Application of Delta PLC For Self Mechanization of The Bucket Wheel Excavator

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Abstract- *In a developed industry it is necessary to reduce the human intervention with machines to avoid accidents. The beneficial way of making an industry automated, yields an enlarged reliability and safety. Hence this will be capable of accomplishing the task in a quicker way and also provide precise reading and working hitch makes the industry to work soundly. An industrial structure which has a heavy bucket wheel excavator performing an ordinary method using safety switch or relays will result in having restraint and a technical hitch .In order to master these complication , a DELTA PLC can be proposed as an alternative for relays which can be used to reduce the complexity .Hence when using a DELTA PLC ,it can be programmed in a faster and simpler way where all the machines are directed by the program which is fed as an input into the PLC by the user. The DELTA PLC can be given numerous input, and it can also change its input according to the operation where the changes are made in the ladder logic program. This project mainly focuses on crawler movement where the carriage moves front and back ,movement of turn table ,pylon structure ,counter weight boom, discharge boom, bucket wheel boom, hoist winch ,bucket wheel rotation and turning of the bucket wheel and the super structure.*

Keywords- bucket wheel excavator, booms, DELTA PLC, ladder logic, relays, Speed.

I. INTRODUCTION

The heavy set bucket wheel excavator is used in surface mining to excavate around 27.6 million tons of coal. Even-though it helps in shovelling enormous coal production, it is operated and controlled using relay..The main disbenifit in using relay is, when a fault occurs it takes a prolonged time to sense the fault which in turn damages the equipment before sending the signal to the circuit breaker. These relays change their state when energies from normally open to close and vice verse. Due to the surplus function, the bucket wheel excavator comprises of more number of wires and relays which engages more power, more space ,manpower and increases the installation capital. Hence the mechanical functions of the relay wear out over time. Because of all the above disadvantages caused the relays it can efficiently replaced by PLC where it uses uncomplicated logic which is conveniently used by the users. This makes the bucket heel excavator more intelligent with less number of hardware failure and maintenance becomes smooth. Hence by using PLC, the timer or counter is programmed by simple logic without any physical component added and it is easily expandable in a cheaper way.

II. METHODOLOGY

Bucket wheel excavator is a bulky machine which is used in surface mining with the aim to shovel the coal .This machine incorporates certain parts which is significant in shovelling. The crawler movement drive the machine to the coal location. A bucket wheel motor is enclosed with the bucket wheel which helps to collect and dig the coal and then send the collected coal to the conveyor belt in the bucket wheel boom. This bucket heel boom enhances the movement of bucket wheel hoisting and slewing. The conveyor belt is used to transfer the coal to the discharge boom conveyor. The superstructure consists of a pylon table which rotates the entire bucket wheel excavator. The centre part of the bucket wheel excavator is attached with the counter balance boom which balances the cutting boom and the discharge boom discharge the coal collected. All these above mentioned operations need man power in order to be driven in a safety condition. In order to reduce the man power and to ensure safety without any accidents the bucket wheel excavator should be made more efficient. Hence all the operations made are automated by using sensors and simple ladder logic in the DELTA PLC which is connected with the power supply.

