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Canal Automation

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***Abstract*—**Water requirement of the people of all the regions are increasing day by day, partially to produce more food grains to feed the ever increasing population and satisfy the industrial and domestic requirements. But the fact remains that the total consumable water resource is limited and a large portion of which is wasted. Hence we need to utilize and conserve water as efficiently as possible. "Canal Automation" provides a tool for minimizing the wastage of water by utilizing the latest technology and computing facilities. Canal Automation is a small step towards a means of controlling the opening of the main gate using fuzzy logic. The fuzzy variables are rainfall, temperature and water-level. Our project is capable of performing the following functions. The amount of water required by the farmers depends on the parameters like rainfall, temperature, water-level etc. Data regarding all the above physical parameters are fed to the "Fuzzy Logic Controller". Fuzzy logic controller basically consists of fuzzification, inference system, rule base and finally defuzzification. The inputs to it are basically the fuzzy inputs. To these fuzzy inputs different combination of fuzzy rules are made. These rule acts as the input to the rule base. This combination forms the inference system. Thus the defuzzified out gives the height of the gate to be lifted. Physical lifting of the gate is done by using stepper motor.

***Keywords*—** Fuzzy logic; fuzzy set; stepper motor; programmable peripheral interface; ADC.

I. INTRODUCTION

India is basically an agricultural country and all the resources depend on the agricultural output. For agricultural output water is the most vital element. Water is normally is supplied to the fields by nature through rains. The water can be collected in reservoir during rainfall and then realizing it when it is required the most. It provides a means of controlling the opening of the main gate using fuzzy logic. The fuzzy variables are rainfall, temperature and water-level. It is capable of performing the following functions. It takes into account the water required by the end user. The amount of water required by the farmers depends on the parameters like rainfall, temperature, water-level etc. Data regarding all the above physical parameters are fed to the "Fuzzy Logic Controller" which basically consists of inference system, rule base and finally defuzzification. The inputs to it are basically the fuzzy inputs. To these fuzzy inputs different combination of fuzzy rules are made. These rule acts as the input to the rule base. Thus forms the inference system.

II. SYSTEM DESIGN AND DESCRIPTION

The entire project consists of both software portions along with the hardware supporting the mechanism. The basic principle of our project is to implement Fuzzy Logic to manage water in the canals very effectively. Data regarding all the above physical parameters are fed to the "Fuzzy Logic Controller". Fuzzy logic controller basically consists of fuzzification, inference system, rule base and finally defuzzification. The inputs to it are basically the fuzzy inputs. To these fuzzy inputs different combination of fuzzy rules are made. These rule acts as the input to the rule base. This combination forms the inference system.

Thus the defuzzified out gives the height of the gate to be lifted. Physical lifting of the gate is done by using stepper motor. The Block Diagram is shown below:

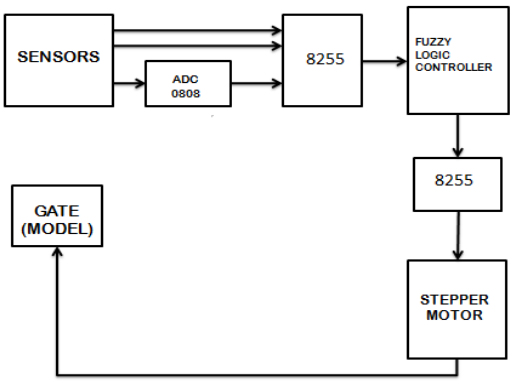

Fig.1. Block diagram.

A. Stepper Motor

A stepper motor is an electromagnet actuator, which translates digital electronic signals to fixed mechanical movements. While conventional motors rotate continuously when energized, a stepper motor rotates or steps in fixed angular increments. It also holds position and thereby provides a positive detent when it is not rotating. The basic step size or step angle obtained with a particular stepper motor is dependent upon the construction of stepper motor and the associated driver scheme. The available step resolution ranges from a fraction of a degree to 90^0, while the range from 1.8^0 to 15^0 is most common. The motor is made to rotate by passing the current through two phases at a time.

B. 8255 PPI

PPI stands for Programmable Peripheral Interface. 8255 is a widely used programmable I/O device. It can be programmed to transfer data under various conditions, from simple I/O to interrupt I/O. It is flexible, versatile, and economical but somewhat complex. It can be used with almost any microprocessor. To communicate with peripherals through 8255, three steps are necessary:-

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1. To determine the base address of 8255 and address for ports A, B, C and of the control register.
2. Write control word in the control register.
3. Write I/O instructions to communicate through ports A, B and C.

C. 0808 ADC

ADC is Analog to Digital Converter. This is an 8-bit microprocessor compatible A/D converter with 8 channels multiplexer. The ADC 0808 data acquisition component is a monolithic device with an 8-bit analog to digital converter, 8 channel multiplexer and microprocessor compatible control logic. The A/D converter uses successive approximation as the conversion technique. The device eliminates the need for external zero and full scale adjustments. Easy interfacing is provided by the latched and decoded multiplexer address inputs and latched TTL TRI-STATE outputs. It offers high speed, minimal temperature dependence and excellent long term accuracy and consumes minimal power.

