"Three Axis Warehouse Control Using Stepper Motor, PLC & SCADA"

Submitted by

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Department Of Electrical Engineering

CERTIFICATE

DATE: 03/05/2013

This is to certify that the dissertation entitled "THREE AXIS WAREHOUSE CONTROL USING STEPPER MOTOR , PLC &SCADA" has been carried out by PATEL MITESHKUMAR P.(110760109036) under my guidance in fulfilment of the degree of Bachelor of Engineering in Electrical Engineering(5th Semester) of Gujarat Technological University, Ahmadabad during the academic year 2013-2014.

Guide: **Head of Department**

Prof.Richa Mali **Prof. Nikunj Patel**

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Any person without practical knowledge is incomplete. He is just like ―Diamond without Polish‖. To bring the spark out of the diamond it is necessary to polish it properly. Likewise to make a Person perfect technically, it becomes necessary to polish him. We would like to take this opportunity to bestow are acknowledgements to all the people who have directly or indirectly been involved with us in making our project feasible and to run it up into a successful piece of work. We take a rather special privilege of thanking Mr.Mihir Raval of National InfoTech who guided us throughout the project. We also forward our special thanks to Prof. Richa Mali and Prof. Nikunj Patel for making these projects a success. Finally, we thank to our entire friend and other people who were continuous source of inspiration throughout the project development.

Thanking you,

PATEL MITESHKUMAR P.

ABSTRACT

This project is based on use of PLCs (Programmable Logic Controllers) and SCADA (Supervisory Control and Data Acquisition) for the purpose of automatic material handling inside the warehouse and the logistics industries. Involvement of manpower has various disadvantages and so automating the process will curb all the demerits .The implementation of this system would reduce the work done by humans to about 90% and thereby resulting in the increase in work/process speed. Automation is the use of control systems and information technologies to reduce the need for human work in the production of goods and services. In the scope of industrialization, automation is a step beyond mechanization. Automation greatly decreases the need for human sensory, mental requirements and saves time as well. Here we take up the case of logistics industry which involves the transfer of goods from one place to another. The success of the logistics industry depends on the promptness with which the products can be delivered to a particular destination or to a client. Time and location are two factors which can either make or mar the logistics industry. System involves the integration of information, transportation, inventory, warehousing, material handling, packaging, and often security. In this project all the goods will transfer automatically by elevators and conveyer belt, which will work on all three axis X, Y, Z). When commands given to PLCs, it sends appropriate signals to elevator and conveyer-belt set-up, then it finds the target in the stack of good.

Table of Contents

List of Figure

CHAPTER 1:

INTRODUCTION

1.1 Problem Summary

In Modern era in all industries.

- Man power requirement is high.
- Industries' having Low processing speed.
- It has Low efficiency.
- Cost of labour is high.
- Inconsistency in production rate.

To overcome these problems this project will give an alternative option.

1.2 Introduction of Material Handling System

Definition:

Material handling involves the movement and storage of material from one place to another place at the lowest possible cost through the use of proper method and equipments.

- Material handling is a necessary and significant component of any productive activity. It is something that goes on in every plant all the time.
- Material handling means providing the right amount of the right material, in the right condition, at the right place, at the right time, in the right position and for the right cost, by using the right method.
- In general, hundreds and thousands tons of materials are handled daily requiring the use of large amount of manpower while the movement of materials takes place from one processing area to another or from one department to another department of the plant.

- In the modern era of competition, this has acquired greater importance due to growing need for reducing the manufacturing cost.
- The importance of material handling function is greater in those industries where the ratio of handling cost to the processing cost is large.

1.3 Introduction of Warehouse

Warehouse is a commercial building for storage of goods. Warehouses are used by manufacturers, importers, exporters, wholesalers, transport businesses, customs, etc. They are usually large plain buildings in industrial areas of cities and towns and villages. They usually have loading docks to load and unload goods from trucks. Sometimes warehouses are designed for the loading and unloading of goods directly from railways, airports, or seaports. They often have cranes and forklifts for moving goods, which are usually placed on ISO standard pallets loaded into pallet racks. Stored goods can include any raw materials, packing materials, spare parts, components, or finished goods associated with agriculture, manufacturing and production.

A warehouse has been generally perceived to be a place to store things, out of sight, and out of mind, certainly not an image of high tech or sophistication. In fact most plant modernization efforts have typically ignored or bypassed the warehouse completely. But, in today's competitive manufacturing and business environment, the vital role of warehousing has to be properly understood. The warehouse is a critical link between a manufacturing plant and the external world and significantly affects the performance of the entire manufacturing and logistics system. The time to pay attention to the warehouse and to integrate it in the material supply chain is long overdue, especially in India.

1.3.1Automation in Warehouse:

Automation in warehousing immediately conjures the image of a high-rise Automated Storage Retrieval System (AS/RS). Therefore, before proceeding with a general discussion on automation in warehousing, let us first understand what is an AS/ Rs. Typically. AS/RS involves the use of high-rise racks with a storage machine operating within the aisle, serving both sides of the aisle. Loads are stored in the racks and retrieved either automatically or in a semi-automated fashion. The loads could either be unit loads that are palletized, or, in some

cases, involve drawers and totes that are used to store smaller parts. The heights of AS/RS systems can vary, depending on the application. The highest systems are 100 feet high.

1.3.2 Advantage of Automatic Warehouse System

The main advantages of a high-rise storage system are as follows:
• High density of storage by utilizing the cubic space available and with the help of narrow aisles.
• Tighter inventory control through computerization resulting in higher inventory accuracy.
• Reduced access in the aisles, improving the security of the material.
• Increased space utilization via random storage versus dedicated space allocated to different parts.
• Ability to tie the storage system to the manufacturing and the distribution systems via computer control, permitting a higher level of system performance.
• Better utilization of storage and retrieval equipment.
• Reduction in manpower.

