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PLC Based Sensor and Instrumentation for Crop Disease Forecasting System

Vhatkar Dattatraya Shivling, Sudhir Kumar Sharma, C Ghanshyam, Harpreet Singh, Shubhani Dogra
Scientist CSIR-CSIO,Chandigarh Prof.JNU,Jaipur, App.Trainee CSIR-CSIO,Chandigarh-160030

ABSTRACT: -The main idea of this paper is to present PLC based data acquisition system for plant disease information to the farmers [4]. The objective of this paper is to develop a predictive model for early forecasting of disease severity for Picrorhiza kurroa and Apple with optimum efficiency, which help to farmers for management and control of use of pesticides to reduce the loss in economical cost and also beneficial to the environment and human health. Firstly, we measure different parameters like temperature, humidity, leaf wetness, solar radiations etc. by use of different sensors. The output analogous signal is applied to the PLC system for data processing by use of predefined mathematical model. The System can detect the small fluctuations in parameters and compare it with past data values to make a decision. PLC uses a different type of programming like ladder, Boolean, Grafcet for implementing a mathematical model [2]. Due to which we will have a complete understanding of the environmental conditions of Apple and Picrorhiza kurroa farms and we would thus able to control these conditions. By use of this data, we can also implement such automatic systems which detect the symptoms of disease at starting stage and perform an action accordingly and spray the pesticides in a control manner without interaction of human [3]. By correlating the plant indices we can provide a valuable information to farmers for improving quality and quantity of crops.

Index terms—**PLC, Regression, Picrorhiza kurroa, Apple.**

I. INTRODUCTION

Pest control is a method used to control pest in an effective manner [1]. Pest control aims to suppress the pest below the injury level. By reducing our dependence on pesticides, insect pests are becoming major irritants in agriculture and horticulture. 10% of the produce is lost to insect pests. It is, therefore, necessary to take a preventive action against pests. Scientists have developed a number of chemicals to avoid the attack of insects. A number of pesticides have been developed to stand against pests. The wide spread of pesticides has resulted in fragile ecosystems. The disease severity is depends upon various parameters like temperature, humidity, leaf wetness, solar radiation [8]. To study the effect of disease severity we implement the model for early forecasting of disease severity for Picrorhiza kurroa and Apple. The temperature range for apple scab spore production is 18-26° C [10]. At an average temperature of 18° C, light infection will result if leaves remain wet for nine hours, but if the leaves are wet for 18 hours or more heavy infection will occur. Lesions will produce conidia after nine days if the temperature averages 18° C. The production of conidia is affected by humidity levels of at least 60-70% are required for spore production. Infection of leaves by ascospores and conidia is highly dependent on how long the leaves or fruit stay wet, and on the average temperature [11]. The infection of picrorhiza kurroa is also depends upon environmental conditions. So there is high need of pest management, which is a method to control the pest in an effective manner and reducing our dependence on the pesticides. The use of pesticides can be reduced with the help of forecasting of disease and pest infection. It predicts risk or no risk for the particular infection to occur on that particular crop. Advanced information about severity of risk help to alert the farmers to manage the quality and quantity of pesticides for particular pest and disease [12]. For our automated monitoring system we are implementing three types of sensors. The sensors to be used are humidity sensor, temperature sensor, leaf wetness sensor. We are building a monitoring system that calculates the various parameters and by use of these parameters developed a mathematical model that predicts the symptoms of plant disease by calculating the various environment parameters. Therefore the farmers can take necessary action before the disease has started to protect their plants from disease so that they can improve the quality and quantity of crop by use of a minimum amount of pesticides and insecticides. We can also reduce the effect of pesticides and insecticides on human and environment. These sensors will be connected to a PLC which will function as the main control unit. The sensors will send a signal to the PLC and the PLC will translate the signals and gives the value of current condition and compare it with previous store values and predict the present condition of the crop. When conditions are favourable with conditions that are required for ascomycete fungus Venturia inaequalis the PLC detects the conditions and issues an alert message to farmers so that they can use pesticides in calculated amount to eliminate the effect of ascospores. For instance, if the present temperature is 30°C and humidity is 43% the system will store the present values now if present temperature is 26 °C and humidity is increased to 60% the PLC calculate this value and compare it with previous values to take the decision related to crop disease. The PLC continuously monitors the environment parameters if there is any changes occur in parameters the PLC detect it and perform various actions.

