RESEARCH ARTICLE

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Automation of Grain Elevator System for Conventional Agricultural Processing Industry for Energy Conservation with Reduced Human Interface

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ABSTRACT

Power consumption in large scale industries is humongous. Thus, power management and energy saving measures in all sorts of operation is of great concern in any industry. This paper addresses one such issue wherein the redundant working of the operation unit is clogged by making use of automation technique. In view of customized need of grain elevator system in agriculture processing industry, automation system has been designed, developed and implemented on prototype basis. The developed automation system controls the motor drive operation by sensing the availability of seeds over the conveyor belt and avoids unnecessary operation of the motor in case of unavailability of seeds thereby saving the electrical energy. The proposed system delivers the low cost, reliable, energy efficient & low maintenance solution for the conventional agricultural processing industry.

Keyword: Automation, energy conservation, grain elevator system.

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INTRODUCTION

The production process in numerous industries employs conveyor belt system [1]. Superior quality automation techniques are practiced in large scale industries as tackling the time constraints and production demand is vital[2]. Moreover, in small scale or medium scale industries these sophisticated automation techniques are ostracized as cost involved in employing them is very high[3].

Figure 1 shows the block diagram of the conventional grain elevator system of an agricultural seeds processing industry of Vidarbha region in Maharashtra. The proposed grain elevator system is panacea to one such operational problem wherein the drive running the conveyor belt continues to operate even when there is absence of raw material input [4].Such unnecessary operation of electrical motors running in miscellaneous areas of the work space at large contributes to huge energy consumption [5]. Proposed prototype model of grain elevator control system is designed using the low cost micro-controller, thereby targetingsuch area of implementation where buyers sought cheapest possible solution to automate belt conveyor system [6].

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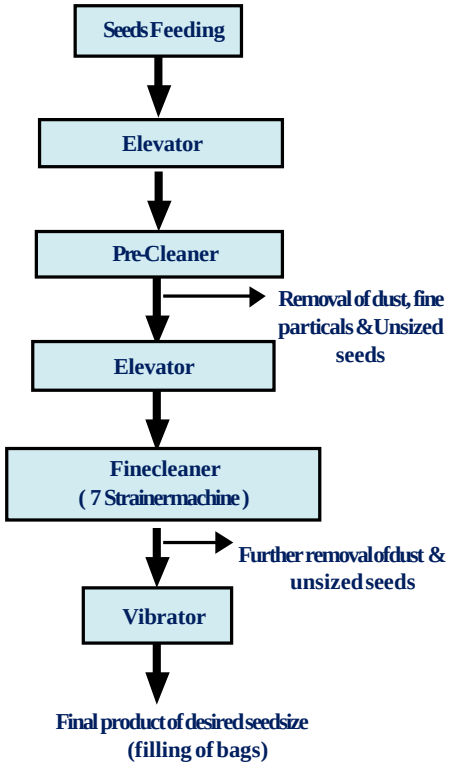

Figure 1: Block Diagram of conventional grain elevator system associated with M/s Ankur Seeds Pvt. Ltd, Kalmeshwar, Nagpur

System Description

Infrared sensor has been used with low cost micro-controller to sense the presence of grains and a relay to switch off the motor driving the conveyor belt during unavailability of the grain.

ALCD display is interfaced with the micro-controller which will indicate "Obstacle"on the screen if the grains are present and sensed by the sensor.

Once the hopper dries out, the sensor will sense the unavailability of the grain and the micro-controller will wait for a short delay time to ensure the complete unavailability of grain before tripping the motor.For tripping the motor, the micro-controller will actuate the relays which in turn will cut-off the supply to the contactor coil of DOL motor starter. The displaywill then indicate "Clear" on the screen due to unavailability of grain. Once the hopper is refilled with the grains, the operator has to switch on the motor manually to continue the process.

Figure 2 is the block diagram of the proposed customized automation with the use of simple, low cost micro-controller and infrared sensor. The infrared sensor senses the presence and absence of grains in the conveyer belt and controls the start and stop/trip operation of the motor. LCD provides the indication to the user of the availability and non-availability of the seeds in the conveyor belt.