Figure 1.1 Sample Warehouse

Chapter 2:

Literature review

2.1 IEEE Paper on A SCADA System Reliability Evaluation Considering Performance Requirement by Chun-Lien Su, Member, ZEEE, and Ya-Chin Chang

Various types of supervisory control and data acquisition (SCADA) system have been implemented by the utilities around the world to provide and maintain the high level of confidence demanded for power system operation. One of the main concerns in the design of a SCADA system is to assure whether the system could fit with the reliability and performance requirements specification. To take the system performance into account in the reliability analysis of the SCADA system, an approach to the reliability and performance analyses is proposed in this paper. This approach is based on a model for evaluating data transmission time, which allows us to find the operation lime needed to complete SCADA functions. With information on performance, the reliability evaluation technique using fault the analysis (FTA) is described and applied for analysis of SCADA system component connectivity to assess the availability of SCADA controls. A sensitivity analysis is also described and used to illustrate the effects of input data uncertainty on the system.

ELECTRIC utility SCADA systems are designed to provide and maintain the high level of confidence demand e for power system operation. For designing a SCADA system, reliability analysis is an important issue. The SCADA system may fail to operate as expected due to hardware and software failures, and may consequently lead to serious and costly consequences. A quantitative analysis to ensure whether the system could meet the reliability Requirements are important and necessary. There are presently little literatures on the assessment of SCADA system reliability. Proposed a composite generation and transmission system reliability evaluation technique for performing the numerical analysis of the joint SCADA and power system model System Structure**.**

2.2 IEEE Paper on Implementation of A VI-Based Multi-Axis Motion Control System for Automated Test and Measurement Applications By

Chaturi Singh* and K. Poddar National Wind Tunnel Facility Indian Institute of Technology Kanpur (INDIA)

For one or two axes requirements, a motion control system can be integrated easily with the test and measurement applications. However, for test and measurement applications with multiple motion control axes, conventional motion control systems soon reach their limitations. This paper presents the implementation aspects of a versatile multi-axis motion control system which combines power and precision to deliver flexible, economical, user-friendly multi-axis motion control solutions. This paper presents the implementation aspects of a VI-based multi-axis motion control system for automated test and measurement applications. The system has been implemented using virtual instrumentation technique and PXI architecture which enhances the productivity and reduce the cost through easy-to integrate application software and PXI modular hardware. The application software of the system has been developed using Lab VIEW-based graphical development environment which enables the user to configure the system for single axis or multi-axis operation. Using the front panel of the application software, multi-axis operation can be configured as free axis or master-slave axes pairs with safety limits. The PXI architecture used for the system is versatile and meets the specific needs of test and measurement applications by adding an integrated trigger bus and reference clock for multi-board synchronization. The system presented in this work is being used at National Wind Tunnel Facility (NWTF), IIT Kanpur to develop various motion control model support systems and test rigs. Few of them include model attitude control beta mechanism; single axis/dual axes turntable motion control systems, multi-axis robotic arm and ram-air parachute attitude control test rigs. The motion control function of these systems is integrated and synchronized with the data acquisition and measurement functions for automated wind tunnel testing. However, motion control system presented in this paper has been configured for automated wind tunnel test applications, but can also be easily configured to perform various motion and position control functions for bio-medical, process control, robotics, and CNC machine applications**.**

2.3 IEEE Paper on Implementation of Motion Control Technique for Stepper Motor Translation Stages in Online Detection System by Zurong Qiu, Shuai Shi and Xinghua Li the State Key Laboratory of Precision Measuring Technology and Instruments Tianjin University Tianjin 300072, China

The process of micro target assembling, the geometrical parameters of the micro target need to be measured in real-time by the online detection system with four-axis linkage. So the moving performance and positioning accuracy of every motorized axis are crucial to the

measurement. This paper proposed a new motion control technique for linear translation stages with stepper motor. The control algorithm was realized on field programmable gate array (FPGA) and digital signal processor (DSP), and met the high-efficiency and high-precision measurement requirements. An efficient and optimized speed control performance was achieved by using a method that was based on speed-difference driving and speed-table supplying, and a high-precision, closed-loop positioning control performance which has an error less than ±0.3 m was achieved by using a method that was based on position feedback, position window restriction and time-window restriction.

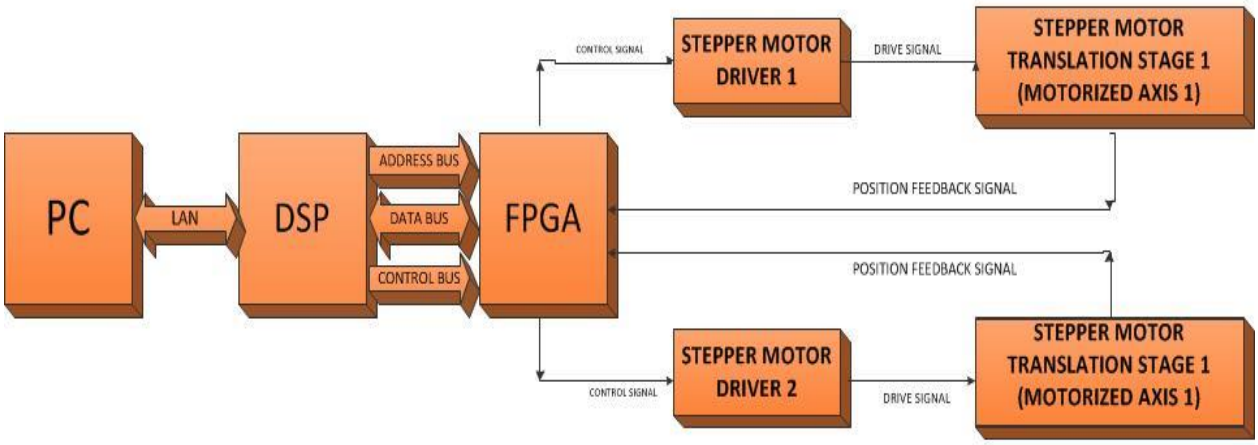

Figure 2.1 Motion Control Algorithm

2.4 PLC-SCADA Based Automated Logistics Warehouse Management System By V. Ramanan & Sachin. R

This paper is based upon use of PLCs (Programmable Logic Controllers) and SCADA (Supervisory Control and Data Acquisition) for the purpose of automatic material handling inside the warehouse and the logistics industries. Involvement of manpower has various disadvantages and so automating the process will curb all the demerits the implementation of this system would reduce the work done by humans to about 90% and thereby resulting in the increase in work/process speed.

