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Crop Irrigation and monitoring System using Programmable logic Controller

Hardik Gupta[1] and Nital Patel[2]
[1]Electrical Engineering Department, Nirma University, Ahmedabad, India
[2]Electronics & Instrumentation Engineering Department, Nirma University, Ahmedabad, India
Email: nital.patel@nirmauni.ac.in

***Abstract*—Now a days automation and monitoring of crop irrigation is required for quality production of the crop. In this paper wheat, tomato and rice are considered for the study. A PLC based system is developed for monitoring and automation of these crops at various stages of growth. For the simulation of the system TwinCat™ software is used. For wheat crop temperature is monitored at germination, growth, and grain filling stages. Also, for wheat irrigation schedule is simulated. For tomato temperature is monitored at various growth stages. For rice crop temperature, soil moisture and humidity content are considered. The monitoring system helps the farmers to maintain the desired conditions for the respective crop.**

***Index Terms*—PLC, Wheat, Rice, Tomato.**

I. INTRODUCTION

The irrigation procedure in agriculture is a key factor in achieving good yields and plant performance. With the modernization of agriculture and the continuous advancement of irrigation technology, automated agricultural equipment has been promoted [8]. The water requirement for each crop is different at various growth stages.
Wheat is mainly grown during Rabi season and has wide adaptability. It can be grown in the tropical, sub-tropical zones, as well as in the temperate zone and the cold tracts of the far north, and at a distance after 60 North altitude [1]. Wheat can tolerate severe cold and snow. The suitable weather conditions for wheat cultivation are cool and moist weather during the vegetative growth period followed by dry, warm weather for grain to mature and ripening. The optimum temperature range for ideal germination of wheat seed is 20-25^0 C. Table 1 shows the temperature requirements at different growth stages of wheat.

TABLE I: TEMPERATURE REQUIREMENTS AT DIFFERENT GROWTH STAGES OF WHEAT [1]

Growth Stage	**Temperature (°C)**
Germination	20 - 25
Accelerated growth	20 - 23
Proper grain filling	20 - 23

Suitable soil moisture is required for normal development of the wheat plant at all the stages of growth. Table 2 shows the irrigation schedule for wheat crop.
A warm and cool atmosphere is necessary for tomatoes. In high humidity, tomato plants cannot survive. Additionally, fruit color, pigmentation, and fruit set are all impacted by light intensity. For seed germination, seedling growth, flower and fruit set, fruit quality, diverse environmental conditions are needed. The

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development of dark red fruits is aided by bright sunlight at the time of fruit set [2]. Table 3 shows the temperature requirements at different growth stages of Tomato.

TABLE II: IRRIGATION SCHEDULE FOR WHEAT CROP [3]

Irrigation	Days
1st irrigation	It could be given 20-25 days after sowing
2nd irrigation	It could be given 40-45 days after sowing
3rd irrigation	It could be given 70-75 days after sowing
4th irrigation	It could be given 90-95 days after sowing

TABLE III: TEMPERATURE REQUIREMENTS AT DIFFERENT GROWTH STAGES OF TOMATO [2]

Growth Stage	Temperature (°C)
Germination	16-29
Seedling growth	21-24
Fruit set (Day)	15-17
Fruit Set (Night)	20-24
Red colour development	20-24

India is an important centre of rice cultivation. On most of the largest areas of farming in India rice is cultivated [4]. A hot, humid atmosphere is necessary for the rice production. The average temperature required throughout the life period of the crop ranges from 21°C to 37°C. The maximum temperature which crop can withstand is 40°C to 42°C. For rice plants, the soil moisture content ranges from 20% to 60% [5]. The humidity level for rice plant is between 60% to 80% [6].