III. METHODOLOGY

There are two parts involved in the Development of Control System: Hardware and Software. Hardware part involves the circuit connections between ADC and 8255 PPI. The circuit Diagram is given in figure 2. The coding is done using C language and PCB is designed using ARES.

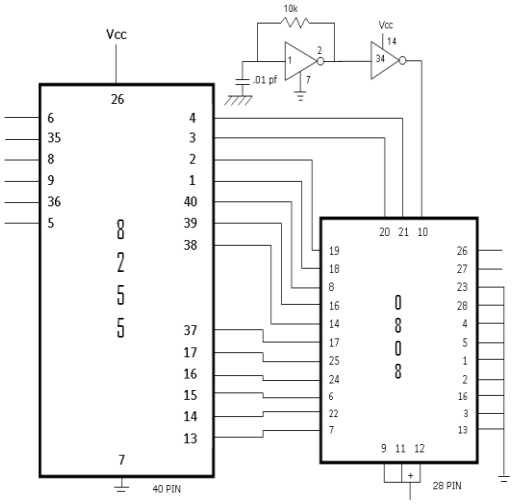

Fig. 2. Circuit Diagram.

The Software portion consists of algorithm employed in the design of fuzzy controller is discussed in this section. The software for fuzzy logic has been written using "C" language. Initially the water level is read, if it satisfies the condition then we precede further, otherwise end the program. If the given condition is satisfied the values for rainfall, temperature are read. The controller reads the value of temperature and rainfall, converts these inputs to a fuzzy form before processing them. The fuzzy sets are determined and the degree of membership of input variable is calculated using the relation degree of membership=m*input, where "m" is the slope of the curve defining the fuzzy set. The next step is to select those rules from the rule base, which are relevant to the present input, and then each ruled so formed is compared with every rule in the rule base. The outputs indicated by those rules whose comparison is successful are stored along with the weightage of each rule. Once the outputs and the weightage of each rule base is determined, defuzzification is carried out on these rules .This is repeated for all rules selected. Defuzzification is repeated for output variable. The crisp output values thus obtained are applied as input to the controlling motor. This is used to control the rotation of stepper motor. Thus, by controlling the amount of rotation of stepper motor, the movement of gate can be controlled.
Following is the flow diagram of our research work.

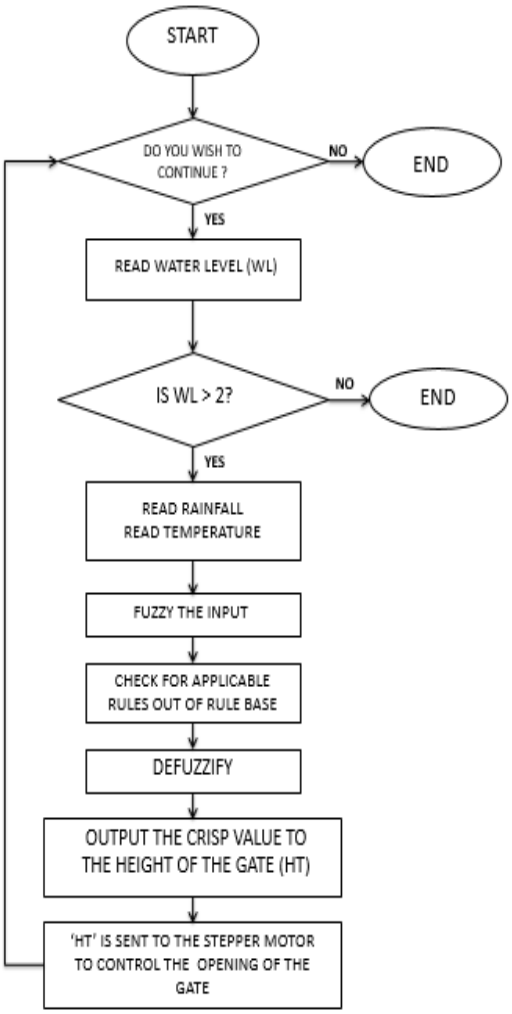

Fig. 3. Flow diagram.

A. Fuzzifier

The first step towards designing a Fuzzy Logic Controller is choosing appropriate inputs which will be fed to the same. These input variables should be such that, they represent the dynamical system completely. Then the function of the Fuzzifier comes into picture. As discussed before, instead of using numerical variables, fuzzy logic uses linguistic variables for processing information. But since the inputs to the FLC are

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in the form of numerical variables (or in other words, crisp sets), they need to be converted into linguistic variables. This function of converting these crisp sets into fuzzy sets (linguistic variables) is performed by the Fuzzifier. The fuzzification technique involves outlining the membership functions for the inputs. These membership functions should cover the whole universe of discourse and each one represents a fuzzy set or a linguistic variable. The crisp inputs are thus transformed into fuzzy sets. Triangular MF, Trapezoidal MF, Bell MF, Generalized Bell MF or Signoidal MF can be used. Even a hybrid of any of the above Membership Functions can be used for fuzzification.