Existing System: There are various methods involved in handling goods/materials in any industry. Some of them are: by using labour force, forklifts, hydraulic lifts, trolleys and many more. But in some form or the other man power is involved it their operation.

Proposed System: The main objective of this system is to automate the entire warehouse/Logistics industry which can be achieved using PLC and SCADA. All the manual operations are replaced by sending signals from the PLC to the respective devices. The work of storing and retrieval of goods from various places is automatically done by a movable elevator-conveyor setup that is controlled by the PLC.

2.5 INDUSTRIAL AUTOMATION SYSTEM by Sanjiv Kumar, Devendra Kumar, Vikash Saini, Jitendra Kumar faculty in EED HBTI Kanpur.

This paper describes how the present automation system comes in to existence through its various stages. In the past, automation is done through relays and contactor logics. Since the human intervention is more, the scope of errors was also more. But with the advent of microprocessors several new tools as PLC's, SCADA, and DCS come in to use. These have reduced human intervention, which in turn has increased accuracy, precision and efficiency. A comparative study has been shown to justify why we have to switch the present technology.

2.6 SCADA

An industrial SCADA system will be used for the development of the controls of the four LHC experiments. This paper describes the SCADA systems in terms of their architecture, their interface to the process hardware, the functionality and the application development facilities they provide.

Introduction:

Widely used in industry for Supervisory Control and Data Acquisition of industrial processes, SCADA systems are now also penetrating the experimental physics laboratories for the controls of ancillary systems such as cooling, ventilation, power distribution, etc. SCADA systems have made substantial progress over the recent years in terms of functionality, scalability, performance and openness such that they are an alternative to in house development even for very demanding and complex control systems as those of physics experiments.

Types of SCADA:

1. D+R+N (Development +Run + Networking)

2. R+N (Run +Networking)

3. Factory focus

Features of SCADA:

1. Dynamic process Graphic

2. Alarm summery

3. Alarm history

4. Real time trend

5. Historical time trend

6. Security (Application Security)

7. Data base connectivity

8. Device connectivity

9. Scripts

10. Recipe management

Manufacture of SCADA:

Modicon (Telemecanique) Visual look

Allen Bradly : RS View

Siemens: win cc

KPIT : ASTRA

Intelution : Aspic

2.6.1What does SCADA mean?

SCADA stands for Supervisory Control And Data Acquisition. As the name indicates, it is not a full control system, but rather focuses on the supervisory level. As such, it is a purely

software package that is positioned on top of hardware to which it is interfaced, in general via Programmable Logic Controllers (PLCs), or other commercial hardware modules.

SCADA systems are used not only in industrial processes: e.g. steel making, power generation (conventional and nuclear) and distribution, chemistry, but also in some experimental facilities such as nuclear fusion. The size of such plants range from a few 1000 to several 10 thousands input/output (I/O) channels. However, SCADA systems evolve rapidly and are now penetrating the market of plants with a number of I/O channels of several 100 K: we know of two cases of near to 1 M I/O channels currently under development.

SCADA systems used to run on DOS, VMS and UNIX; in recent years all SCADA vendors have moved to NT and some also to Linux.

2.7 Logistic Automation by Yam, K. L. "Encyclopaedia of Packaging Technology", John Wiley & Sons

Logistics automation is the application of computer software and/or automated machinery to improve the efficiency of logistics operations. Typically this refers to operations within a warehouse or distribution center, with broader tasks undertaken by supply chain management systems and enterprise resource planning systems. Logistics automation systems can powerfully complement the facilities provided by these higher level computer systems. The focus on an individual node within a wider logistics network allows systems to be highly tailored to the requirements of that node.

Benefits of logistics automation A typical warehouse or distribution center will receive stock of a variety of products from suppliers and store these until the receipt of orders from customers, whether individual buyers (e.g. mail order), retail branches (e.g. chain stores), or other companies (e.g. wholesalers). A logistics automation system may provide the following: Automated goods in processes: Incoming goods can be marked with barcodes and the automation system notified of the expected stock. On arrival, the goods can be scanned and thereby identified, and taken via conveyors, sortation systems, and automated cranes into an automatically assigned storage location. Automated Goods Retrieval for Orders: On receipt of orders, the automation system is able to immediately locate goods and retrieve them to a pickface location. Automated despatch processing: Combining knowledge of all orders placed at the warehouse the automation system can assign picked goods into despatch

units and then into outbound loads. Sortation systems and conveyors can then move these onto the outgoing trailers. If needed, repackaging to ensure proper protection for further distribution or to change the package format for specific retailers/customers. A complete warehouse automation system can drastically reduce the workforce required to run a facility, with human input required only for a few tasks, such as picking units of product from a bulk packed case. Even here, assistance can be provided with equipment such as pick-to-light units. Smaller systems may only be required to handle part of the process. Examples include automated storage and retrieval systems, which simply use cranes to store and retrieve identified cases or pallets, typically into a highbay storage system which would be unfeasible to access using fork-lift trucks or any other means.

2.8 PLC-SCADA Based Automated Logistics Warehouse Management System by V. Ramanan & Sachin. R

This paper is based upon use of PLCs(Programmable Logic Controllers)and SCADA(Supervisory Control and Data Acquisition)for the purpose of automatic material handling inside the warehouse and the logistics industries . Involvement of manpower has various disadvantages and so automating the process will curb all the demerits The implementation of this system would reduce the work done by humans to about 90% and thereby resulting in the increase in work/process speed.

