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Automatic Animal Food Feeding System

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ABSTRACT: India dominates among other countries in terms of agriculture production, and is one of the largest milk-producing country in the world. A huge human population in India relates itself to agriculture and livestock. Because of this, there are a massive number of cattle farms & dairy farms in India. Also, there is large number of poultries present. According to a survey conducted by the national dairy development board in 2019, there are more than 192 million cattle in India and is at least one personal is required for every 10 animals. In gigantic dairy farming the manpower required is also huge as well as the operations are very laborious and time consuming. By the use of automated machines, it is possible to control the number of required man power, and to avoid financial loss. The time required for process is also reduced. The main objective of the project discussed in this paper is to introduce a laboratory model for automation in animal food feeding process using instrumentation and control strategies. It is thought that the implemented model discussed in this paper can also be used with AMS (automatic milking system) in future.

KEYWORDS: arduino, automatic feed system, automatic milking system, infrared sensors, instrumentation, PLC.

I. INTRODUCTION

To feed the growing size of human population in India and across the globe it is very important to increase the productivity and efficiency of all kinds of farmers. With special attention to dairy farmers, growing herd sizes in dairy and bull fattening farms are leading to higher workloads, making it very laborious and time consuming. Farmers have a variety of choice to deal with this aspect. However, they often decide to automate several work processes at their farms. In recent years, a marked trend towards automation especially in dairy farming can be seen. One example of this is automatic milking systems (AMS), which has become widespread in India and abroad the last decade. However, the automated feeding of mixed feed ratios is also becoming more and more important in dairy farms. AFS (Animal Feeding Systems) are used among others, because of their potential for increasing productivity and efficiency. Farmers with an AMS can aim to increase cattle activity by a increasing the feeding frequency in automated fashion helping them to achieve more uniform use of their AMS on regular basis.

II. LITERATURE REVIEW

India is an agriculture dominant country around 70% people are farmers. Along with farming they have side businesses such as cattle farming, dairy farming, backyard poultry, goat farming. India is one of the largest producer of milk in the world where cow farms and buffalo farms are the foundation of the dairy industry. Breeds of buffaloes like Jaffarbadi, Murrah, and Mehsani, are the high breeding ones while Gir, Rathi, Red Sindhi, and Sahiwal are the top milk breeders from India

Indian government have various schemes for dairy farming and poultry. India has vast livestock resources. Livestock sector contributes 4.11% GDP and 25.6% of total Agriculture GDP [1]. Home to more than 60 million milk cows, India produced more than 187 million metric tons of milk in fiscal year 2019. The population of poultry stood

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at over 851.8 million in 2019 across India, while this number was about 535.8 million for livestock in the same year. Between 2012 and 2019, poultry population grew at an exponential 16.8 percent compared to livestock's only 4.6 percent [2].

Where there are such dairy plants or poultries, they have animals and hens on large scale. If the owner wants to make more profit from businesses, he should check the quality of products. Quality of products can be increased by increasing quality of the food which is given to their cattle, animal or hen. The animal should be fed in time-to-time manner for quality products [3][4] and for this large man power is required as one person can handle only 10 animals at a time. Many dairy industries use AMS (automatic milk system) for milk yielding from animals. More manpower is required to handle thousands of animals. Therefore, it was decided to design, model and implement an AFS (automatic food system) using hardware and software components that are based on instrumentation and control systems. This model discussed in this paper uses PLC based controller system which responses to the Infrared sensors connected to a specially design printed circuit board. It is thought that by using the modelled concept, it can be possible to reduce the problem of manpower and also reduce the time required for feeding the animals.

III. MATERIALS AND METHODS

The conceptual idea of the AFS discussed in this paper is illustrated in figure 1. The system is made up of a hopper, container and feeder platform on wheels that moves on a rail. The wheels feeder and wheel are motorized and can travel on the rail within the left and right boundaries (ends of the rails). The boundaries are sensed using the limit switches. The feeder motor is operated based on the IR sensors data knowing the presence or absence of cattle near the gate.

