Review on PLC Based Wireless Crane Control System

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Abstract: EOT crane is used to move and lift the material in industries. Here human operates the crane using remote control called as pendant. But the person handles the material and the pendant as well, which can be a very dangerous scenario. Also in traditional crane control system the movement of crane is executed by using contactor and relay logic circuit. This involves drawbacks such as more wiring work, large mechanical fault occurrence, difficulties in troubleshooting and repair work. To avoid such problems the contactor and relay logic circuit can be replaced by using VFD and PLC for efficient operation. This method is controlled by using wireless remote control.

***Keywords*- EOT, Variable Frequency Drive (VFD), PLC (Programmable Logic PLCs), Wireless remote control**

I. INTRODUCTION

Electric overhead travelling cranes (EOT) are one of the most commonly used overhead cranes. These cranes are useful in critical industrial applications such as moving and lifting the materials which can be very advantageous thus move loads beyond normal capability of human. It consists of parallel runaways where the gap is spanned by a travelling bridge on which the hoist is mounted, shown in fig 1.1.

The crane' control allows an operator to direct the movement of crane and hoist. The motion of crane in x,y,z plane is done by cross travel motor,end carrier motor and hoist motor respectively.The hoist consist of cross travelling motor,wire rope hoist motor and rope drum.The control panel for the hoist is placed along hoist which consist of contactor and relay logic.The motors which are used in conventional method are usually the slip ring induction motors due its high starting and braking torque and good speed control

Prior to the late automated industries, the devices were primarily controlled by discrete inflexible circuit consisting of electromechanical relays and coils hardwired to panel. Here a PLC can provide greater speed, more reliability, higher efficiency, wider versatility than manual controller operations. PLC control operation sequence of a large system surveying special module such as link, analog and position control. The controlled program is developed by using ladder diagram and necessary mnemonics codes are also provided.

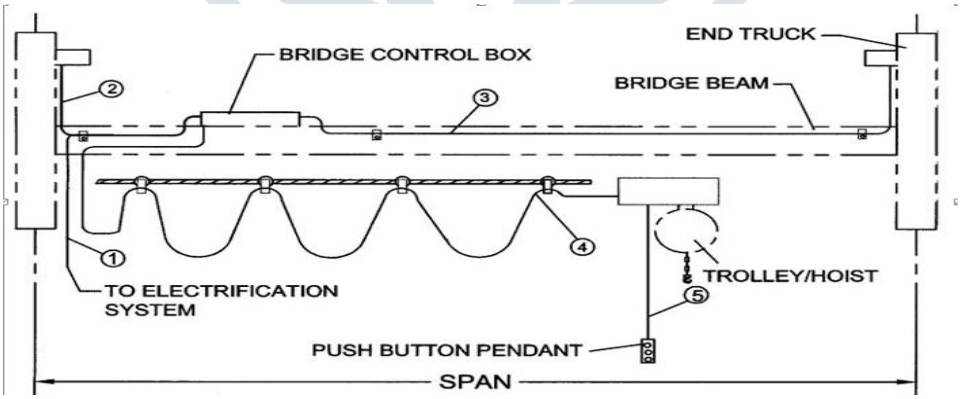

Fig 1.1 Conventional EOT Crane Structure

II. METHODOLOGY

The fig.2 represents elementary diagram for the conventional eot crane control system.Generally motors which are used are slip ring induction motors. The speed of a motor is control by connecting resistance box accross rotor winding of the motor. Here contactors are used to control the the direction of the rotation of motor. A set of contactors is used to drive the motor in forward direction where as phase reversal method nis used to drive the motor in reverse direction. The phase reversal is done by interchanging any two of the phases.The overall function of contactors is controlled by employing relay logic circuit as shown fig 2.