CHAPTER 3

STUDY OF HARDWARE:

3.1 Wiring diagram & description:

3.1.1 Proposed Wiring Diagram:

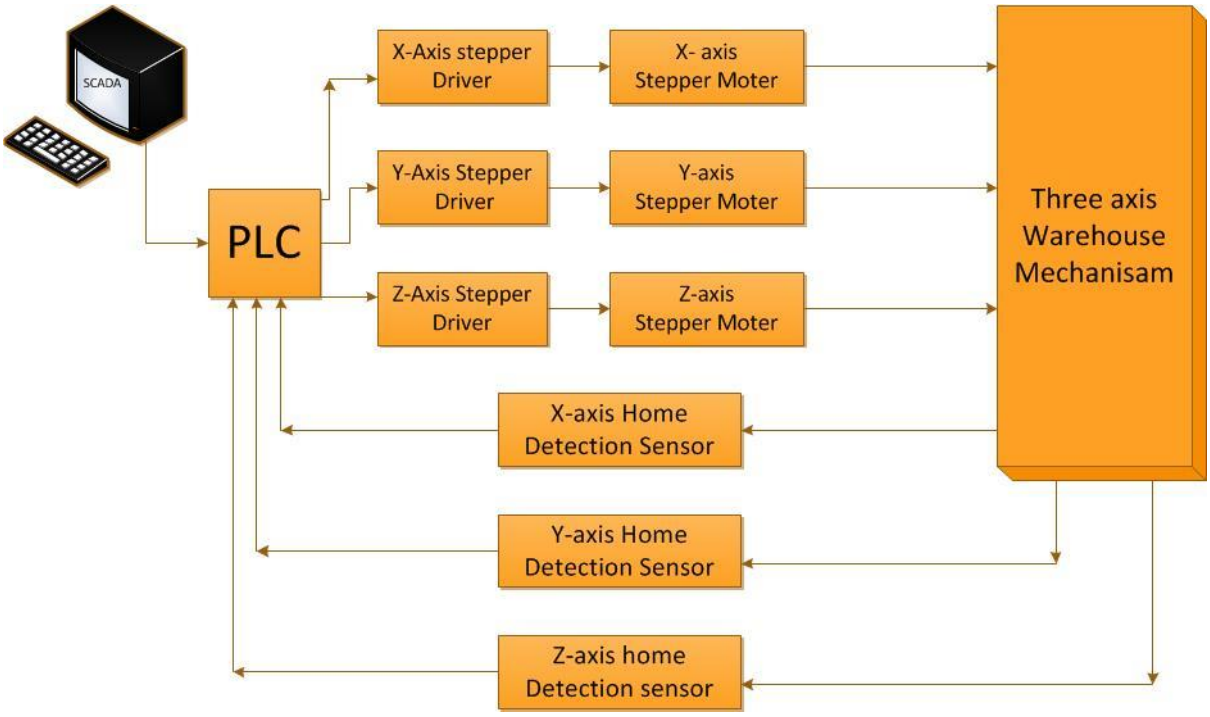

Figure 3. 1 Motion Control Algorithm

3.1.2 PLC power wiring diagram:

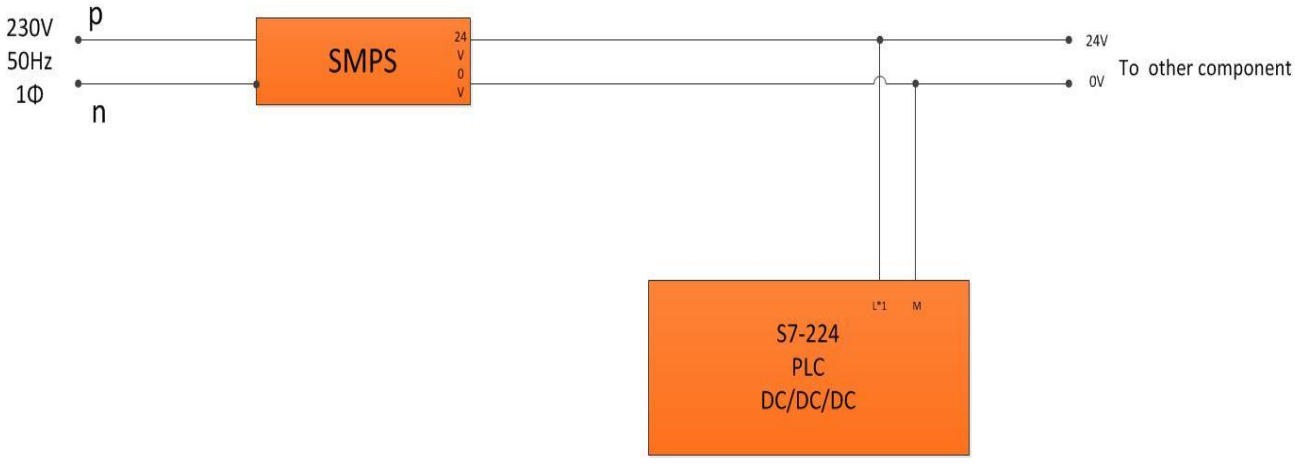

Figure 3. 2 connection of SMPS with PLC

Here our supply is single phase 230 V & 50 Hz frequency.Plc used in this project is S7-224 PLC which have DC source.So, through the SMPS we will convert @$ V DC & give the supply to the PLC & other component.