II. METHODOLOGY

In this project we are using Unitronics vision-570 programmable logic controller (PLC). For data collection and for acquisition purpose Beta regression model is

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being used. Beta regression model is a prediction model that gives us analytic values. It employs a parameterization of the beta distribution in terms of its mean and a precision parameter. Simple beta regression models are similar to generalized linear models. In this data is measured in a continuous scale and restricted to the unit interval, i.e. $0 < y < 1$ [9]. The generalized equation of the beta regression model is developed for the forecasting of disease in Apple and Picrorhiza kurroa for this project:

$$Y = p\, t^{q}\, (1\text{-}t)^{r}\, W^{s}$$

t= (T –Tmin)/(Tmax – Tmin),

The above equation can be linearized to:

$\log(Y) = \log(p) + q \log(t) + r \log(1 - t) + s \log(W)$

Specification [14]

- Up to 1000 I/O; Supports Remote I/O
- Digital, Analog, Temperature, Weight
- 5.7” Color Touch Screen, 64K Colors
- Auto tune PID 24 loops
- 2MB Logic, up to 500 Images (12MB)
- Cellular Communication- SMS, GPRS
- Ethernet, Can-bus, RS485, MODBUS RTU/IP, CAN open, J1939, SNMP
- Web Server, send emails & attachments
- SD Card, Data logging, Recipes & Cloning

Fig. 2.1: Vision 570 [14]

III. BLOCK DIAGRAM DISCRIPTION

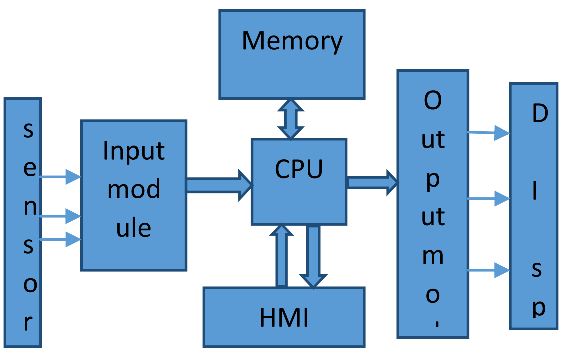

Fig. 3.1: block diagram of PLC interfacing with sensors

1. *PLC:*
   To achieve the objective a model is implemented in PLC technology [5]. PLC is a digitally operating electronic system which uses a programmable memory for the internal storage of instructions and for implementing specific functions such as logic, sequencing, timing, counting and arithmetic, to control various types of machines or processes through digital or analog input/output modules, A PLC uses 24 VDC power supply. The programming of the system is also stored in the PLC itself. It also stores all the data from sensors [6].
2. *Human machine interface:*
   The user interface or human–machine interface is an important part of the machine which handles the human–machine interaction. [9].

SENSORS USED:

3. *Humidity sensor:*
   We will use humidity sensor for measuring the humidity of air. After that signal is sent to the PLC and value of humidity is stored. In future any change in humidity is noted down and compared with the previous values and the output is sent to the farmer so that he can take necessary action.
4. *Temperature sensor:*
   We will use a temperature sensor to measure the temperature. The output signal is sent to the PLC and the particular set point is given if temperature falls or arise at set points the system will suggest related action.
5. *Leaf wetness sensor:*
   Leaf wetness sensor is used to calculate the wetness of the leaf. Which is highly effected the action of spores. A set value is given if the data is fall or rise above the given range the necessary action has to be performed.

IV. PROGRAMMING

The ladder-logic approach is used for programming the PLC. Two vertical lines supplying the power are drawn at each of the sides of the diagram with the lines of logic drawn in horizontal lines [7].