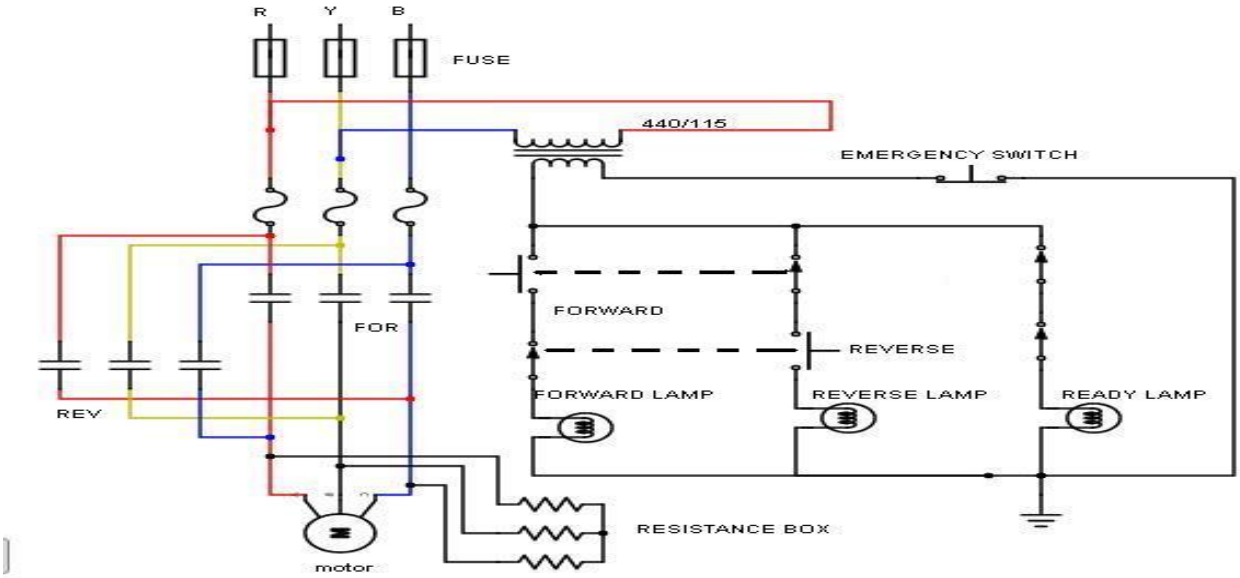

Fig 2.1 Elementary Diagram of Conventional Crane control System

Issues while working with conventional EOT crane control systems are-

1. Reduced human safety due to simultaneous handling of material and pendant.
2. More wiring work which can cause difficulties while maintenance and repairing work.
3. Contactors can get damaged due to frequent operations leading to high repairing and maintenance cost.
4. Irregularity of relays.
5. Future modifications in relay logic is complex.
6. Electrical losses due resistance box.

III. DESIGN PARAMETERS

3.1 PLC

A Variable Frequency Drive is a motor control device that controls the speed of the AC induction motor and provides protection for it. It also controls the speed of the motor during starting and stop cycle, as well as throughout the run cycle. VFDs are also referred as Adjustable Frequency Drives (AFDs) or Variable Voltage Variable Frequency Drive (VVVFD).

As slip ring induction motor is usually used, the losses caused due to resistance box can be reduced by using VFD which can provide wide range of speed control and dynamic braking as well

VFD converts input power to adjustable frequency and voltage for controlling speed of motors. The frequency of power applied to the motor determines the motor speed, based on following equation:

$$N=(120\times f)/P \qquad (1)$$

Where,

N= Speed of the motor.

P= No. of poles.

f= Supply frequency.

Hence from above equation it is clear that the speed is proportional to frequency.

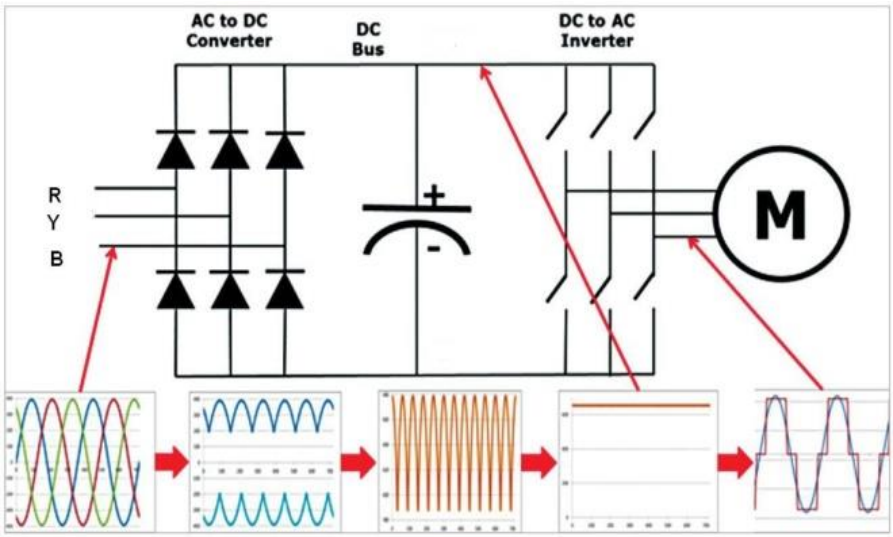

Fig 3.1 Circuit model of VFD

The input section of the VFD is rectifier. It contains six diodes, arranged in an electrical bridge. The diode converts ac power to pulsating dc power. The diodes are replaced by the IGBTs (Insulated Gate Bipolar Transistor) in recent trends. Filter or DC bus section is used to smooth out the waveform. Here we get the rid of the AC ripple on the DC side by adding capacitor. So we get pure DC waveform. The inverter section inverts DC voltage back to AC but in variable voltage and frequency output. The frequency of the output voltage can be control by controlling switching time of the transistors. Higher the frequency, higher will switching time of the transistors.