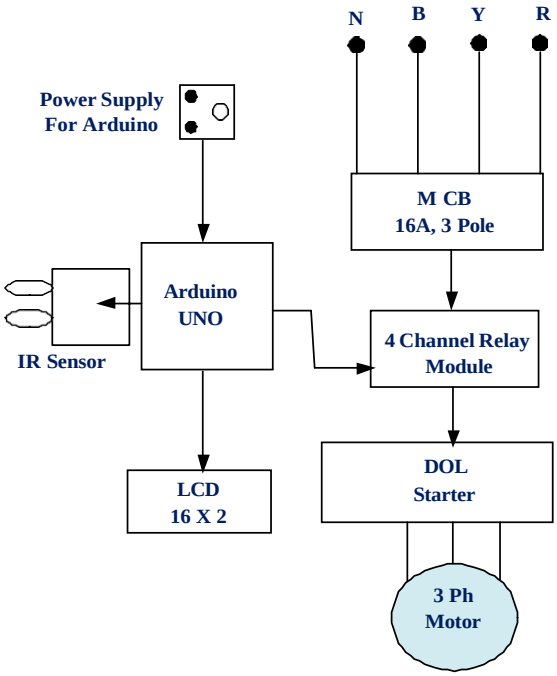

Figure 2: Block diagram of proposed customized automation

Power and Control Circuit

The power circuit for motor control is provided with the MCB protection for short circuits and overload relay in case of overloading. The main contactor controls the START/STOP of motor which is governed through the control circuit.

The control circuit consists of arduino Board interfaced with IR sensor module for sensing the availability/non-availability of grains [7]. The NO contact of Relay module is controlled through Arduinofor tripping the contactor in case of non availability of grains.

Figure 3 and Figure 4 shows the power circuit and the control circuit of the proposed customized automation for controlling the motor.