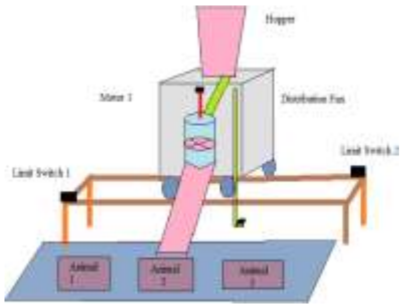

Figure 1. The proposed system setup for AFS

The feeder consists of a distribution fan to control the feed rate as per the requirements of the cattle. Figures 2 and 3 illustrate the hardware and process control block diagrams. Table 1 lists all the hardware components and its details specifications used to practically implement the AFS discussed in this paper [5].

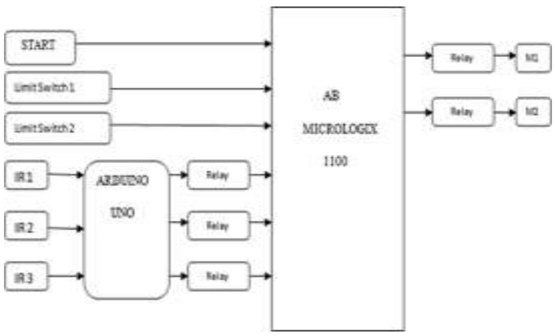

Figure 2. Hardware block diagram of the AFS

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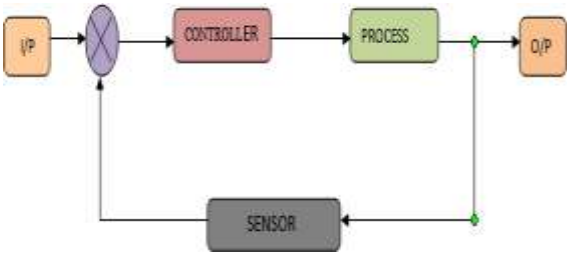

Figure 3. The process control diagram of the AFS

IV. HARDWARE DESIGN

Table 1. Components its specifications

Components	Specification
Infrared sensors	1. Proximity range up to 7 centimeters 2. Active High digital Output (+5V) 3. 3mm mounting hole 4. Two onboard LED's 5. Calibration Pot
12V DC motor	1. 60 RPM 12V DC motors with Gearbox 2. 6mm shaft diameter with internal hole 3. 125gm weight 4.2kgcm torque 4. No-load current = 60 mA (Max), Load current = 300 mA (Max)
Transformer	1. 10RPM 12V DC motors with Gear 2. 6mm shaft diameter with internal hole 3. 125gm weight 4. 12kgcm torque 5. No-load current = 60 mA (Max), Load current = 300 mA (Max)
Rail Track	1. Weight Carries: up to 10 kg 2. Length of Track: 90 cm 3. Height of Track: 10 cm 4. Width between two Rails: 15 cm
Arduino UNO	1. Microcontroller-ATmega328P 2. Operating Voltage- 5V 3. Digital I/O Pins- 14 (of which 6 provides PWM output 4. Analog Input- 6 5. Flash Memory- 32KB
Distribution Structure	1. Size of Structure: - L= 30 cm, W= 15 cm

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	2. Height of Structure: - 45 cm 3. Total Weight of structure: - 2.5 kg 4. Distribution with respect to time: - 200 gm /10 sec approx.
PLC	1. Controller name: - Allen Bradley 2. MicroLogix 1100 PLC system. 3. Analog inputs: - 2 analog inputs 4. Digital inputs: - 10 digital inputs. 5. Digital output: - 6 digital outputs 6. Power supply required: - 12/24 v dc.
Relay	1. 12V Four channel DC relay module 2. Relay specification 10A/24V DC 3. Trigger level 2 ~ 5 VDC 4. LED on each channel indicates relay status 5. Header connector for connecting power and trigger voltage
Limit Switches	1. Input Voltage: 125VAC-6A 250VAC-3A 2. Hole Diameter: ½” 3. N.O. (normally open) 4. Push Button
Plastic Hopper as depositor	1. Diameter: 13.5 cm/9.5 cm/6 cm. 2. Heat resistant from 0 up to +80 degrees Celsius. 3. Not Microwave safe 4. PP Polypropylene (BPA-free).