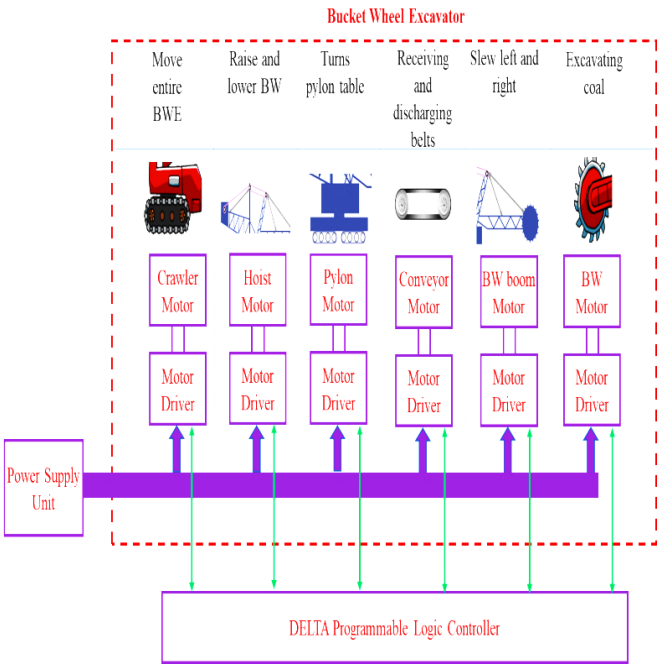

Figure 1:Block Diagram Of a BWE

LADDER DIAGRAM:

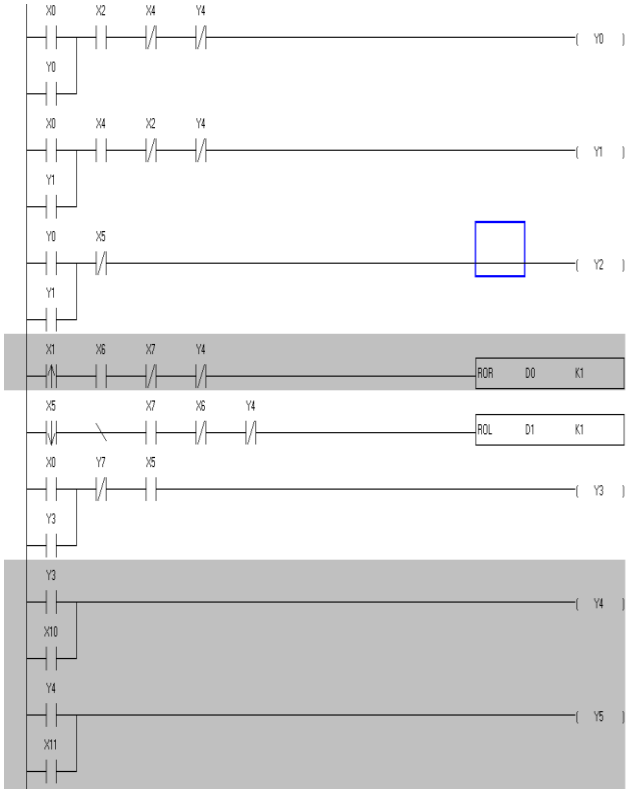

Figure 2(a): Crawler Working

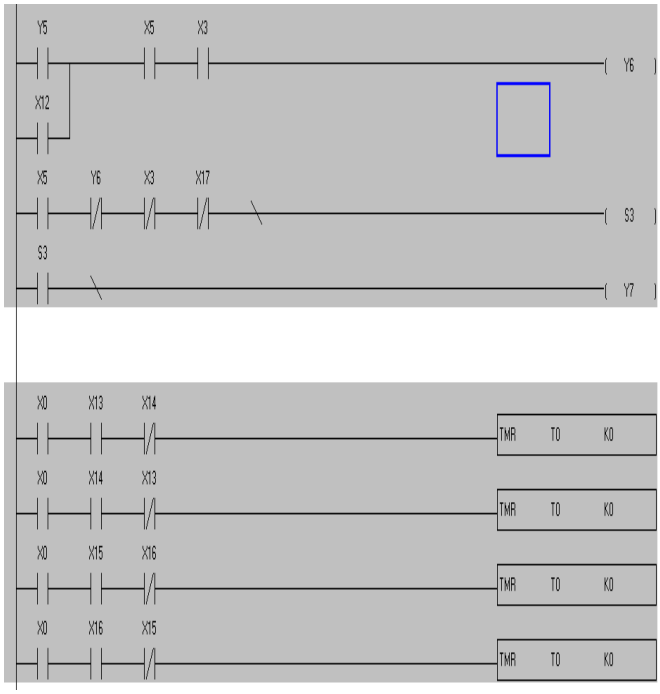

Figure 2(b): Bucket Wheel Working

LADDER DIAGRAM EXPLANATION:

