GREENHOUSE CLIMATE CONTROL SYSTEM BASED ON PLC

[1]Vittal Abakkanavar, [2]Mahabaleshwara Sharma K

[1]PG Scholar, [2]Assistant Professor
[1]Department of Electrical and Electronics Engineering,
[1]NMAMIT Nitte, Karkala, India

Abstract— **The main reason for applying Greenhouse Monitoring and Control System (GMCS) in greenhouses is to achieve optimal growing environment. Because of its complexity, excessive control in greenhouses can adversely affect financial feasibility of the growing crops. We need an optimal control to accomplish these complicated objectives, including low emissions and reduced production costs. This paper describes one practical approach to the real-time control system in a greenhouse. Control system cyclically reads the data from the sensors and implements appropriate response on the actuator, based on required greenhouse conditions. Most challenging is the design of the control algorithm for this kind of process, due to complexity of influential greenhouse variables. Green house agriculture is a combination of integrated information and production-based farming system that is designed to increase long term site-specific farm production efficiency and profitability while minimizing unintended effects on greenhouse environment. It requires intensive sensing of the climate conditions at ground level and communication of data to the central control room. Greenhouse is the advanced facility available in which we can control the climate to increase plant growth and avoid the effect of season changes on the plants.**

***Index terms - Greenhouse*, GMCS, optimal growing environment, financial feasibility.**

I. INTRODUCTION

The agricultural growth in future would increase immensely if improvements are made in the productivity of farming systems with a specific focus on regional specialization and sustainable management of natural resources. Key role is played by agro-processing and other value added activities in diversifying agriculture. Climate condition monitoring is one of the most important aspects in agricultural production that has a direct impact on the productivity and maintenance of crop. A huge loss occurs every year due to damage of crops by various diseases caused by improper climatic conditions [1].

Greenhouse Monitoring and Control System (GMCS) plays a significant role in the production of out-of-season fruits, flowers and vegetables as well as high value and sensitive plants like capsicum. The purpose of greenhouse environmental control is to get the best climatic conditions

(controlled temperature, humidity, light and level of carbon dioxide) for crop growth, increased crop yields, improved quality of crops, and regulated growth cycle of crop. The main reason for GMCS is to achieve maximum plant growth and yield.

GMCS monitors:

- Inside the greenhouse (soil and air temperature, humidity, carbon dioxide concentrations and soil moisture)
- Outside the greenhouse (temperature, relative humidity, solar radiation, wind speed, wind direction and rainfall rate).

Each climate parameter should be maintained at optimal level, which is determined by a type and state of the crop [2]. Location and sensor numbers depend on the structure and dimensions of the GMCS. The sensors should be placed at plant level in the greenhouse.

Numerous applications of a control system have significantly increased through the development of new materials for highly efficient actuation and sensing, by reducing energy losses. An automatic control system includes sensors, PLC and actuators [3].

Greenhouse ventilation is most important for controlling the temperature, relative humidity and CO2 level. A good ventilation in the greenhouse can be achieved with a combination of a roof vent, front doors and fans [4].

In the case of high temperature and relative humidity in the greenhouse, the PLC activates the electric motors and roof vent opens for 10 %, depending on the wind direction [5].

To provide enough light for a normal crops growth (during winter and cloudy days). The lack of natural light, directs the PLC to turn the lights on [6].

The PLC can calculate the required illuminating time based on the growing season of crop, in order to determine the amount of light needed for the process of photosynthesis [7].

II. PROPOSED WORK

The block diagram shown in fig 1 describes the entire process of controlling and monitoring of the greenhouse parameters in greenhouse, here only three parameters are controlled, humidity sensor is used to sense the percentage of humidity present in the air and temperature sensor is used to sense the air temperature and soil temperature inside the greenhouse, temperature sensor and humidity sensor are connected to the Programmable Logic Controller (PLC) with power supply circuit of 12Vdc.