3.1.3 Stepper Driver Power Wiring Diagram:

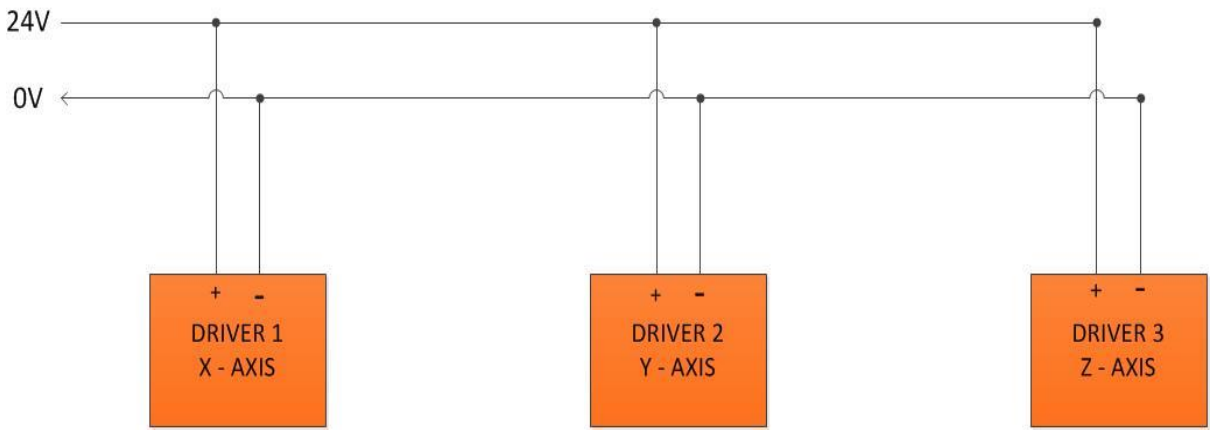

Figure 3. 3 Stepper Driver Power Wiring Diagram

As discussed above, we are having 3 axis stepper motor & driven so, through SMPS will supply DC voltage to the X axis Y axis & Z axis stepper driver.

3.1.4 PLC Four Input Wiring Diagram:

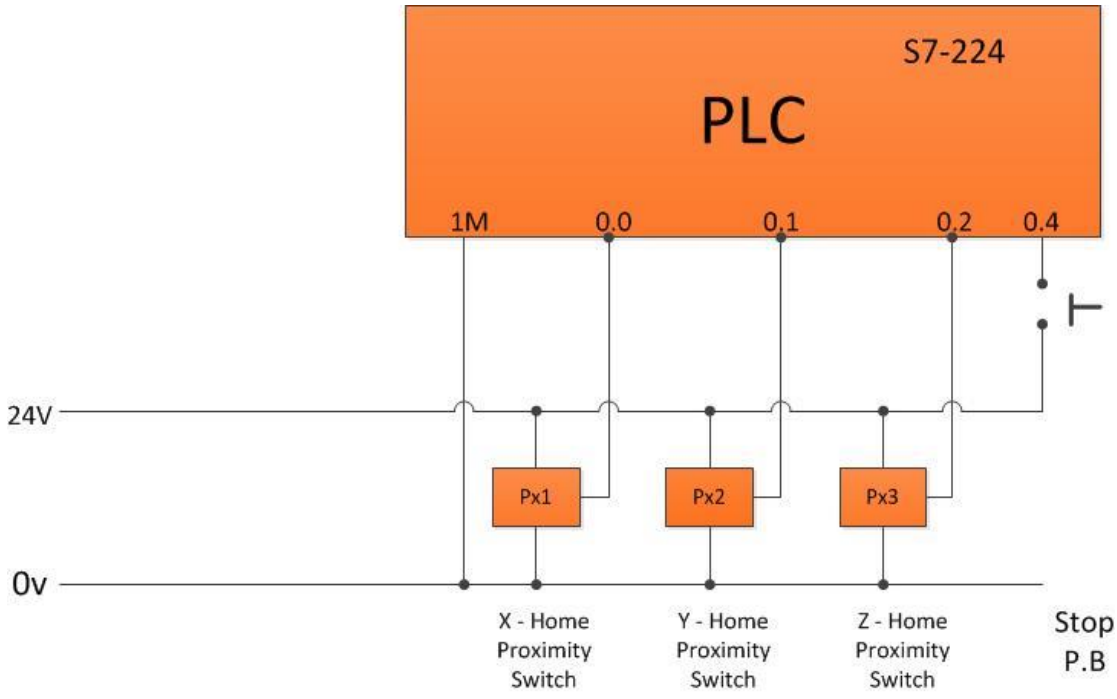

Figure 3. 4 PLC Four Input Wiring Diagram

4 input of PLC, which are connected with optical proximity sensor of X axis,Y axis,Z axis & proximity is used for homing of the target.Another is stop push button switch,is used in emergency case.