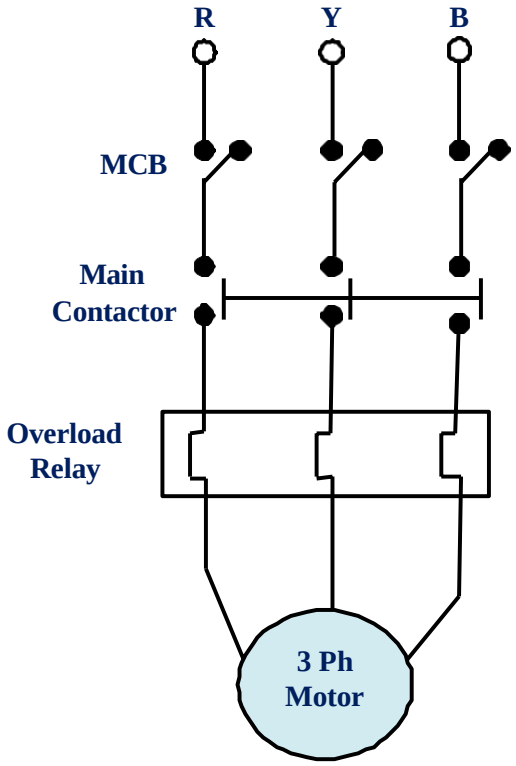

Figure 3 : Power circuit of proposed customized automation

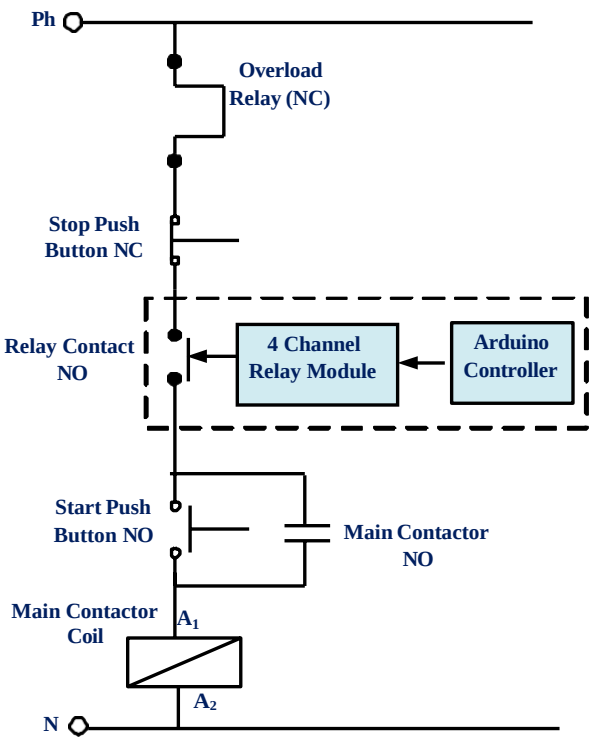

Figure 4: Control circuit of proposed customized automation

METHODOLOGY

The foremost component of the proposed system is Infrared sensor (IR). The Infrared sensor being easy to use and provides digital output it was interfaced easily with the microcontroller. The micro-controller was programmed for the control of motor operation using IR sensor. Flow chart of the microcontroller program in arduino software is demonstrated in Figure 5. The timer of the micro-controller is configured to provide time delay during the starting operation and also to ensure the complete unavailability of grain before tripping the motor. The LCD display updates the user on when to start the motor, the actual sensing of the obstacle grain and also provides trip indication when the motor is tripped. The overall cost of proposed scheme at existing setup is around five thousand only.

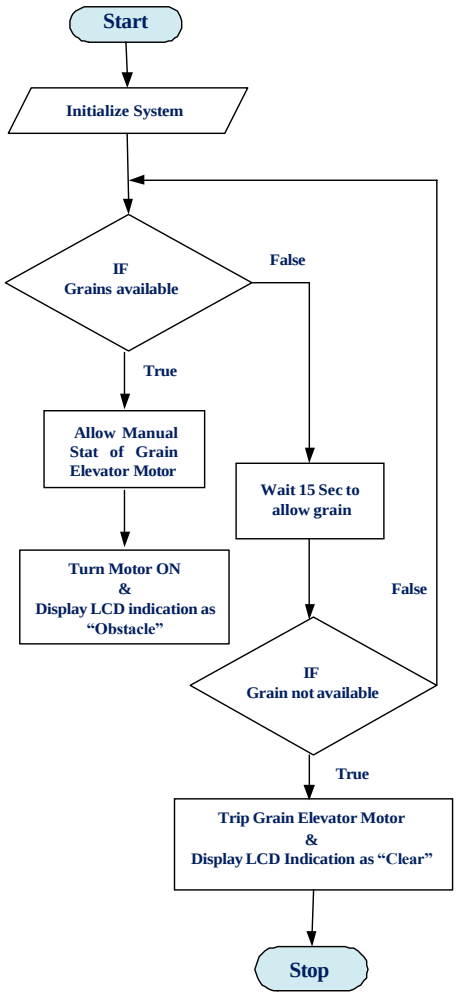

Figure 5: Flow chart of the proposed solution

HARDWARE IMPLEMENTATION

Prototype model of grain elevator control system was fabricated by replicating the actual Industrial system process. The major components of the prototype were 1H.P. Induction motor, MS prototype structure of grain conveying arrangement with bucket elevator, DOL starter with automation.

The prototype model for proposed system (Front and side view) is shown in Figure 6.

Figure 6: Prototype model of grain elevator control system

AUTOMATION SYSTEM OPERATION

When the Arduino is energized, 4 channel relay goes into 'ON' state. Meanwhile, LCD display will show notation as "Start DOL within 15 seconds as shown in Figure 7.

As DOL starteris turned ON, the motor will run and seed will flow from the PVC pipe with the help of bucket elevator through the conveyor belt. As the flow of seed is continuous the notation "OBSTACLE" will be blinked on the LCD display, at this stage, the relay is in "ON" state as shown in Figure 8.

If there are no seeds the controller will wait for 15 sec before tripping the motor. During this periodthe LCD will keep blinking the "OBSTACLE" indication andafter 15sec the motor will be tripped by the controller and the LCD will blink "CLEAR" as shown in Figure 9.