From Figure 4 it is clear that the IR sensors placed near the feeder gate are hardwired to a open source microcontroller board called Arduino. as well as depending on the sensor signals the relays are controlled in on-off fashion. The relays are also hard wired to the Arduino board. Whereas, the power required to drive the relays is also provided from the Arduino itself.

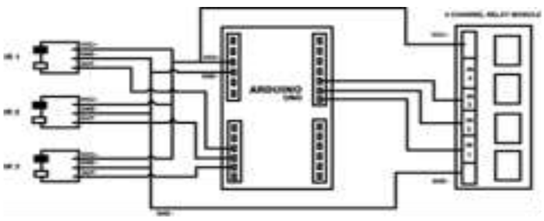

Figure 4. The Arduino based circuit diagram to read the IR sensors in the AFS.

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As shown in figure 5, the wheel motors of the feed storage container are controlled from the PLC via a specialised motor driver circuit, who direction is also controlled via using two relays. This way the feed storage container can travel on the support rail in both directions until it reaches the extreme edges of the rail. The extreme edges are sensed using two limit switches whose signals are hard wired to the PLC. While travelling and depending on the presence of absence of cattle as sensed by the IR sensors, the container will first stop. Then it will start the feed motor to deliver an appropriate amount of cattle feed using its dispenser at the gate. The fed storage container can be refilled by loading the feed in the hopper mechanism [6].

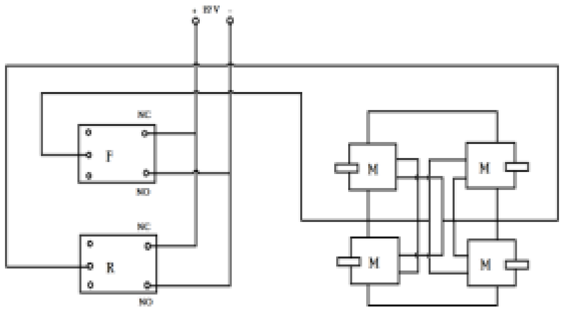

Figure 5. The PLC based wiring diagram to control the motors on the AFS.

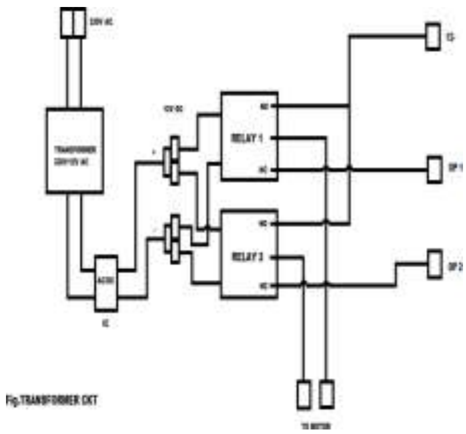

Figure 6. The system wiring diagram to supply power to the AFS.

V. SOFTWAR DESIGN

The software used to acquire sensor data and to take control actions is designed based on the flow diagram as shown in figures 7 and 8. As shown in figure 7 the wheel motor keeps running as long as the IR sensors are generating zero signal which means no Cattle is available at the gate. the moment the there is cattle, the motor will stop its rotation at the respective position and then start the feed dispensing motor.

As shown in figure 8, the software algorithm keeps on checking the states of all motors in simultaneous manner. for example it will check the state on-off state of the feeding motor versus the dispensing motor versus the wheel motor so that only one motor shall keep running at one time in the turn. This way it ensures that the feed is not getting wasted by getting dispensed accidently while travelling on the rails.