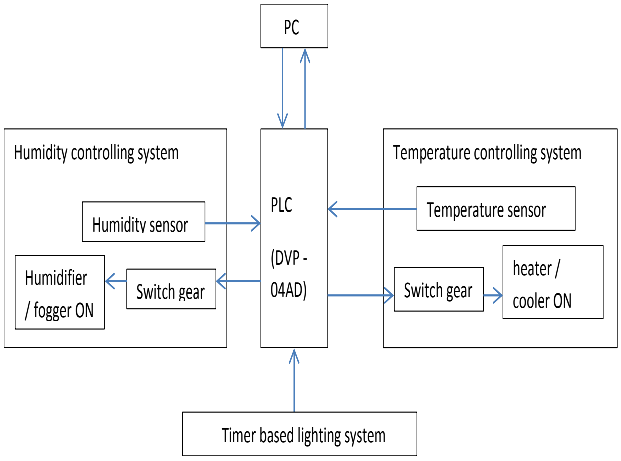

Fig 1: block diagram.

For both temperature and humidity control and monitor the comparator is used in ladder logic diagram. Preset value is provided by user as per requirement of crop. The present value of temperature and humidity inside the greenhouse is compared with the preset value of temperature and humidity respectively. If the present value of both humidity and temperature are below or above the pre-set value, switch gear system actuates and turns on the loads to increase or to decrease the temperature and humidity inside the greenhouse. To increase temperature, the heating system is turned on and to reduce temperature cooling system is turned on. To increase/decrease humidity inside the greenhouse, fogger will be turned on/off . For timer based lighting system, the 100ms timer is used in ladder logic diagram and 12Vdc lamp is turned on/off to provide light hours during day time/dark hours during night time respectively. The PC is connected to the PLC with RS-232 cable.

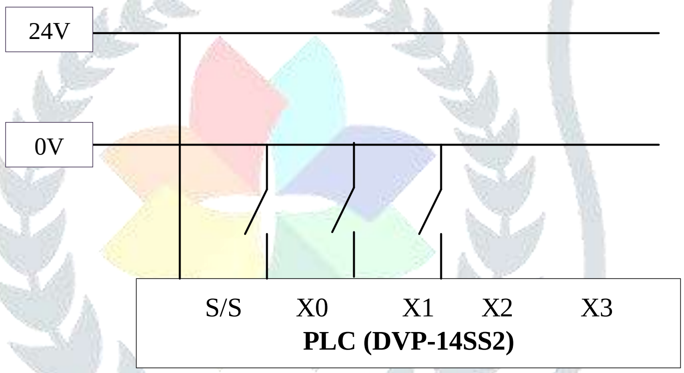

Fig 2: PLC input module electrical circuit.

The layout shown in Fig 2 is the PLC input module to 24Vdc electrical circuit. Temperature sensor and humidity sensor are connected to PLC and power circuit as shown below. Here the source/sink(s/s) terminal of the PLC is connected to positive terminal of the 24Vdc power supply and input terminals *x0,x1,x2…..* are connected to the ground terminal of the power supply circuit.

Layout shown in Fig 3 is the PLC output module. Here com terminal of the PLC is connected to the positive terminal of the 24Vdc power supply circuit. And output terminals *y0, y1,y2….* are connected to the ground terminal of the same power supply circuit.

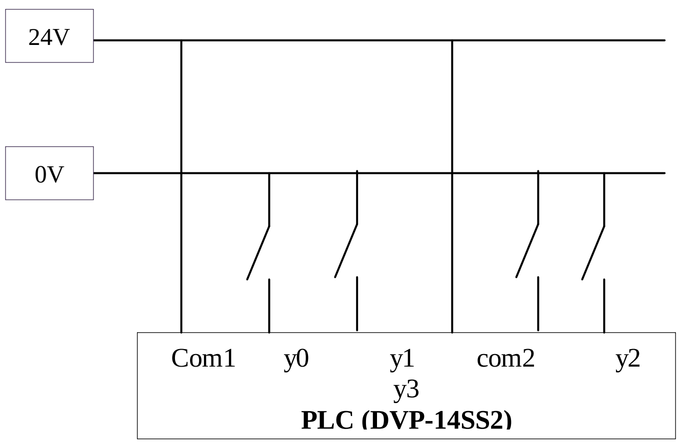

Fig 3: PLC output module electrical circuit.