In this ladder diagram there are several kinds of process involved detailed as follows. In this first ladder diagram three switches have been placed in order to convert that into a DPDST switch. Initial we have an open switch which fed as an input through that pathway some more switches are also there which are used to act as like a DPDST switch the output has been fed nearer to the initial supply to continue the flow of supply throughout the process till it has to be ended. Next to the switch 1 (X0) there are two different kinds of switches one is NO (Normally Open) and another one is NC (Normally Closed) which acts like a passive switch. After the first ladder diagram there is a second ladder which imitates as first ladder. In order to switch rotation of motor the supply has to be reversed for that kind of purpose the second ladder has been created. In this both ladder there are two common switches one is the (X2) NO (Normally Open) which acts as passive NC (Normally Closed) in another ladder when the switch (X2) has been turned ON, in the second ladder there won't be any supply of power due to passive NC switch (X2) after the supply in (X2) has been turned off it will be closed, in second ladder while we turning on the switch (X4) in second ladder the rotation of the motor has been reversed. This process continues like this for several operations. Both the output (Y0) and (Y1) in both ladders denotes the direction of the motor. According to the output the motor (Y2) will rotate, while both ladder was in off condition the output will also be zero there will be no supply to the motor. After that process the machine will do the assigned

work, for that we have placed two switches one is the initial power supply switch and another one is that used to stop the whole process for some maintenance or for some fault repair purpose. When the switch (X0) which is turned ON it generates the output according to the machine, then output which is again fed using a loop near the supply switch (X0) next the output of the ladder (Y3) was plugged as an input to get the desired output (Y4). Again, the output (Y4) was sourced as an input in order to get the expected output, likewise several outputs (Y5), (Y6) was plugged as an input to get the next output. If any fault occurs to any machine in middle of the process the output will get stopped it can't able to be source as an input to get output of the next part. So, if any fault occurs to a particular part it will not lead to loss of energy and work, instead of that the next process will be cut down. Because of this there is no wastage of energy and work. Due to this kind of operation using ladder diagram it is efficient to utilize the way of work and decreasing losses. Considering some of the safety measures one sequence of process will run at a time in order to protect the machine and also if a fault occurs in the last part of process there will be a loss to discard that kind of losses, we have included a ladder with inverse sequence. In this ladder (Y6) there are two switches located the first one is (X5) and another one is (X3) it is like a fault switch for checking the fault condition the switch has been used. After that ladder sequence a new ladder which contains both (X5) and (X3) but here it is present as closed switch. Also, it has some other switches like normally closed (Y6) the output of the previous one which is also closed here. In addition to that a normally closed switch also placed and next to that an inverse switch is placed to give (S3) as an output. The (S3) output plugged as an input for next ladder but here next to that an inverse was placed to activate emergency shutdown switch (Y7) which is plugged near (X0) which gives the first output in the (Y3) sequence. Once the fault got detected in any of this sequence the output will be changed by switch (Y7) which was connected in series with switch (X0). After that the whole sequence process got shut down. To avoid the collision between process, there is a normally closed switch (Y4) was placed in the first sequence. By mistake all the switches were kept in ON condition in the first sequence though it can't able to run the output because of the normally closed switch (Y4). The output (Y4) switch has to be in OFF mode to activate the other process. Due to some other faults the machine got disabled due to this the first sequence may run. But the output will not be activated because of the safety (X5) switch and the switch will be in ON condition till the process has to be ended. In order to switch the process, the switch (X5) has to be turned OFF otherwise it won't allow other process to produce its desired output. At last there is some sequential process which was made with timer for different kind of purpose. The process which consist of some nc and np switches, which can reversed to produce the sequential output.