3.1.5 PLC Output and Stepper Driver Connection:

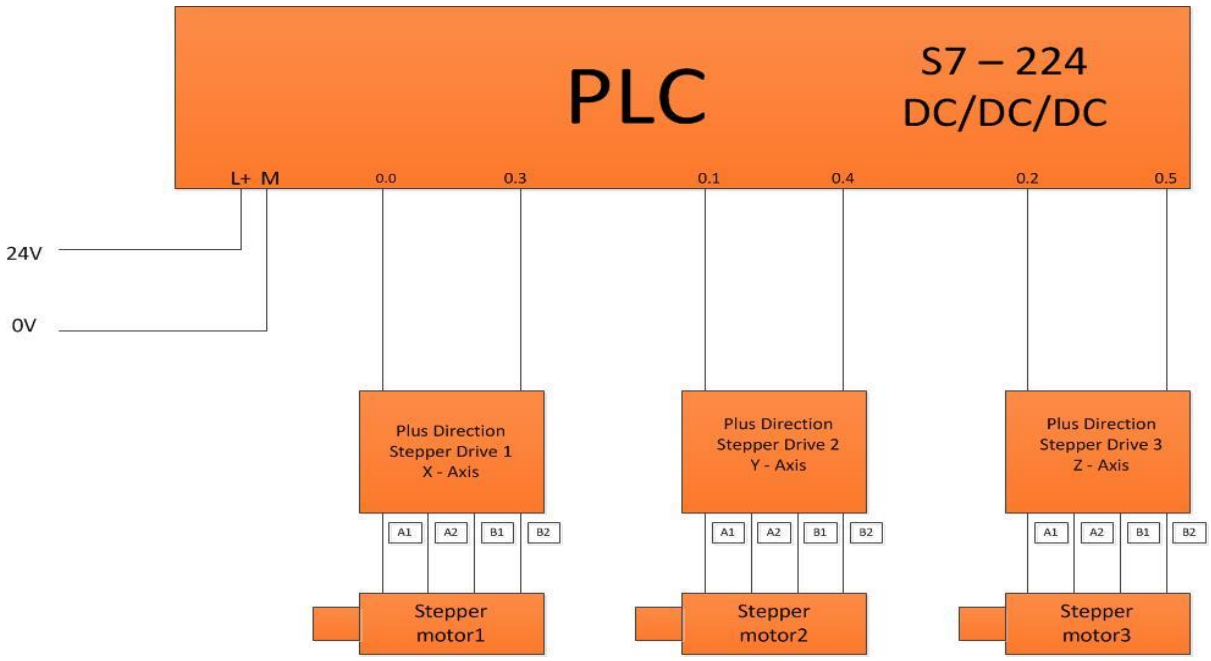

Figure 3. 5 PLC Output and Stepper Driver Connection

PLC's output is connected to the stepper driver is connected to stepper motor. Stepper driver generates pulses to drive the stepper motor in clockwise or anticlockwise direction. As if the pulse required to drive the motor & if low pulses are given then motor will move in clockwise direction & if high pulse is given to the motor in anticlockwise direction.

3.1.6 PLC and Pc Communication Connection:

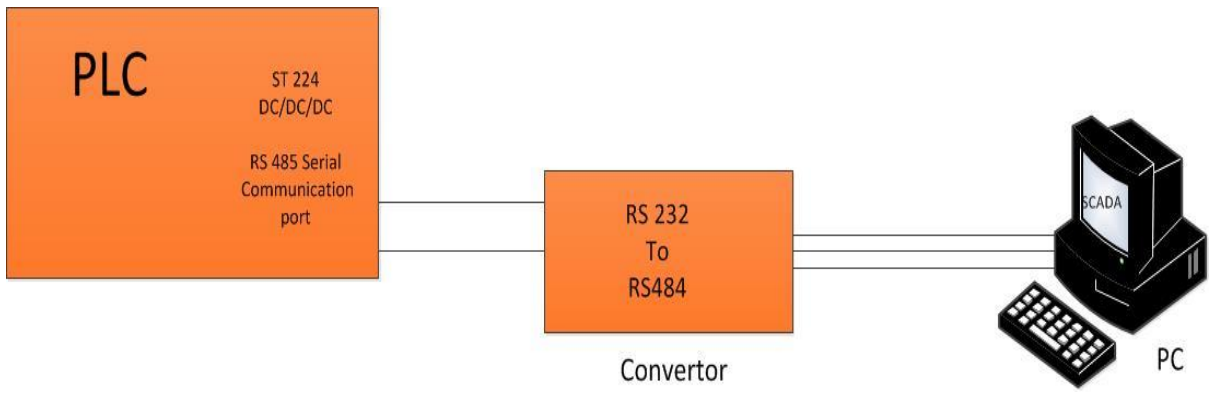

Figure 3. 6 PLC and PC Communication Connection:

PLC & PC are connected with the RS232 port & in PLC RS485 is for serial communication port.

3.2Model description & working:

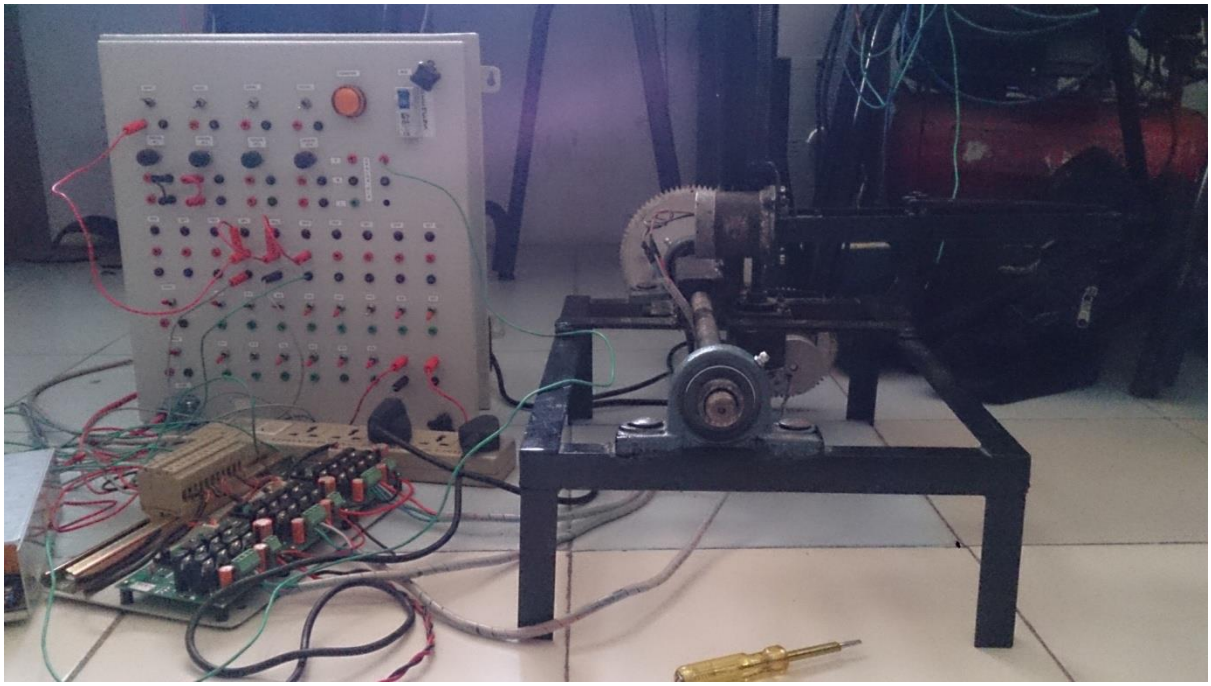

Figure 3. 7 Connection of Model with PLC and stepper Driver

We are going to implement model of three axis stepper motor based warehouse control system. An automated system for storing and retrieving objects from multiple object categories. A plurality of storage rack assemblies is included. The model will simulates working of finished goods handling in warehouse. Each storage rack assembly has a plurality of slots sized for storing objects. A storage transport is movable alongside each respective storage rack assembly for positioning adjacent any slot. A plurality of horizontal tracks are arranged to be perpendicular to the storage rack assemblies. Each storage rack assembly has an end adjacent the tracks.