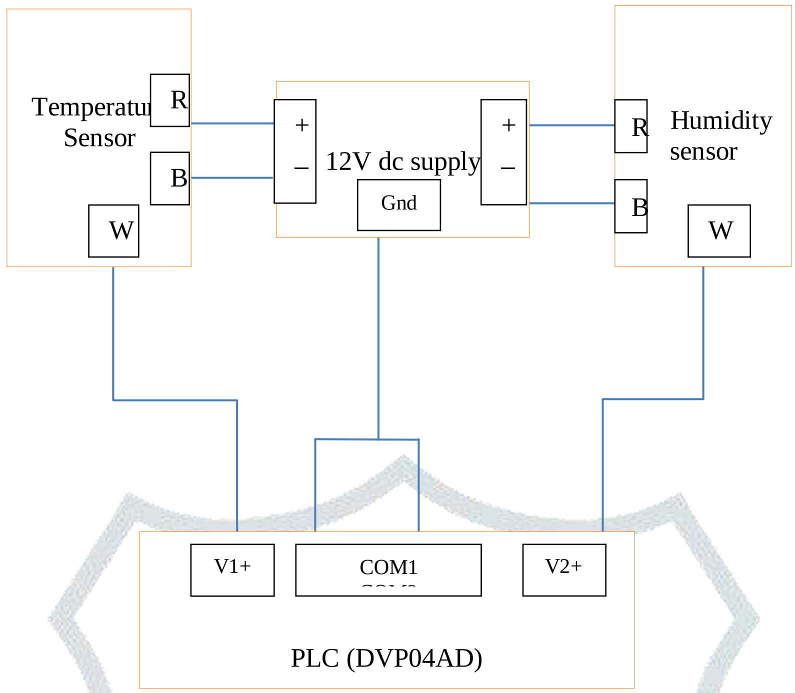

Fig 4: sensors connections to PLC with power module of 12Vdc.

The layout shown in fig 4 describes the sensors connections to PLC module with 12Vdc power supply circuit. Both sensor terminals of red colored are connected to the positive terminal of 12V dc power supply circuit, and black colored terminals of both the sensors are connected to the ground terminal of the same power supply circuit. The white colored (output) terminal of temperature sensor is connected to the V1+ terminal of the PLC(DVP04AD) as shown. Humidity sensors white colored (output) terminal is connected to the V2+ terminal of the PLC. The terminals com1 and com2 of the PLC are connected to the ground terminal of the 12V dc power supply circuit.

The PLC (DVP04AD) is used to connect both the sensors to the 12V dc power supply module as shown in fig 4. The values sensed by the sensors are converted to the digital values by using the PLC (DVP04AD). The PLC used is converts the analog value to the digital value. PCL (DVP-14SS2) is used to connect input and output terminals to the 24Vdc power supply module and load of 24V dc lamps respectively. Both PLCs are interfaced by their ports.