II. PROGRAMMABLE LOGIC CONTROLLER

Programmable logic controller (PLC) is a digital controller that is used for automation of industrial processes [7]. Here the PLC is used to prepare the monitoring of various parameters (temperature, humidity, soil moisture) as well as to turn on and off the water supply. Inputs are temperature sensor, humidity sensor and soil moisture sensor. Outputs are lights and motor. The sensors are to be connected to the input module and lights and motor to be connected at output module of the PLC

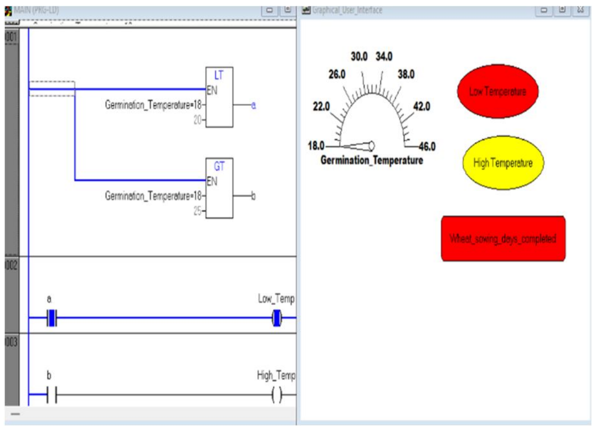
III. LADDER LOGIC AND GUI

WHEAT CROP: Figure 1 shows Ladder Logic and GUI for wheat crop. This Ladder Logic is dedicated to monitor system for wheat crop. In this logic, LT (LESS THAN) and GT (GREATER THAN) compare function blocks are used to provide the range for germination temperature. A 24-hr clock for 25 days is used with the help of timers and counters to count the sowing days and after 25 days the bulb will glow which shows that total sowing days are completed. The list of inputs, outputs and variables is shown in table 4.

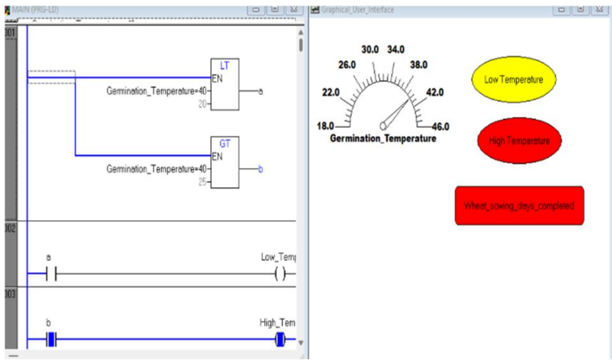
TABLE IV: LIST OF INPUTS, OUTPUTS, AND VARIABLES FOR WHEAT CROP MONITORING SYSTEM

INPUTS	OUTPUTS	VARIABLES /Function Blocks
Germination Temperature START STOP	Low Temperature High Temperature Normal Temperature Wheat Sowing completed	a b T1, C1, C2 Total_sowing_days

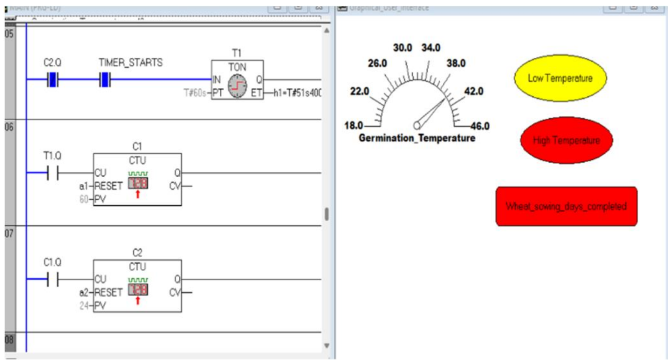
As shown in figure 1(a) when the wheat germination temperature is less than 20°C the low temperature bulb will glow as red color. When the wheat germination temperature is greater than 25°C the high temperature bulb will glow as red in figure 1(b). If the wheat germination temperature is between 20°C to 25°C both the bulbs' colors are yellow means the germination temperature in normal rage. As shown in figure 1(c) when 25 days complete after sowing the wheat seeds the wheat_sowing_days_complete bulb will glow as yellow as it indicates 1st irrigation is required.