A runner transport is coupled to and movable on each track for receiving one of the objects from, or providing one of the objects to a storage transport. The heart of the control system will be a PLC which will receive commands from SCADA software (installed in a PC). PLC will drive the stepper motors with the help of stepper driver. To give commands to stepper driver high speed pulses will be generated with proper algorithms and programs (interpolation etc.) Two conveyor rack assemblies are located at opposite ends of the tracks, aligned perpendicularly to the track. Conveyor transports are adjacent the conveyor rack assemblies for transferring objects between the conveyor rack assembly and the runner transports.

Storage and retrieval operation requests are generated by simultaneously providing positioning signals to a conveyor transport, a runner transport and a storage transport. Storage

transports are selected in accordance with a predetermined transport selection function. Storage slots are selected in accordance with a predetermined slot selection function. Stepper motor will actuate the three axis mechanical gantry to have desired positioning operation. Homing of all three axis will be done with the help of optical (IR) proximity switches. A database stores the category, age and location of each of the objects.

Component Description:

3.3 Stepper Motor

First of all, a stepper motor is a motor. This means, that it converts electrical power into mechanical power. The main difference between them and all the other motors is the way they revolve. Unlike other motors, stepper motors does not continuously rotate! Instead, they rotate in steps (from which they got the name). Each step is a fraction of a full circle. This fraction depends mostly from the mechanical parts of the motor, and from the driving method. The stepper motors also differs in the way they are powered. Instead of an AC or a DC voltage, they are driven (usually) with pulses. Each pulse is translated into a degree of rotation. For example, a 1.8o stepper motor will revolve its shaft 1.8o on every pulse that arrives. Often, due to this characteristic, stepper motors are called also digital motors.

3.3.1 Types of Stepper Motor

- Permanent Magnet Stepper
- Hybrid Synchronous Stepper
- Variable Reluctance Stepper
- Lavet Type Stepping Motor

3.3.2 Hybrid Synchronous Stepper Motor

We are going to use this type of stepper motor in warehouse system. The hybrid stepper motors are named so, because they combine the characteristics from both VR and PM stepper motors. They have excellent hold and dynamic torque, and very small step angles, from 0.9o to 5o, giving them A+ in accuracy. Their mechanical parts can rotate at high speeds relatively to the other stepper motor types. This is the type of motor used for high end CNC and robots.The major disadvantage is the cost.

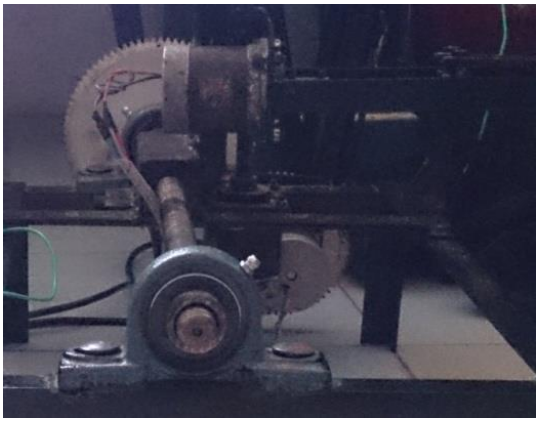

Figure 3. 8 Stepper Motor

The following animation shows a hybrid stepper motor with 75 steps per cycle (5o per step). Worth to notice that the 6 coils are in pairs of two, each one with its opposite coil. Although someone would expect to find these pairs with angle difference of 60o, it is not so. If we suppose that the first pair is the most top and most bottom coil, then the second pair is with angle difference of 60+5o from the first, and the third 60+5o from the second. This angle difference is the reason why the motor moves! Full and half stepping can be applied, as well as single-coil excitation for power saving. In this animation i use full step drive. With half step drive, the steps are increased to 150.

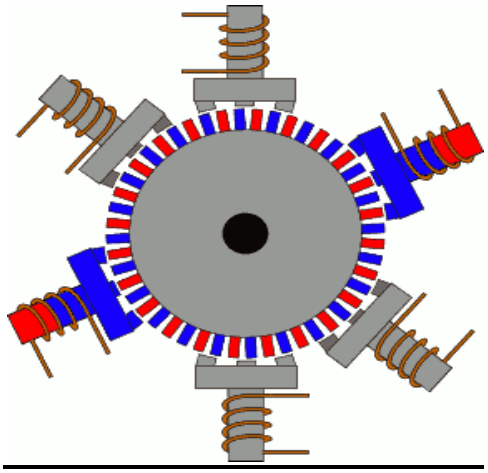

Figure 3. 9 Cross section view of Stepper motor

Just focus on one coil and wait. You will notice that, whenever this coil is actuated, there are 3 North poles (red) 5o back, that are pulled to the rotation direction, and another 3 South poles (blue) 5o front that are pushed to the rotation direction. The coil that is actuated is always between the North and South poles.

3.4 Stepper Motor Driver

The stepper motor driver receives step and direction signals from the control system and converts them into electrical signals to run the step motor. One pulse is required for every step of the motor shaft. In full step mode, with a standard 200-step motor, 200 step pulses are

required to complete one revolution. The speed of rotation is directly proportional to the pulse frequency. Some drivers have an on-board oscillator which allows the use of an external analog signal or joystick to set the motor speed.