DRIVER CIRCUIT:

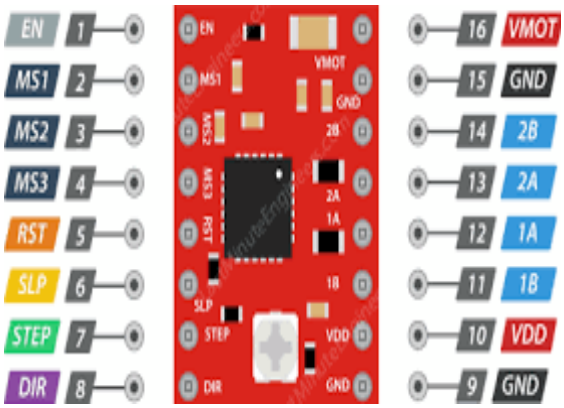

Figure 3: PIN Diagram of a Driver Circuit

In this driver circuit fig 3,the output of the PLC will be connected in STEP, DIR ports to run the motor. The speed of the motor has been controlled by the potentiometer, by varying the voltage level of the motor we can able to vary the speed of the motor. The PLC produces the input for motor which is connected with the A4988 driver, according to the set commands given by the driver the motor will rotate in the assigned direction. The step of the motor also controlled in this way.

HARDWARE IMPLEMENTED:

The hardware parts which were made for building the BWE is followed in the below figures:

Figure 4: Bucket Wheel

Figure 5: Delta PLC

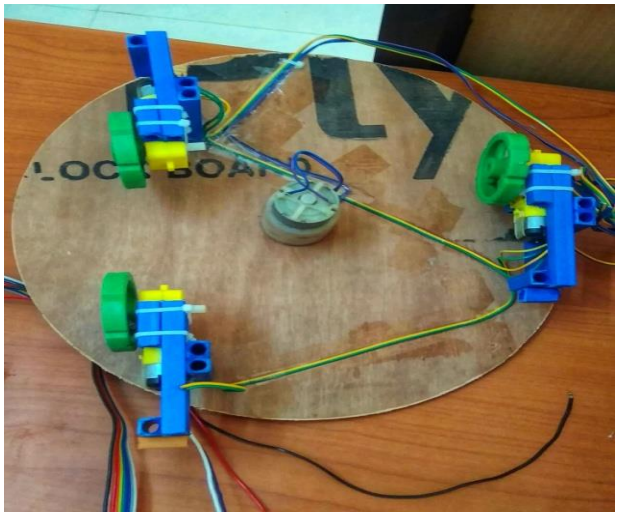

Figure 6 : Pylon Table

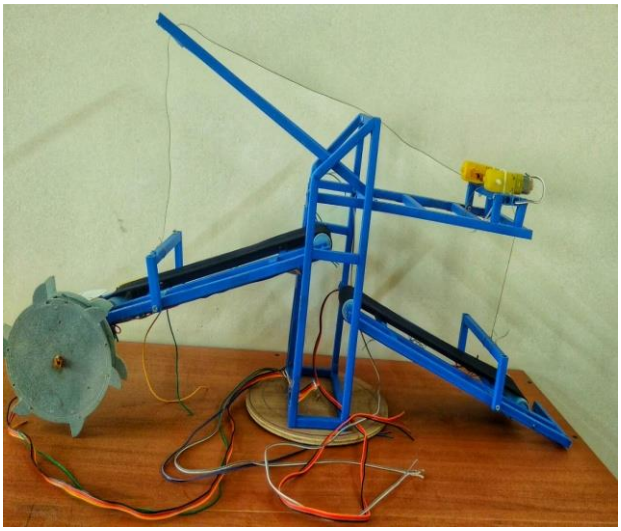

Figure 7: Chasis Of a Bucket Wheel Excavator

III. CONCLUSION

Through this project, the actual problem in finding the fault is achieved in a healthy way. By using the PLC it reduces man – power and ensures safety, it helps in reduce the complication and also achieves heavy tasks in a better way.

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