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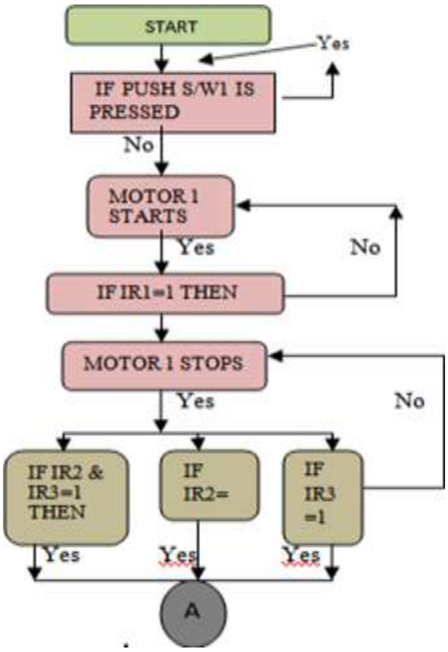

Figure 7. The software flow chart for data acquisition and control system in the AFS (part a).

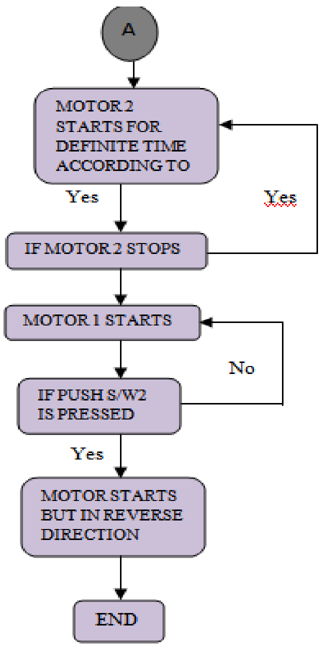

Figure 8. The software flow chart for data acquisition and control system in the AFS (part b).

VI. RESULTS AND DISCUSSIONS

As shown in figure 9. the rail track was made using aluminium for implementing the mobility of feed distribution structure of the practical AFS. As discussed in earlier sections. The distribution structure is supposed to move on rail track, when the feeding system is powered. However, it shall stop and reciprocate when it reaches the both ends of track as it is connected to alternate pair of limit switches.

Figure 9. The rail track

Figure 10. The System setup

As shown in figure 10, the distributions structure is mounted on the wheels for distribution of feed to the cattle The structure contains four 12 VDC motors of 60 rpm and 2 kg/cm torque. These motors are at base of the structure, and base chase made of stainless steel. the upper structure, was implemented using plywood sheets. For distribution of food, plastic made vertical turbine like structure is created which distributes according to motor mounted at its vertical shaft. This motor is 12 VDC of 10 rpm and 12 kg/cm torque. So, this system distributes food according to rotation of this motor with respect to time. Whereas the hopper was

VI. CONCLUSION

The initial idea behind the development of the AFS discussed in this paper is based on using instrumentation and control technologies. The systems were practically implemented using low cost electronic and mechanical hardware components such as analog and digital sensors, motorized actuators and PLC and Arduino to define the control the data acquisition and control strategies. It is clear that with an increasing demand in the area of Agricultural Automation, PLCs become significantly useful in this field. Also, Automatic Animal Food Feeding system (AAFS) using PLC is typical process control system, so how food distribution system is going to work, is necessary for everyone to know the procedure of control system. For this reason, PLC based AAFS is designed in laboratory. However, with slight modifications, the same system can be widely implemented in fields to resolve the practical challenges on labor and time-consuming processes. It is clear that this model reduces man power requirement. for example, by utilizing fully automatic mechanism, it is possible to control required man power and financial loss. This also reduces time required for the completion process of feeding animals. However, it should be noted, that if the IR system fails it can affect the whole system.

VII. ACKNOWLEDGMENT

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