Питання управління в складних системах

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MONITORING AND CONTROLLING OF SMART OVERHEAD TRAVELLING CRANE USING PLC AND SCADA

This paper describes the automatic control of overhead travelling crane based PLC and SCADA are the two new approaches used to control the motion of electric overhead travelling crane. Crane are designed in SCADA software and communication between PLC and Scada is done with the help of Omron simulator. This paper describes the automatic control of overhead travelling crane. An overhead travelling crane, also known as a bridge crane, is a type of crane where the hook-and-line mechanism runs along a horizontal beam that it runs along two widely separated rails. Crane is used to lift and move materials in industries. For efficient operation, used an induction motor with PMDC in industrial applications. The relay logic in crane control is implemented using PLC. In this paper, using sensors that are used to sense the overhead travelling crane motion and supplied by 220 AC and DC 12 V.

Keywords: *PLC based overhead crane, overhead travelling crane automation, Programmable Logic Controller (PLC), sensor, scada.*

Introduction

A crane is the type of machine mainly used for handling heavy loads in different industry branches: metallurgy, paper and cement industry. By the construction, cranes are divided into overhead cranes and gantry cranes. Overhead and gantry cranes are typically used for moving containers, loading trucks or material storage. This crane type usually consists of three separate motions for transporting material. The first motion is the hoist, which raises and lowers the material. The second is the trolley (cross travel), which allows the hoist to be positioned directly above the material for placement. The third is the gantry or bridge motion (long travel), which allows the entire crane to be moved along the working area[1]. Electrical technology for crane control has undergone a significant change during the last few decades. The shift from Ward Leonard system to DC drive technology and the advent of powerful Insulated Gate Bipolar Transistors (IGBTs) during the 1990s enabled the introduction of the AC drive [2]. The standard crane comprises a welded steel frame, liberally rated crane-type motors, high-carbon steel gears, precision ball bearings, oil-sealed gearboxes, robust electro-mechanism brake, automatic over winding prevention and centralized lubrication. In this paper, Programmable Logic Controller (PLC) is used to control the overhead travelling crane movements. This paper mainly presents the programming and operation of an Overhead Travelling Crane in Automobile Production Factory. It can pick up the container which included an automobile to a desired place. PLC can 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 [3].

Main part

This paper presents the loading zone and unloading zone. Three-motors namely Main hoist, long travel And Cross travel are used for accomplishing movements of electric overhead travelling cranes in desired directions.. PLC are used for controlling the three motors using programs. Drives are used to control the speed of motors proportional to the weights. SCADA techniques simulator, PLC and other control systems of the crane. A programmable logic controller is a solid state control system that continuously monitors the status of devices connected as inputs. Based upon a user written and designed SCADA simulator program, stored in memory, it controls the status of devices connected. The term logic is use primarily concerned with implementing logic and switching operations. Input devices e.g. switches, and output devices e.g. motors, being controlled are connected to the PLC and then the controller monitors the inputs and outputs according to this program stored in the PLC by the operator and so controls the machine or process. The PLC can be implemented using two logics, namely ladder logic and fuzzy logic. The fuzzy logic implementation requires high expertise here ladder logic is implemented. The PLC has 16 ports inputs, and which 8 ports in output.

1. Operation of overhead travelling crane using programmable logic controller (PLC)

The girder of a crane moves in the travelling axis, the trolley moves in the traversing axis and the object transferred by the crane goes up and down. Their movements are described with positions and velocities in the X-Y-Z coordinates, as shown in fig. 1.

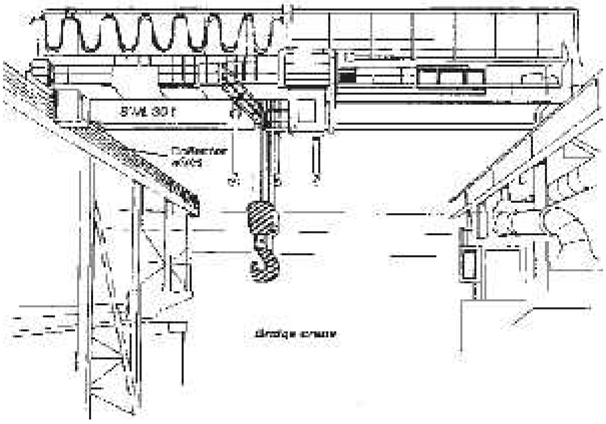

Fig. 1. Overhead travelling Crane structure

The travelling axis is described with X axis, the traversing axis with Y axis and movement of the object in up and down direction with Z axis. Firstly, the hook is in the up-condition. When switch or input is ON, the hook moves down by running motor No.3. Sensor No.1 is the down-condition sensor. When it signals, motor No.3 stops and then Timer No.1 operates.