Advantages of VFD:

1. Energy saving.
2. Smooth starting.
3. Reversal of motor.
4. Controlled starting, stopping and acceleration.
5. Different types of protection (i.e. Short Circuit, Overload, Earth Leakage, Phase Loss etc).

3.2 PLC

Programmable logic controllers are computer based device capable of controlling many types of industrial equipments and entire automated system. Industrial companies use many different types of machinery to produce the product that they manufacture. The machinery may be used for machine tooling, injection molding, textile production, die casting, wood working etc.

Industrial companies use many different types of machinery to produce the product that they manufacture. The machinery may be used for machine tooling, injection molding, textile production etc. The use of PLC eliminates the large cost involving complicated relay based control systems. PLC performs the operations such as logic, sequencing, timing, counting and arithmetic operations in order to control the output devices i.e. motor.

The PLC can operated using two logics, namely ladder logic and fuzzy logic. Here ladder logic programming is used. The input device i.e. switches and output devices i.e. motors which are to be controlled are interfaced with PLC. Then PLC monitors the input and output according to the program saved in memory of PLC and controls the process .The advantage of PLC over hard wired relay and timer system that it is possible to modify the system without rewiring entire connections of input and output devices.

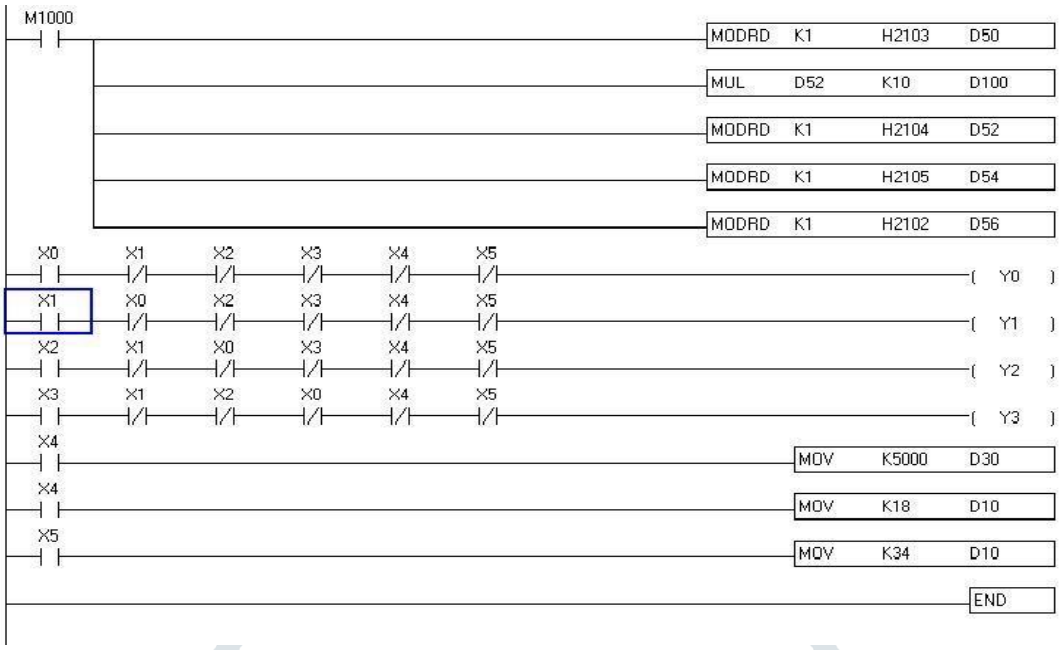

Fig 3.2 Ladder diagram for crane control on Delta PLC WPL software

Following are the PLCs available in the market

- Allen Bradley
- Aseas Brown Bovery (ABB)
- Siemens
- Omron
- Mitsubishi
- Hitachi
- DELTA

3.3 Wi-Fi Module

A wireless Wi-Fi module is interfaced with PLC to overcome the problems caused due to wired pendant. The Wi-Fi receiver and motor are connected to input and output module of the PLC. The six switches are connected to transmitter module of the Wi-Fi module to control the movement of the crane.