Basic rules of ladder-logic [13]

1. The vertical lines indicate the power supply for the control system 12 VDC to 240 VAC. The power flow is visualized to move from left to right.
2. Read the ladder diagram from left to right and top to bottom.
3. Electrical devices are normally indicated in their normal de-energized condition. This can sometimes be confusing and special care needs to be taken to ensure consistency.
4. The content associated with coils, timer, counters and other instructions has the same numbering convention as their control devices.
5. Devices that indicate a start operation for an item particular are normally wired in parallel.

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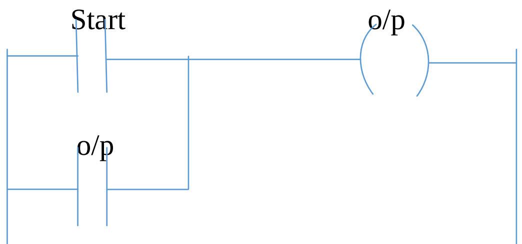


Fig. 4.1: NO circuit

6. A device that indicates a stop operation for a particular item are normally wired in series.

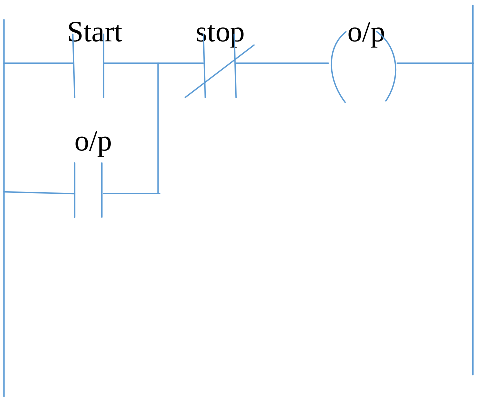


Fig. 4.2: NC circuit

7. Latching operations are used, where a momentary start input signal latches the start signal into the on condition, so that when the start input goes into the OFF condition, the start signal remains energized ON.

V. FLOW CHART

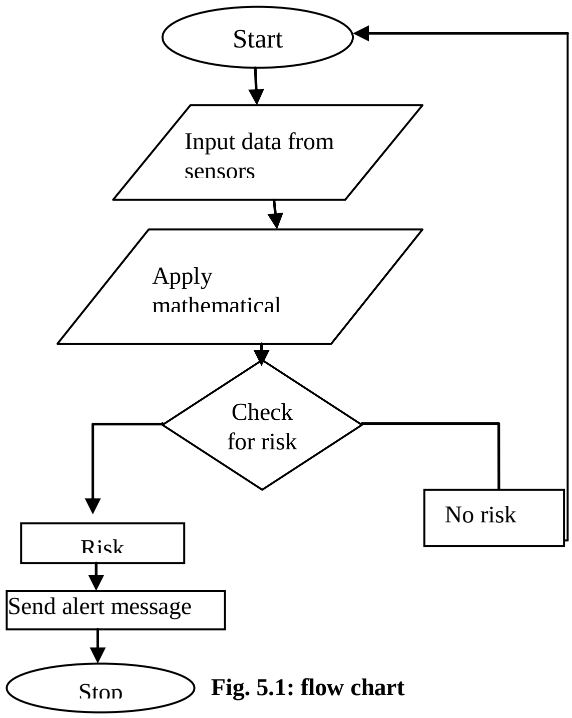
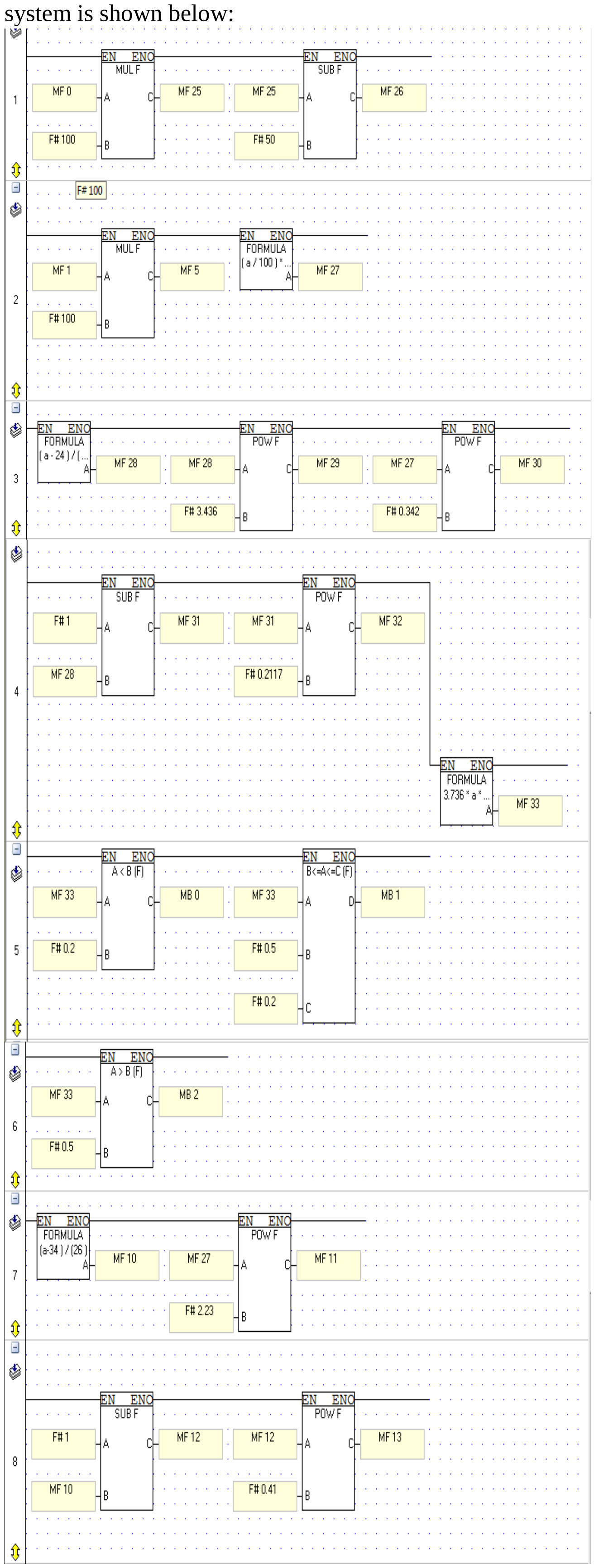