(a) Low temperature for wheat crop



(b) High Temperature for wheat



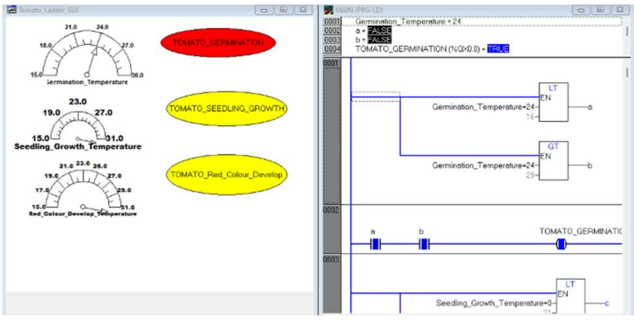
(c) Completed wheat sowing days

A. Tomato Crop:

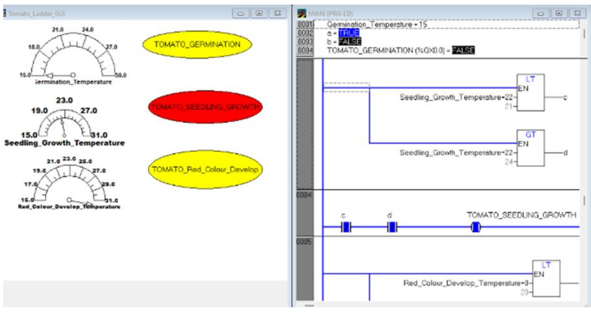
Figure 2 shows Ladder Logic and GUI for tomato crop. In this logic LT (LESS THAN) and GT (GREATER THAN) compare function blocks are used to provide the range for germination temperature, seedling growth and red colour develop temperature. The list of inputs, outputs and variables is shown in table 5.

TABLE V: LIST OF INPUTS, OUTPUTS, AND VARIABLES FOR TOMATO CROP.

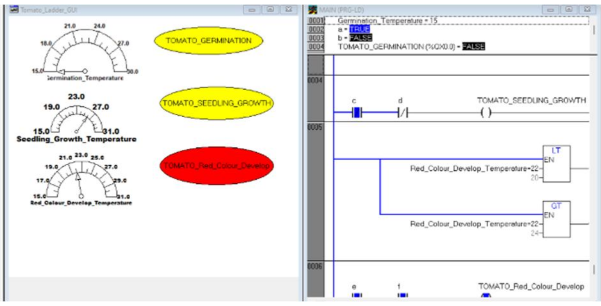
INPUTS	OUTPUTS	VARIABLES
T_Germ_Temp	TOMATO_GERMINATION	a
	TOMATO_SEEDLING_GROWTH	b
T_Growth_Temp		c
	TOMATO_Red_Colour_Develop	d
T_Color_Develop_Temp		e
		f



(a) Tomato germination temperature



(b) Tomato seedling growth



(c) Tomato red color development temperature

Figure.2: Ladder Logic and GUI for Tomato

As shown in figure 2(a) the Tomato_ Germination bulb is used to indicate the status of the germination temperature. If the tomato germination temperature is between 16°C and 29°C the Tomato_ Germination bulb is red colored. If the temperature is out of the range, it will be yellow colored. As per figure the 2(b) the Tomato_seedling_growth bulb is turned red when the seedling_growth_temperature is in the range of 21°C to 24°C, otherwise the bulb will glow with yellow color. As per figure the 2(c) if the value of Red_color_develop_Temperature is between 20°C to 24°C the Tomato_Red_color_Develop bulb is turned red, otherwise the bulb will glow with yellow color.

B. Rice Crop:

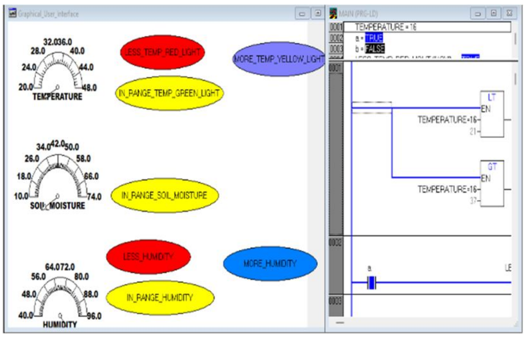
Figure 3 shows Ladder Logic and GUI for rice crop. In this dedicated monitoring system for rice logic, we have used LT (LESS THAN) and GT (GREATER THAN) compare function blocks to provide the range for temperature, soil moisture and humidity. Using the outputs of LT and GT functions, we make different combinations of NOT, OR and AND gate to get outputs for different conditions like more, less, or in range. The list of inputs, outputs and variables is shown in table 6.