III. METHODOLOGY

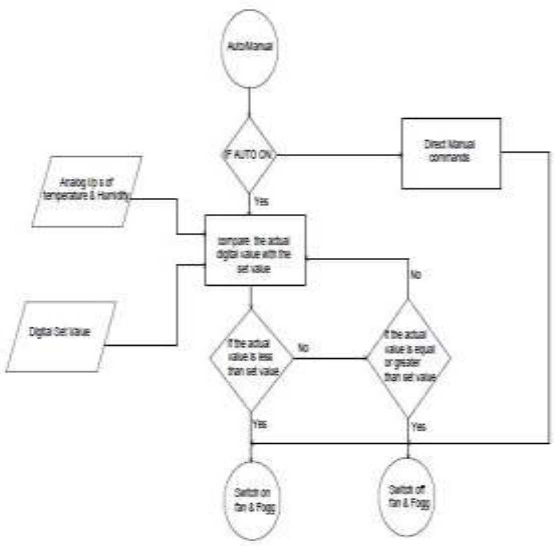

Fig 5: flowchart for temperature and humidity control logic.

The algorithm for automatic control of the GMCS includes several steps:

1. The sensor detects the level of climate parameter and sends a signal to the PLC.
2. The PLC checks whether it is in the range or not (above or below).
3. When the measured value is above the maximal or below the minimal pre-set value the PLC performs action. It runs the actuators until the climatic parameter is brought back to its optimum.

The flowchart shown in fie 5 is the ladder logic diagram of the temperature and humidity control and monitoring in greenhouse for sustainable greenhouse production.

Initially select auto or manual function, if auto is off then manual function will be done by user to on/off the load to control temperature and humidity in greenhouse. Otherwise the preset value of both temperature and humidity in digital will be compared with present digital value of the both temperature and humidity.

Compared value of both pre-set and present digital value in greenhouse is as follow.

If digital pre-set value is less/greater than digital present value, make sure that present digital value is equal to pre-set digital value to get desired outcome in the greenhouse. To make both values equal turn on/off the loads as per requirements.

To increase/decrease the temperature level inside the greenhouse, the load used will be heating/cooling system. And to increase/decrease the humidity level inside the greenhouse the load used will be the humidifier. Humidifier will be turn on to increase the humidity level and to decrease humidity level, humidifier will be turned off. Fig 9 shows the output of both temperature and humidity control system.

IV. RESULTS AND ANALYSIS

These are all the results obtained during simulation of the project work using WPL Software.

Fig 6: Ladder diagram for humidity control system.

Fig 6 shows the maintained humidity level for plants in greenhouse by the fogger system, as the humidity in the GMCS decreases, the fogger will be turned on and it will maintain the required humidity for the greenhouse.

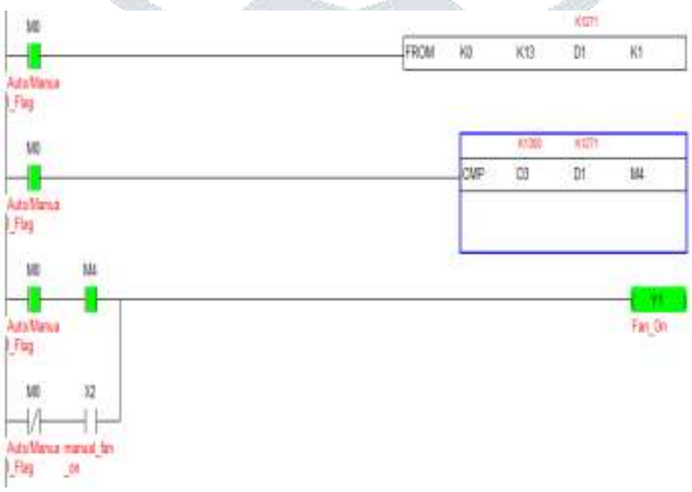

Fig 7: Ladder diagram for temperature control system.

Fig 7 shows the maintained temperature level for plants in greenhouse by using lamp in the system, as the temperature in the GMCS decreases, the lamp will be turned on and it will maintain the required temperature for the greenhouse.