Fig. 5.1: flow chart

VI. PROGRAM FOR PLC

The programming for PLC based data acquisition system is shown below:



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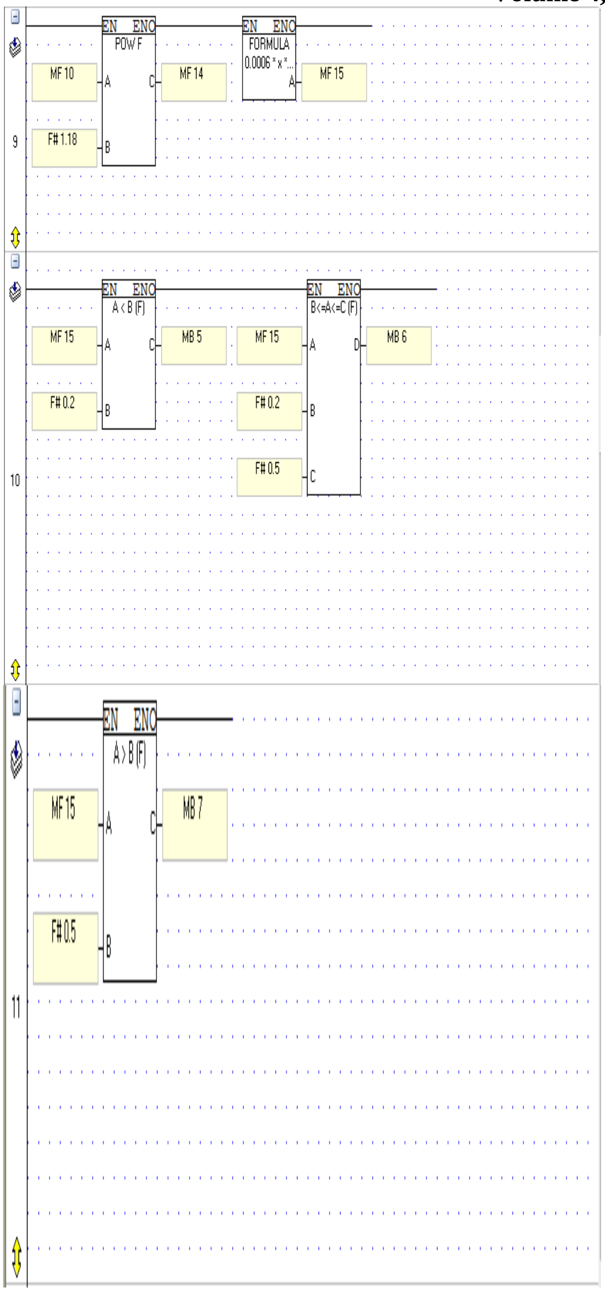