As shown in figure 3(a) if the temperature is in range of 21°C to 37°C the IN_RANGE_TEMP_GREEN_LIGHT will turn on as green otherwise as yellow. If the temperature is less than 21°C then LESS_TEMP_RED_LIGHT will turn on as red color otherwise as yellow color. If the temperature is greater than 37°C then

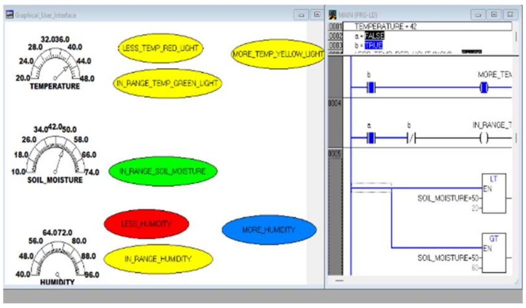
MORE_TEMP_YELLOW_LIGHT will turn on as yellow color otherwise as red color. As per figure 3(b) if the SOIL_MOISTURE value is in the range of 20% to 60% the IN_RANGE_SOIL_MOISTURE bulb is turned on as green if the value is out of range the bulb will remain as yellow. As shown in figure 3(c) if the HUMIDITY value is between 60% to 80% the the IN_RANGE_HUMIDITY bulb gets turned on as red. If the value is less than 60% the LESS_HUMIDITY bulb gets turned on as red. If the value is greater than 60% more HUMIDITY bulb gets turned as red.

TABLE VI : LIST OF INPUTS, OUTPUTS, AND VARIABLES FOR RICE CROP.

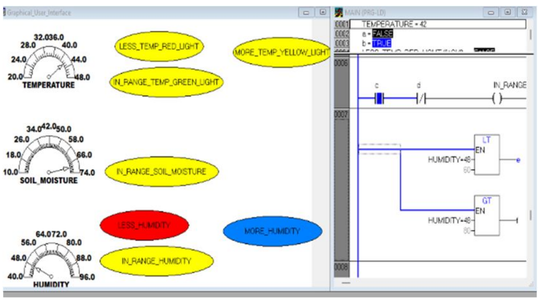
INPUTS	OUTPUTS	VARIABLES
TEMPERATURE	LESS_TEMP_RED_ LIGHT	A B
	MORE_TEMP_ YELLOW_LIGHT	
	IN_RANGE_TEMP_ GREEN_LIGHT	
SOIL_MOISTUR E	IN_RANGE_SOIL_MOISTURE	C D E F
HUMIDITY	LESS_HUMIDITY MORE_HUMIDITY IN_RANGE_HUMIDITY	



a. Temperature for rice Crop



b. Soil moisture for rice crop



c. Humidity for rice crop

Figure.3: Ladder Logic and GUI for rice crop

IV. Conclusion

In the present study a crop monitoring system for crops wheat, tomato, and rice is developed. In this study programmable logic controller (PLC) is used for the automation of crop monitoring system. Based on the conditions of the parameters like temperature, humidity, soil moisture of the particular crop the farmers can take the decision. In future actual sensors can be connected to the input and output modules of PLC and stand-alone system can be developed.

References

[1] https://dwd.dacnet.nic.in/DWD_UploadDocuments/Climate_22062020_Climate.pdf

[2] http://agropedia.iitk.ac.in/content/climatic-and-temperature-requirement-tomato

[3] http://agropedia.iitk.ac.in/content/irrigation-wheat-crop

[4] https://farmer.gov.in/cropstaticsrice.aspx

[5] https://www.greenwaybiotech.com/blogs/gardening-articles/how-soil-moisture-affects-your-plants-growth#:~:text=All%20plants%20need%20to%20be,between%2020%25%20and%2060%25

[6] https://view.officeapps.live.com/op/view.aspx?src=http%3A%2F%2Fagropedialabs.iitk.ac.in%2Fagrilore%2Fsites%2Fdefault%2Ffiles%2Frice%2520climate.ppt%23%3A~%3Atext%3DMoist%2520humid%2520weather%2520during%2520vegetative%2Cis%2520said%2520to%2520be%2520optimum&wdOrigin=BROWSELINK

[7] M. Kowsalya, A. Elakya and R. Pradeep, “Solar Operated PLC Based Automated Irrigation System With Fault Preventer”, ICSCCS-2021.

[8] W. Ma, F. Sun, Y. Wei, C. Li and S. Wang, “Design of PLC Automatic Water and Fertilizer Integrated System in Greenhouse”, ESMA-2018.