Automation of Grain Elevator Control Unit

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Abstract*—Power consumption in large scale industries is humongous. Thus, energy-efficient practices and the system is paramount. This paper addresses one such issue wherein the unnecessary working of the operation unit is stopped by making use of simple automation technique. The automation system designed does tripping operation in which it disconnects supply to the motor running conveyor belt. Thus, escaping unnecessary running of the unit under certain abnormalities. The trip circuit has been prepared using a contrived automation technique and involves an IR sensor.The Ardiuno programming device has been used forgiving the trip signal to the control system.

Index Terms—*Arduino board, belt conveyor, bucket elevator, IR sensor module*.

I. INTRODUCTION

The production process in many industries uses a conveyor belt system [1]. Superior quality automation techniques are practiced in large scale industries as tackling the time constraints and production demand is paramount. Moreover, in small scale industries and medium scale industries these sophisticated automation techniques are unpopular as the cost involved in employing them is very high. The working practices in medium scale industries are mostly hand-operated or to an extent are semi-automatic.

The grain elevator control system is a panacea of one such operational problem wherein the drive running the conveyor belt continues to operate even when there is an absence of raw material input. Such unnecessary operation of electrical motors running in miscellaneous areas of the workspace at large contributes to huge energy consumption. Grain elevator control system is designed targeting such areas of implementation where buyers sought the cheapest possible solution to the automized belt conveyor systems.

Manual operation of the motor driving the belt conveyor leads to the overheating of the motor, wastage of electricity and do increase the manpower required for the controlling of the motor. So, to decrease these losses automation is needed. Is to be done for the economical operation of the plant and to reduce the losses of the motor which may be caused due to overheating of the motor because of the continuous operation of the motor.

The authors in [2] have designed modern automated materialhandling systems to reduce the transportation complexity of materials during picking and storage. The authors have presented a solution for material handling operations in amanufacturing cell environment using the holoniccontrol approach [3].

The author's contribution to the proposed work is a demonstration of an automatic grain elevator system that stops DOL starter supply which in turn disconnects the supply to the motor. Hence, this will avoid the unnecessary operation of the motor under the absence of raw material inlet.

II. REAL TIME PROBLEM STATEMENT

The proposed problem has been inspired by a company were this automated technique is absent for controlling the operation of the motor. The objective of the proposed work is to develop a prototype model ofan automated grain elevator control unit using aArduino UNO hardware platform.

III. DESCRIPTION OF COMPONENT

The various components used for this work are listed in Table I. The main component is Infrared sensor (IR). For the purpose of sensing the seeds it has been used. The Infrared sensor is easy to use, its output is digital so it can be easily interfaced with microcontrollers such as Arduino UNO, even the Raspberry Pi or Raspberry Pi zero.

Table I. List of components with details

Sr. no.	components	Dimension/type/rating	Quantity
1.	Work bench	3*3.5 feet	1
2.	Induction motor	3-phase, 1 H.P, 415 V, 4 pole, 1000 rpm,sq. cage,	1
3.	Belt conveyor	B60	1
4.	Bucket elevator	1 mm, steel sheet	6
5.	Direct online starter		1
6.	Ardiunouno module		1
7.	5V, 4 channel relay module	5volt relay	1
9.	Display module		1
10.	Pulley	Upperpulley = 6 inch Lower pulley =8inch	2
11.	Push buttons		2
12.	Bride bar	2.5 feet	
13.	Wheels	-	4
14.	Funnel	1	1
15.	Bearing	6205	-
16.	Grain	Wheat	15 kg

IV. HARDWARE IMPLEMENTATION

Arduino UNO microcontroller board has been used in this work. The programing for the motor operation and control through IR sensor has been implemented in Arduino board. The flowchart of the developed program is shown in Fig. 1.

