, Pump and Lamp



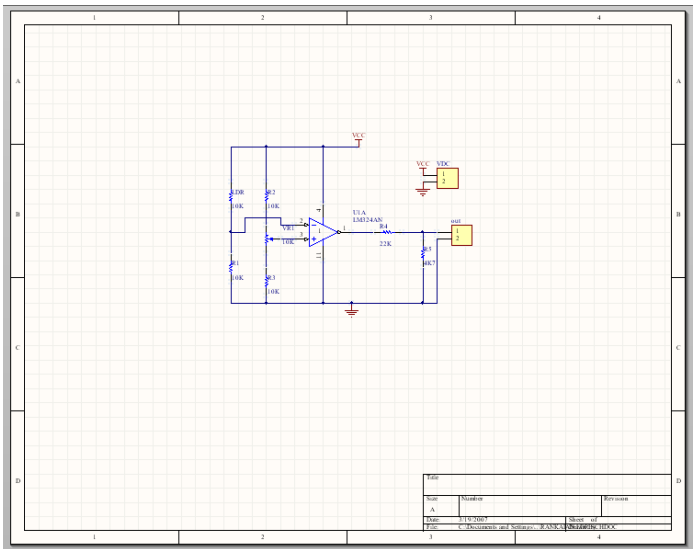


Fig. 4 Electronic Circuit of LDR Sensor

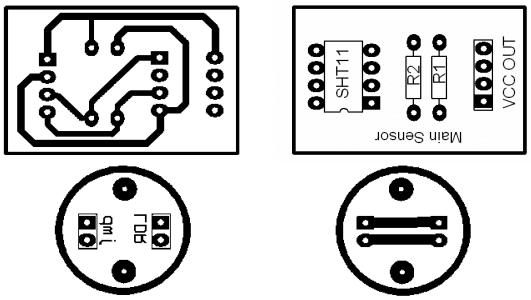


Fig. 5 PCB Layout of LDR sensor

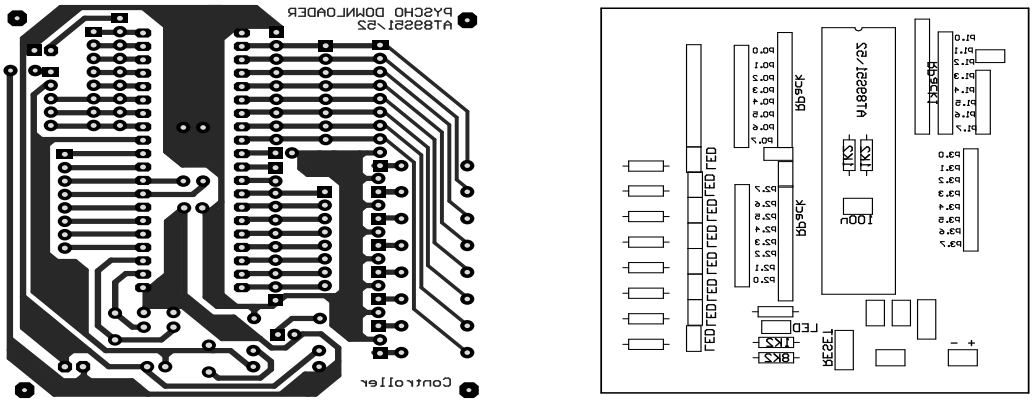


Fig. 6 PCB Lay Out and Component Lay Out of Minimum System

4. Sensory System Procedure

At the entry of data, there are some options in the menu to choose the input timer data for lamp, adjust the value of temperature and adjust the value of humidity that it wants. Here are the explanations:

a. Emitting lights adjustment

At the entry of data for adjustment how long the time of emitting, these are the options:

a) Lamp will be turned on for 8 hours and will be turned for 16 hours
b) Lamp will be turned on for 12 hours and will be turned for 12 hours
c) Lamp will be turned on for 16 hours and will be turned for 8 hours
d) How long the lamp will be used depends on the user (user option)

For the options 1-3 the adjustment for time of emitting has already been set up in the memory of the program. User only has the optional to push the particular buttons. For 4^{th} choice, the adjustment to emit the light will be handed over to the user. Emitting time is the input of data times 1 minute. The meaning is if the user pushes the number 10 at menu for adjustment lamp, so the lamp will be turned on for 10 minutes and will be turned for 23 hours and 50 minutes.