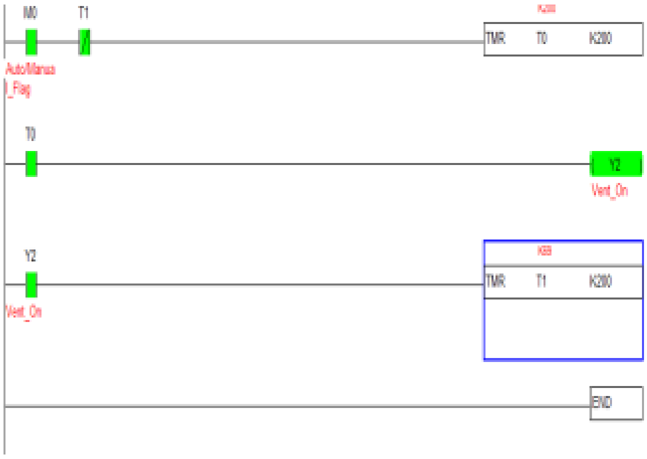

Fig 8: Ladder diagram for lighting system.

From the ladder logic as shown in fig 8 can make artificial light hours and dark hours, light hours by turn on the lights during daytime, and dark hours by turn off the lights during night time.

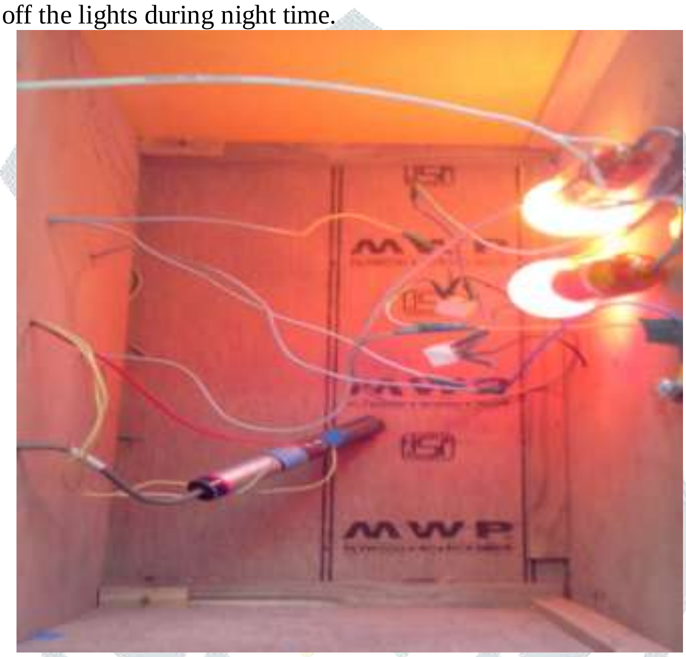

Fig 9:output.

V. ADVANTAGES AND DISADVANTAGES

Advantages of GMCS are.

- No exposure to atmosphere. Hence protects crop from insects.
- Can expect more yield.
- We can grow seasonal and non-seasonal crops.
- Protects crops from heavy rain and wind.

Disadvantages of GMCS are.

- Comparatively high initial cost.
- Needs continuous power supply causes more operating cost.

VI. CONCLUSION

Implementation of such an effective system could be affordable only with large greenhouses. Its profitability rises with the growing size of the land covered. Even smaller greenhouses can absorb such a sophisticated system if the monitoring concept is based on the centralized main unit and distributed local boxes and censuring in the neighboring assets. Each separate greenhouse is covered with belonging PLC, and then the set of PLCs constitutes a distributed monitoring system with a single governing main unit. This way, a set of different plants can be grown in separate sections and yet a climate would be uniquely managed.

The proposed approach has a great potential for remote crop monitoring and control using PLC technology for large greenhouses. The system presented here is user friendly and can be easily implemented, but only the higher initial cost is its drawback.

VII. FUTURE WORK

In this project the humidity and temperature are controlled by using humidity and temperature sensors, and timer based lighting system is done. In future carbon di oxide concentrations, soil moisture and solar radiation can be controlled in greenhouse using respective sensors, and also can control effect of heavy rainfall and wind speed on the crops.

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