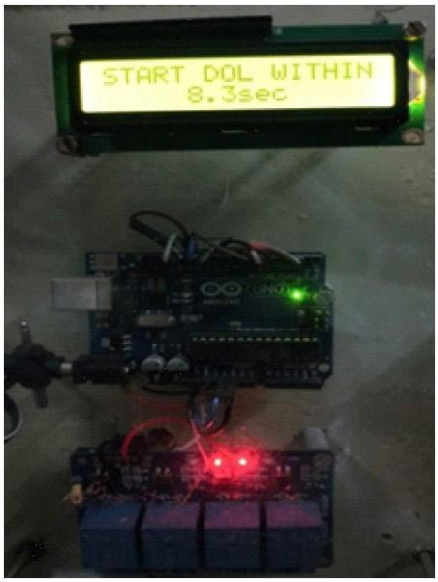

Figure 7: System status before starting the motor

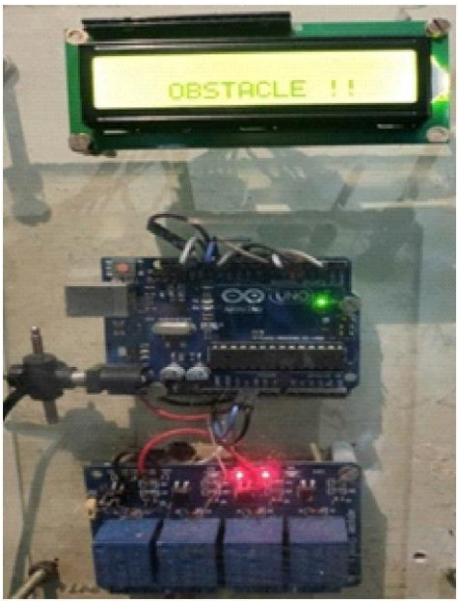

Figure 8: System status before starting the motor

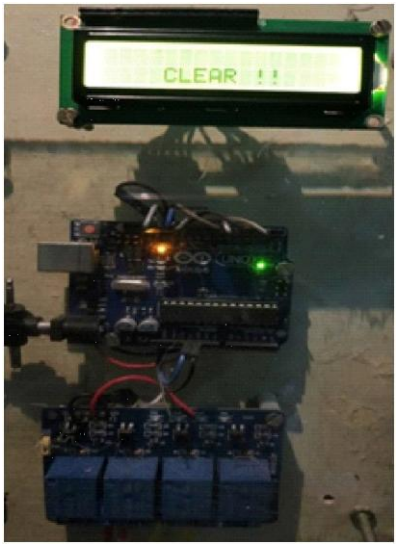

Figure 9: System status during absence of grain

ENERGY CONSERVATION

An analysis has been carried out to demonstrate energy conservation in the process through automation. Considering the fact that after every one hour in the process, the hopper dries out and it requires 15 minutes to refill the hopper, during thisperiod the motor was unnecessarily running during this interval, the motor operation can be automated and energy during this period could be conserved. Table 1 shows the energy consumption comparison of the actual existing system with proposed automated system.

Table-1: Energy consumption comparison

Daily Energy consumption in actual existing system	Daily Energy consumption in proposed automated system
The motor run continuously throughout the day for 24 hrs including the time when the grain is not available. Daily energy consumption in actual existing system without automation for a 3Ph,415V, 1 H.P, 0.75 pf, 82.5% Efficient Induction motor=**21.70 kWh**	Considering the motor remaining in OFF condition for 15 minutes every hour due to unavailability of grain, the motor will run for 18 hrs in a day. Daily energy consumption in proposed automated system considering the same induction motor=**16.27 kWh**

Therefore, it is concluded that with the implementation of the proposed automation, the existing system of grain elevator would conserve around 25% of the total energy.

CONCLUSION

The automated prototype model for grain elevator system was designed, fabricated and successfully tested. The performance of the automated prototype system was evaluated for all the operating conditions and was observed satisfactory. Authors in this paper have understood and metthe customized need of automation for conventional grain elevator system. The proposed automation system would help agricultural industry conserve around 25% of energy in the grain elevation process. The novelty of the proposed work is that being low cost it caters all thetechnical challenges of automation and is capable for the Industrial environment. The automation is simple, compact, reliable and very user friendly and recommended for the conventional grain elevator systems for energy conservation and reduced human intervention in system operation.

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