We use the model of DELTA PLC with 16 ports input and 12 port ouput. Using ladder diagram of WPL software because cheep, free instillation, and very easy to changing of control.

List of symbol meaning from ladder diagram:

X0 – System stop; X1 – System start; X2 – Sensor No.1; X3 – Sensor No.2 (3' above the ground & Motor No.1 operates in forward direction); X4 – Sensor No.3 (end of X direction & start of Y direction); X5 – Sensor No.4 (end of Y direction & start of – Z direction); X6 – Sensor No.5 (Load reaches at the ground); X7 – Sensor No.6 (The hook reaches to the original position & Motor No.2 operates in reverse direction); X10 – Sensor No.7 (end of Y direction & Motor No.1 operates in reverse direction); X11– Sensor No.8 (Motor No.1 stops & the hook reaches to the original position).

Y0 – Master Control Relay; Y1 – Motor No.3 (forward direction); Y2 – Motor No.3 (reverse direction); Y3 – Motor No.3 for Z direction; T0 – Timing Solenoid No.1; Y4 – Motor No.1 (forward direction); Y5 – Motor No.1 (reverse direction); Y6 – Motor No.1 for X direction; Y7 – Motor No.2 (forward direction); Y10 – Motor No.2 (reverse direction); Y11 – Motor No.2 for Y direction; T1 – Timing Solenoid No.2.

2. Power calculation for motor

The motor used here is a PMDC Motors through the practical experimental to determine the parameters & characteristics for steady-state of this type of motors. The most important conclusions in this paper are:

1. This type of motors have Efficiency higher than Electromagnetic D.C motors.

2. The damping coefficient (B_m) have negative effect on characteristics of motor especially at no-load steady state. The equivalent circuit for PMDC shown in fig. 2.

3. Easy control by using armature resistance method and voltage supply methods.

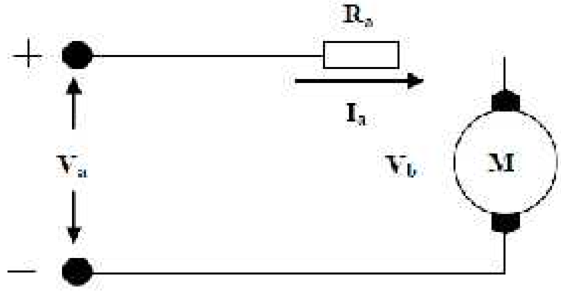

Fig. 2. Equivalent circuit for PMDC

3. Mathematical model of PMDC

In ideal case the mechanical power equal to electrical power shown the equations below:

$$T_m \cdot \omega_m = V_b \cdot I_a \,;\quad T_m = 9.55 \cdot P_0 / N\,;$$

$$T_m \cdot \omega_m = T_L \cdot \omega_L\,;\quad V_a = E_b - I_a R_a\,;\quad W = 2\pi N/60\,,$$

where T_m – mechanical torque, ω_m – the angular speed of motor, V_b – the back e.m.f, I_a – armature current.

Based on the design specification the output power and the output torque of the motor are calculated by a simple calculation.

Power and torque calculation. The gear ratio 1:20.

Weight of cabin= $2\,kg \cdot 9.8 = 20N$; $R_a = 0.8\,ohm$;

$$I_a = 4A\,;\quad V_a = 12\,V\,,\quad E_a = 8.8V\,;\quad F = 0.2m/s\,;$$

$$P_i = 36watt\,;\quad P_0 = 36watt\,;\quad eff = 70\%\,;$$

$$K_t = K_v = 0.07\,;\quad T_m = 9.55 \cdot 36/1200 = 0.28N \cdot m\,;$$

$$\omega_m = \omega_L = 1:20 \text{ where } T_L = 5.6\,N \cdot m\,;$$

$$N_m = 1200\,r.p.m.\,,\quad N_L = 43 raq/sec\,;\quad \omega_L = 6.28\,.$$

4. Results and discussions

User interface is designed in CX-supervisor Software with the help of CX-One package, which makes the task easier. It has been cleared from SCADA picture that starting as well as running performance of electric overhead travelling crane is improved and variable frequency drive simulation shows in fig. 3 better performance when compared with contactor logic and these will help us in reducing electrical failures and helps us in improving the performance of electric overhead travelling crane.