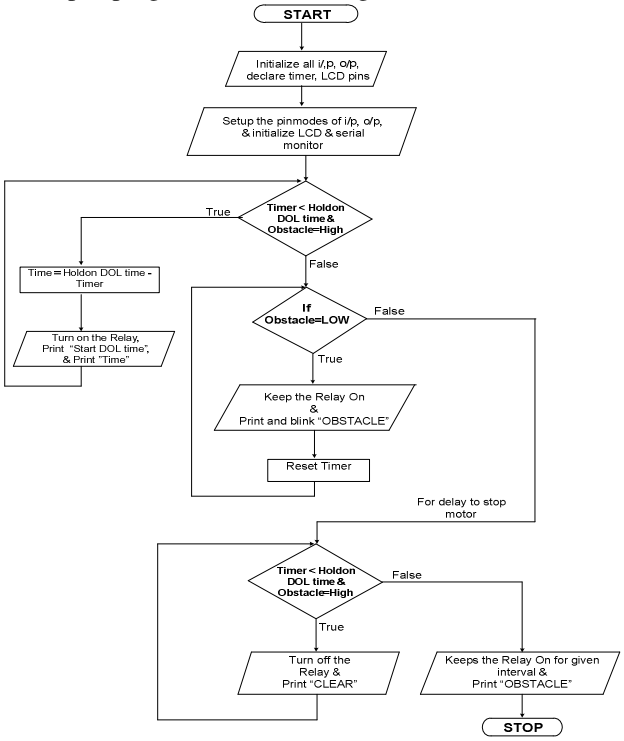

Fig. 1. Flow chart of the proposed project

V. WORKING OF THE PROJECT

In this project, the main motto is to switch off the motor driving the conveyor belt, for that purpose Infrared sensor has been used which is interfaced with Arduino UNO and a relay. The hopper when fully filled will deliver the grain to the next stage and there will be no interruption by the circuit. The display provided will then show "Obstacle" on the screen as the grains are being sensed by the sensor. Once the hopper dries out, the sensor will sense it and will wait for the described delay time which is given. The delay time is given for the purpose, for example, if suppose the flow of grain stops due to some unwanted means even though there are grains in the hopper, so for that, the Arduino will wait till the delay time, and as soon as the delay time passes, Arduino will give a signal to relay, the relay is connected before the DOL for cutting the supply of the motor. As soon as the Arduino gives a signal to relay the relay will issue trip signal and the motor gets off, the display will now show "Clear" on the screen as there are no grains flowing. Once the hopper is refilled the operator has to switch on the motor manually and then the process will continue. The process from sensing the grains to the tripping action of the relay will be followed in the loop and the operator has to switch on the motor manually after every trip action of the relay.

Fig. 2. Prototype of grain elevator control system

VI. ANALYSIS AND RESULT

For the justification of the proposed approach, an analysis has been performed. Considering that total of 8 motors is working in one operational unit. And it is

assumed that after every one hour the hopper dries out and it requires 15 min to refill the hopper.

The project objective is to attain cost-benefit vis-à-vis electricity bill of an industry. The detailed analysis of approximate cost-cutting of the operational unit for a year is presented here. It is divided into two parts the first part is the Energy bill for a year before implementation of the project and the second part is the Energy bill for a year after implementation of the project.

Part 1:- Energy bill for a year before implementation of the project

Consumption of single motor in a day
If motor runs for 24 hours
Then,
Total kWh= $0.746 \times 24 = 17.904\ kWh$
In the whole operational unit there are 8 motors
Thus,
Daily consumption of one operational unit $= 8 \times 17.904 = 143.232\ kWh$
Cost of 1 unit = Rs. 6
Total Energy consumption of 1 operational unit (for 1 month) = $143.232 \times 6 \times 30 = 143.232 \times 6 \times 30 = Rs.\ 25{,}781.75$

Part 2:- Energy bill for a year after implementation of the project

Consumption of single motor in a day
If motor runs for 24 hours
Then, after every one hour the hopper dries out and it requires 15 min to refill the hopper.
Therefore, the motor will be switched off automatically by the sensor during this time, which will in turn save approximately 4 hours of the motor working.
Therefore,
Wastage of energy due to absence of sensor= $4 \times 0.746 = 2.987\ kWh$
Total 8 motors are working in one operational unit,
Thus,
Daily wastage of one operational unit $= 8 \times 2.987\ kWh = 23.895\ kWh$
Total energy saved in one operational unit $= 23.895 \times 6 \times 30 = Rs.\ 4{,}301.$

Therefore, it is observed that after the implementation of the proposed approach one may save $Rs.\ 4{,}301$as compared to without implementation of the proposed approach.