The condition of the lamp for on and off will be depends on its timer program. LDR Sensor only plays the role for anticipating the disturbance. If the timer program decided to set the lamp in ON and the condition of surrounded environment in cloudy/dark/night time, the lamp will be turned on. But, if the program timer shows the setting lamp ON and environment condition shows daylight or bright, and then the lamp will be turned off.

This condition shows the efficiency. It means that if the sunlight that can helped photosynthesize process, so the lamp in green house (for the timer shows the condition of the lamp is ON). So the function of the lamp that has already been set up is to anticipate the situation that have controlled by

timer program and LDR sensor. So, the time that have been taken for photosynthesize cycle will be optimal.

Data setting of timer program 1 = lamp is set ON 0 = lamp is set OFF	Data condition of LDR Sensor 1 = cloudy/dark/night time 0 = bright/daylight	Lamp condition
1	0	OFF
1	1	ON
0	0	OFF
0	1	ON

Moreover, sensor can be used at normal condition. The sunshine will decreased frequently so sensor will not turned on lamps directly. The sensor will activate the lamps when the environment's condition has been dark. During the time between sunshine starts to decrease until lamps turned on can be used by plants for taking rest and recharge the energy for up coming photosynthesis.

b. Temperature adjustment

The adjustment for temperature condition that it wants will be the user's decision. It means user can set the value of temperature that they wanted. The way is user can control the button that already facilitated and then, the user can see the indicator of the temperature control at the display. After the temperature has been determined, the temperature sensor will be starting to work.

The setting of the temperature will be detected fluently by the sensor. When the temperature at the green house exceeded than its determination, and the sensor will detect it and send the signal to the control system. The control system will be activated the fan. The fan will stop working when the

temperature in the green house environment has already below the temperature setting. This cycle will be continuously happen and being controlled automatically

c. Humidity adjustment

The adjustment controls same with the temperature adjustment control. The value of humidity that happen in the green will depend by user's will. After the humidity value has been set for certain points. And then the sensor will be activated and monitor it frequently.

If the humidity inside the green house less than the value of the setting point, so the sensor will be detected and started to send the signal to the control system. The control system soon will start to activate the fan to increase the humidity. If the humidity limit have already fixed, the water pump will be stopped. This cycle also working frequently and continuously.

- If the temperature is normal and humidity is low

  → Programs will arrange the water pump.

  The aim is to give more water to plants if the water intensity is low and make humidity of greenhouse normal.

- If the temperature is high and humidity is low

  → Programs will arrange the water pump and fan or blower.

- If the temperature is high and humidity is high

  → Programs will arrange the fan or blower.

  The aim is for decreasing the temperature by make a flowing air out of the greenhouse.

IV. EXPERIMENT

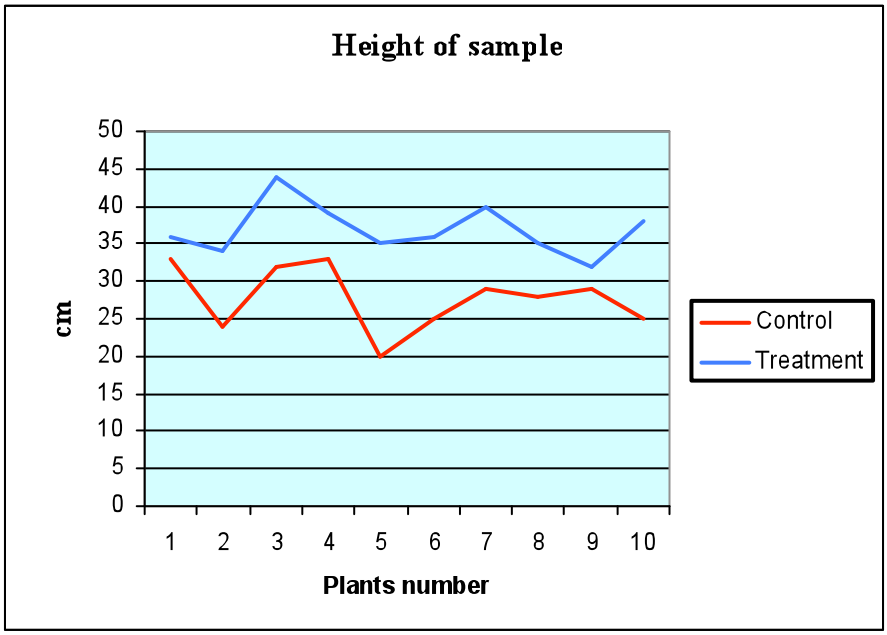
In this experiment, there is three factors that could be taken as a reference, that is the condition of greenhouse includes light intensity, temperature, and humidity. Here report from 20 seeds of red beans *(Arachis hypogaea)* which is used as samples. Those seeds have been divided into two groups, 10 seeds of them are used as control and the rest is used as treatment. Control plants are placed in a conventional greenhouse and treatment plants is placed in a greenhouse with sensor. This report is arranged after observation of growing the plants during one week.