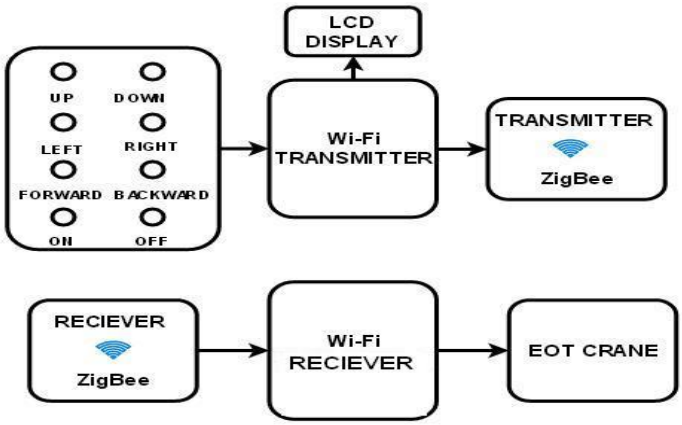

Fig 3.3 Wi-Fi Transmitter and Receiver Module

3.4 SMPS

A switch mode power supply converts the power from AC to DC. As PLC and Wi-Fi module requires DC supply, SMPS is employed.

IV. PROPOSED SYSTEM

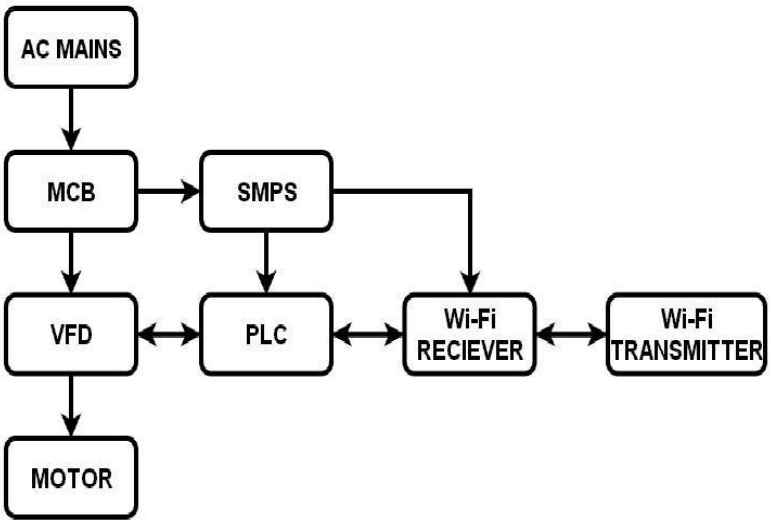

Fig 4.1 Block diagram of proposed model

Operation of the system:

1. AC supply is being fed to drive through MCB for protection purpose.
2. SMPS is used to supply the PLC a 24 volt DC supply.
3. The data is transmitted using Wi-Fi transmitter module and received at receiver module.
4. Then receiver will decode the data using decoder.
5. This decoded data will be given input to the PLC.
6. PLC will perform logic operations and instruct the VFD as it is interfaced with PLC.
7. VFD will drive the motor depending on the input to it.

V. CONCLUSION

Hence a robust EOT crane control system can be implement using PLC based wireless crane control system. The operation of motor can be controlled by using VFD. Where PLC eliminates complex wiring involved and makes troubleshooting very easy. Hence providing tremendous soft wiring advantage. This control system will be very simple, flexible, reliable and user-friendly efficient compared to conventional crane control system. The major concern which is human safety while operating EOT can be totally eliminated. And this system can be implemented in process industries.

REFERENCES

[1] Modern Power electronics and AC Drives by Bimal K.Bose

[2] Mohammed Bani Younis and Georg Frey.," A Formal Method Based Re-Implementation Concept for PLC Programs and Its Application". 1-4244-0681-1/06/2006 IEEE.

[3] Industrial Control Electronics Devices System and Application by Terry Bartelt

[4] Ling Wang1,Hong Yingwei2, "Development Of A Distributed Control System For PLC Based Applications", Proceeding of ninth international conference on machine learning and cybematics,Qingdao,11-14-Jully 2010 978-1-4244-6527-9/10/©2010 IEEE

[5] Power Electronics and Motor Control by Shepherd, Hulley, Liang

[6] Vijay Kumar Khatri, Ahsan JavedGhangro, Jetandar Kumar and Syed Jaad UI Haque.,"Industrial Data Acquisition and Control System using two PLCs' Networked over MPI Network", 2009 IEEE symposium on Industrial Electronics and Application