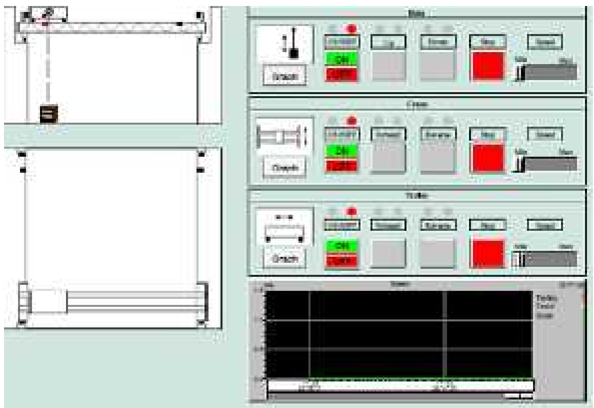
Fig. 3. HMI of simulation and contactor logic simulation

Conclusion

A robust crane control system is designed by using PLC and SCADA, by scada we controlled simu lation program by CX-Supervisor and operated using manual and computerizing control (simulation and experimental as shown in fig. 4.

a

b

Fig. 4. A, B Experimental works

The speed control is achieved using gearbox module (the ratio of gearbox 1/20). In this paper, Programmable Logic Controller (PLC) in industrial work shop PLC Delta Company, magnet sensor, pushbutton, limit switch, light, DC and AC supply (220/12) V, cable software, resistance of control speed by armature method, electric magnet 220 V and hoist-load to designed and implemented over head crane testing this model, the operation of motor in the travelling axis, the trolley moves in the traversing axis and the object transferred by the crane goes up and down. Their movements are described with positions and velocities in the X-Y-Z coordinates, when the motor crane ON, see the all motors off (trolley and hoist), when the hoist motor on, the operation this motor work by nine location in PLC control to hoisted load from the zero point to 0.9 point and reverse direction and well see the crane motor and trolley motor off, when the trolley motor on, we see the hoist and crane motor off as shown in the website https://www.youtube.com/watch?v=Dsb0uFwnu4A.

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МОНИТОРИНГ И УПРАВЛЕНИЕ ИНТЕЛЛЕКТУАЛЬНЫМ МОСТОВЫМ КРАНОМ НА БАЗЕ ПЛК И СКАДА

Ахмед Ибрахим Джабер Альзубайди, В.П. Дорогобид

Описывается автоматическое управление мостовым краном на базе ПЛК и СКАДА. Кран разработан в программном обеспечении SCADA, связь между ПЛК и SCADA осуществляется с помощью симулятора Omron. В представленной статье описывается автоматическое управление мостовым краном. Подвесной мостовой кран представляет собой тип крана, в котором механизм крюка и кабеля проходит вдоль горизонтальной балки. Кран используется для подъема и перемещения материалов в промышленности. Для эффективной работы используется асинхронный двигатель с PMDC в промышленных применениях. Логика реле в управлении краном реализована с использованием ПЛК. В этой работе используются датчики для определения движения мостового крана и питания 220 В (переменного тока), 12 В (постоянного тока).

Ключевые слова: *мостовой кран на базе ПЛК, автоматизация мостового крана, программированный логический контроллер (ПЛК), датчики, скада.*

МОНІТОРИНГ ТА УПРАВЛІННЯ ІНТЕЛЕКТУАЛЬНИМ МОСТОВИМ КРАНОМ НА БАЗІ ПЛК ТА СКАДА

Ахмед Ібрахим Джабер Альзубайді, В.П. Дорогобід

Описується автоматичне керування мостовим краном на базі ПЛК та СКАДА. Кран розроблений в програмному забезпеченні СКАДА, зв'язок між ПЛК та СКАДА здійснюється за допомогою симулятора Omron. У представленій статті описується автоматичне керування мостовим краном. Підвісний мостовий кран являє собою тип крану, в якому механізм гака і кабелю проходить уздовж горизонтальної балки, що проходить уздовж двох широко розділених рейок. Кран використовується для підйому і переміщення матеріалів в промисловості. Для ефективної роботи використовується асинхронний двигун з PMDC в промислових цілях. Логіка реле в управлінні краном реалізована з використанням ПЛК. У цій роботі використовуються датчики для визначення руху мостового крана і живлення 220 В (змінного струму), 12 В (постійного струму).

Ключові слова: *мостовий кран на базі ПЛК, автоматизація мостового крана, програмований логічний контролер (ПЛК), датчики, скада.*