B. *Inference System*

The inference system of a Fuzzy Logic Controller consists of the following three paradigms:

Rule base: It consists of a number of If-Then rules. The if side of the rule is called the antecedent and the Then side is called the consequence. These rules are very much similar to the Human thought process and the computer uses the linguistic variables, derived after fuzzification for execution of the rules. They very simple to understand and write and hence the programming for the fuzzy logic controller becomes very simple.

Database: It consists of the all the defined membership functions that are to be used by the rules.

Reasoning mechanism: It performs the inference procedure on the rules and the data given to provide a reasonable output. It is basically the codes of the software which are process the rules and the all the knowledge based on a particular situation.

C. *Defuzzifier*

A defuzzifier performs the exact opposite function of a fuzzifier. It transforms the fuzzy variables (which are obtained as output after processing of the inputs) to crisp sets. The defuzzifier is necessary because in the real world the crisp values can only be taken as inputs to the other systems. Even though the fuzzy sets resemble the human thought process, their functionality is limited only to the above processes.

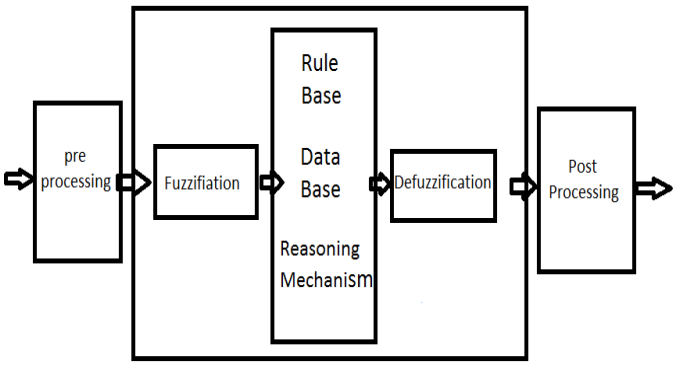
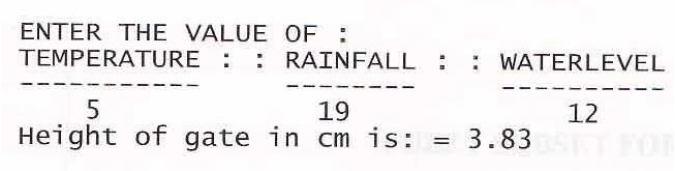
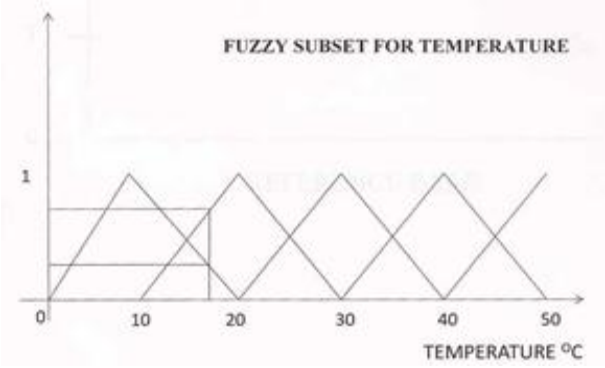


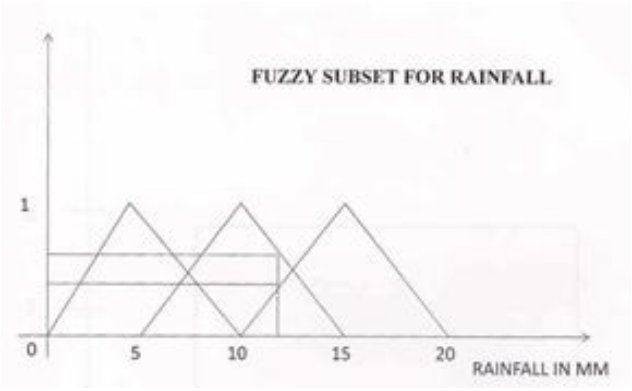
Fig. 4. Block diagram of controller.

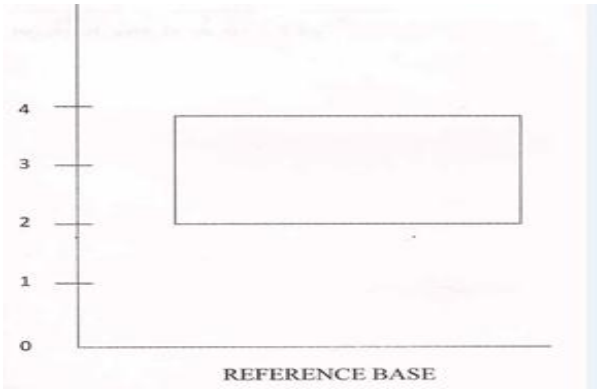
IV. Results and Discussions

Fuzzy Logic Control is used to achieve the desired task. For the controller, the input chosen are temperature and rainfall. These variables decide to what height the gate should be lifted. The amount of rotation needed for the stepper motor is decided by these variables.









Canal automation is an essential step for any significant improvement in the efficiency of existing and new irrigation schemes.

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