HMI view of PLC

1. Initial window of project

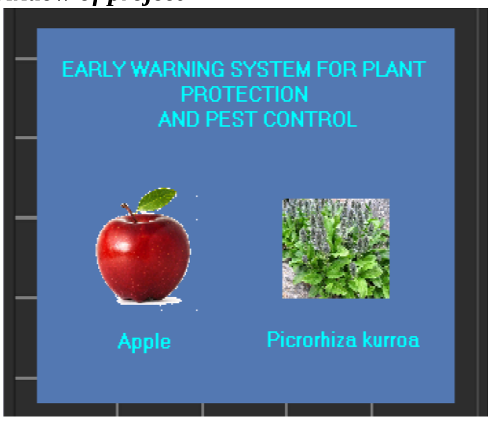

Fig. 6.1: Initial window

2. Display for Apple disease

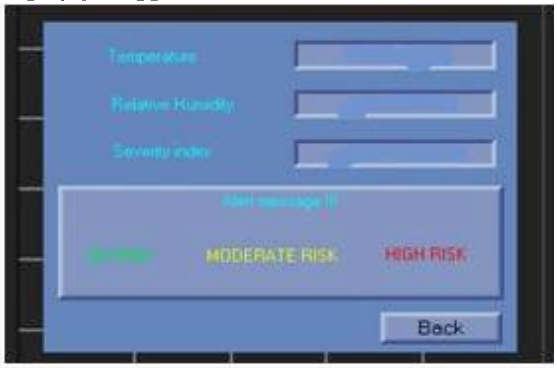

Fig. 6.2: Display for Apple disease

3. Display for Picrorhiza kurroa disease

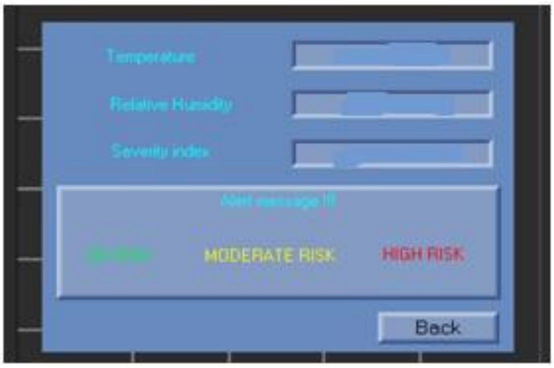

Fig. 6.3: Display for picrorhiza kurroa disease

VII. CONCLUSION

In this paper, we discuss all the system requirements to implement a cost effective and economical pest control system. The various parameters involved in pest management have been discussed and a relation between various parameters to find out the optimum conditions for pest growth has been established. The developed system measures first different parameters of the environment and leaf e.g. Air temperature, air humidity, leaf wetness. This system acquires all the information which will affect crop growth and provides the capability of controlling the growth of pest which increases crop growth. There is huge future scope to upgrade and application of this work presented here. The system can be upgraded with the GSM and GPRS, information about crops can be sent directly to farmers on their mobile phones and also can be sent to the server located hundreds of miles from remote locations of implanted system.

VIII. FUTURE ENHANCEMENT

Presently in this project we are using three sensors to measure various environmental parameters such as temperature, humidity and leaf wetness. For future enhancement purpose, we can make use of many more sensors to detect several more environmental parameters. This project can further be enhanced and be used for remote sensing of various diseases. The data collected through these sensors can be transmitted to various destinations wirelessly or through ethernet cables.

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