When the Arduino is energized, the supply to the Arduino is switched on. The 5V relay goes into 'ON' state and this is indicated by the red light indicator. Meanwhile, LCD display will show notation as " Start DOL within" as shown in Fig. 3.And will insert countdown of 15 seconds. By the time countdown is started seed already starts coming through the delivery pipe.

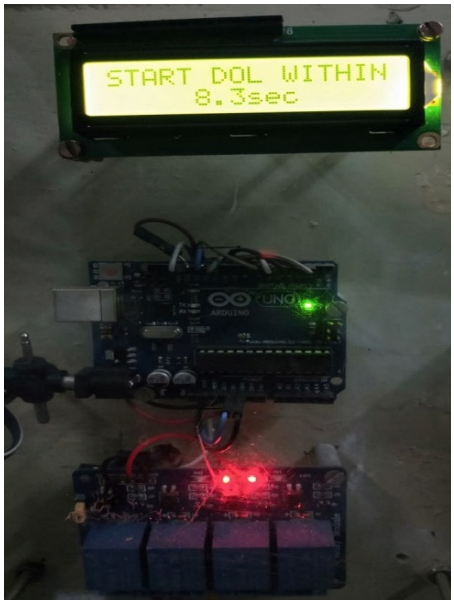

Fig. 3.LCD showing countdown to start DOL

During countdown when seed flow is started sensor will sense it and the notation on the LCD screen will be "OBSTACLE". As the flow of seed is continuous the notation "OBSTACLE" will be in blinking fashion, at this stage, the relay is in "ON" state. It is shown in Fig. 4.

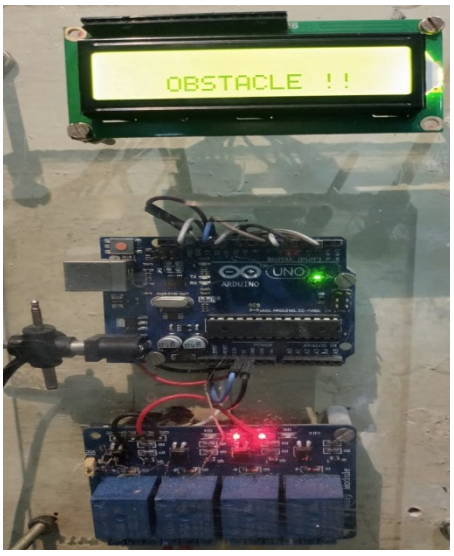

Fig. 4.LCD showing sensing status

When there is no seed flow (i.e. if there are no seeds) the LCD reflects "OBSTACLE" in steady-state fashion and the relay remains in the "ON" state for 15sec. After 15sec, the relay goes into the "OFF" state with no indication and the LCD displays the result as "CLEAR". It is shown in Fig. 5.

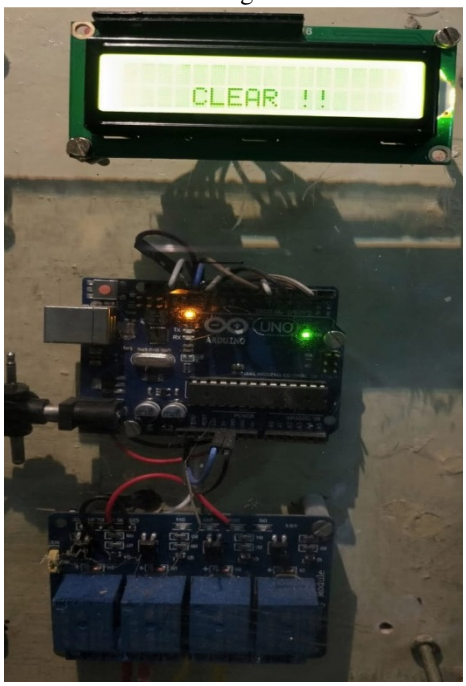

Fig. 5.LCD showing hopper status

CONCLUSION

The proposed approach has been successfully implemented in the prototype model. The results show that it has benefited the existing system significantly. The following points are drawn from the work:

- Cost benefits that are attained after implementation is notable.
- Though semi-automatic, the system is reliable and easy to operate.
- Use of Arduino has made it's designing even simpler.

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