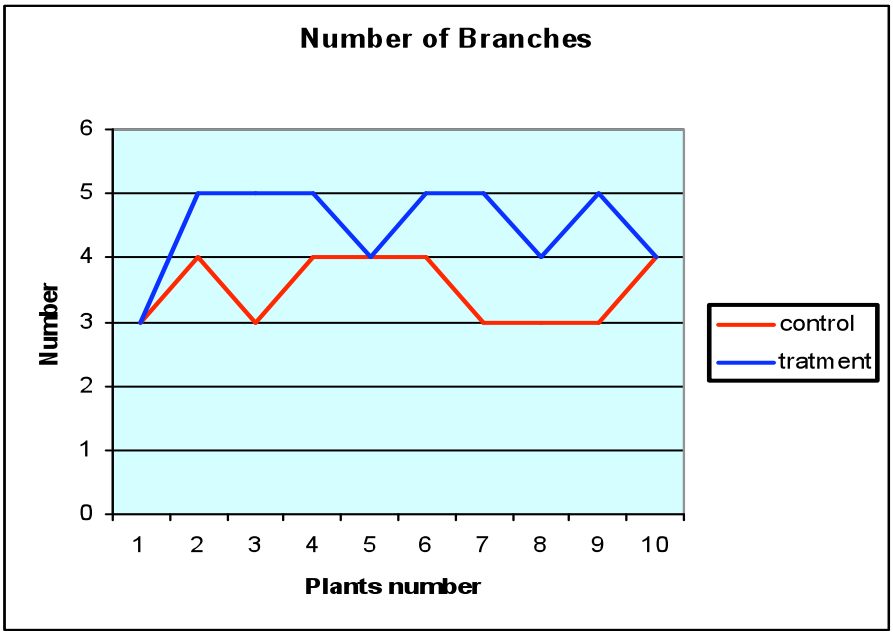
Height of sample (cm)

No.	Control	Treatment
1	33	36
2	24	34
3	32	44
4	33	39
5	20	35
6	25	36
7	29	40
8	28	35
9	29	32
10	25	38

Number of branches

No.	Control	Treatment
1	3	3
2	4	5
3	3	5
4	4	5
5	4	4
6	4	5
7	3	5
8	3	4
9	3	5
10	4	4




Number of Branches
Number
6
5
4
3
2
1
0
1
2
3
4
5
6
7
8
9
10
Plants number
control
tratment

V. DISCUSSION

It is already shown by the data that the plants, which have treated with a greenhouse with sensor, will have an enormous growth. The number of branches also more than plants that treated with a conventional greenhouse. It is also shown that the optimalization of environment's condition can affect the growth of plants and make it grows up optimally.

VI. CONCLUSION

After through theoretical discussion and equipment trial, could be concluded that the aim of this project has reached well. From the experiment could be seen if the automatic greenhouse sensor design which is made could increasing the productivity of plants, especially for leaves part.

As has been mentioned on the preface, the benefit from this construction to emphasize on the crop productivity, especially to shorten the planting cycle so that it can give a maximum result and increase the planting product have been reached. Thus it is hoped that with this construction, productivity of cropping can be continuously increased so it can handle famine problem around the world.

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