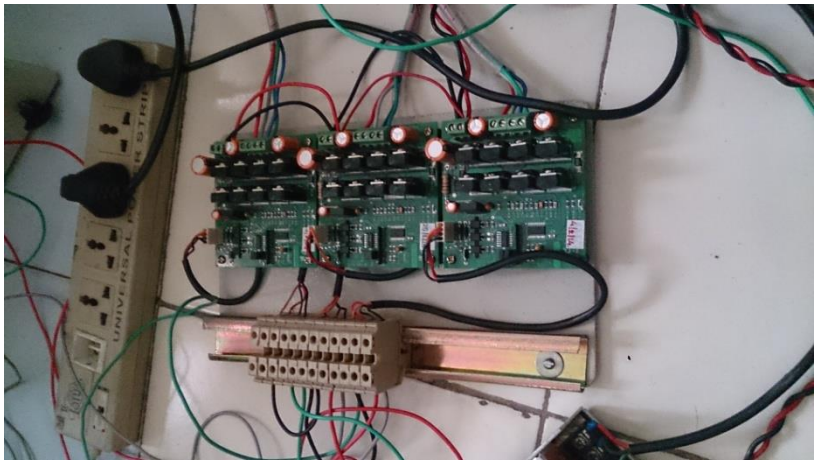

Figure 3. 10 Stepper driver

3.4.1 Typical Stepper Driver description:

- Full step, Half Step and Micro stepping until 1/16.
- Automatic current reduction.
- Uses highly integrated Trinamic Driver IC.
- Low Power dissipation.
- Can be interfaced with Microprocessor, PC and PLC.
- Ease of installation due to integration.
- Auto pulse generator for self testing.
- Cost effective system due to compactness and reduced wiring.

3.4.2 Key Features of Stepper Motor Driver

- Digital stepper motor drives with PLC functionally.
- Suitable for driving two phase bipolar stepper motors.
- Compact design.
- Single DC power supply (14-36 V).
- Current rating: 3 A rms, 4 A peak.
- Both Auto and Pulse and direction mode.
- Mixed decay for batter motor performance.
- Optically isolated input signals-Pulse, Direction and Disable.

- Connection to motor power supply and control signal can be easily made by pluggable terminal blocks.
- With protection function of short circuit, over temperature and reverse polarity.

3.4.3 Application of Stepper Motor Driver

- Industrial applications
- Robotics
- Pressing diamond rings
- Batch coding
- Setting of extrusion die
- Label application
- Wood working

3.4.4 Motor Speed Calculation

The speed of the motor is depended on some parameters viz. number of steps per Rotation, micro step resolution and number of pulses per second applied. Pulse input Signal controls the velocity and acceleration of the motor. The velocity depends on pulse Frequency and the acceleration on the change of frequency.

Motor speed in rotations/sec = $1 * \frac{No.of\ pulses/sec}{Ns*Resolution}$

Where,
Ns = 200 (Steps per rotation) for 1.8°step angle motors
Resolution = 1….16 (micro steps per step) depends on DIP switch position
No. of pulses = the number of pulses per second applied to Pulse pin

3.5 PLC (Programmable Logic Circuit)

A Programmable Logic Controller, PLC or Programmable Controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLCs are used in many industries and machines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory. A PLC is an example of a hard real time

system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation will result.

3.5.1 Basic Components of PLC

There are five basic components in a PLC system

- The PLC processor, or controller
- I/O (Input /Output) modules
- Chassis or backplane
- Power supply
- Programming software that runs in a PC
- In addition to these 5, most PLCs also have:
- A network interface

3.5.2 Major Components of a Common PLC

Power Supply

Provides the voltage needed to run the primary PLC components. A power supply is needed to provide power to the PLC and any other modules. Power supplies come in various forms:

- Power supply modules that fit into one of the slots in a chassis
- External power supplies that mount to the outside of a chassis
- Stand alone power supplies that connect to the PLC or I/O through a power cable
- Embedded power supplies that come as part of the PLC block

I/O Modules

Provides signal conversion and isolation between the internal logic- level signals inside the PLC and the field's high level signal.

- Physically connect to field devices.
- Input modules convert electrical signals coming in from input field devices such as push- buttons, to electrical signals that the PLC can understand.
- Output modules take information coming from the PLC and convert it to electrical signals
- The output field devices can understand, such as a motor starter, or a hydraulic solenoid valve.
- I/O comes in various forms.

- Input modules interface directly to devices such as switches and temperature sensors.
- Input modules convert many different types of electrical signals such as 120VAC, 24VDC, or 4-20mA, to signals which the controller can understand.

Input modules

Input modules convert real world voltage and currents to signals the PLC can understand. Since there are different types of input devices, there is a wide variety of input modules available, including both digital and analog modules. Discrete modules use only a single bit to represent the state of the device. For example, a switch is either open or closed. Therefore, the bit is either a 0 (switch is open) or a 1 (switch is closed). Discrete modules are also known as Digital modules. Analog modules use words to represent the state of a device. An analog signal represents a value.. For example, the temperature could be 5, 9, 20, 100, etc degrees. Analog modules use a value, such as 52, rather than a 0 or 1 to represent the state of the device.

Analog Module

Devices that have a number associated with them, such as a temperature sensor, get wired to analog modules. Analog modules come in a variety of types, such as 4 to 20 mA or 0 to 10 VDC. You can buy analog modules that allow you to connect anywhere from 2 to 16 devices. Since it takes 1 word to represent a number, a 16 point analog module requires 16 words of memory in the controller to store the value of all the numbers on the module. Each word in a PLC takes 16 or 32 bits (depending on the PLC), therefore it takes 16 or 32 times the amount of PLC memory to store analog points vs. digital points.

Discrete Module

Devices that are either on or off, such as a pushbutton, get wired to discrete modules. Discrete modules come in a variety of types, such as 24VDC or 120VAC. You can buy discrete modules that allow you to typically connect anywhere from 2 to 32 devices, with the most popular being 16 devices. Since it takes only 1 bit to represent the state of a device, a 16 point discrete module only requires 16 bits of memory in the controller to store the states of all the points on the module.

Output Module

Output modules interface directly to devices such as motor starters and lights Output modules take digital signals from the PLC and convert them to electrical such as 24VDC and 4 mA that field devices can understand .Output modules take a signal from a PLC and convert it to a signal that a field device needs to operate. Since there are different types of output devices, there is a wide variety of output cards available, including both digital and analog cards.

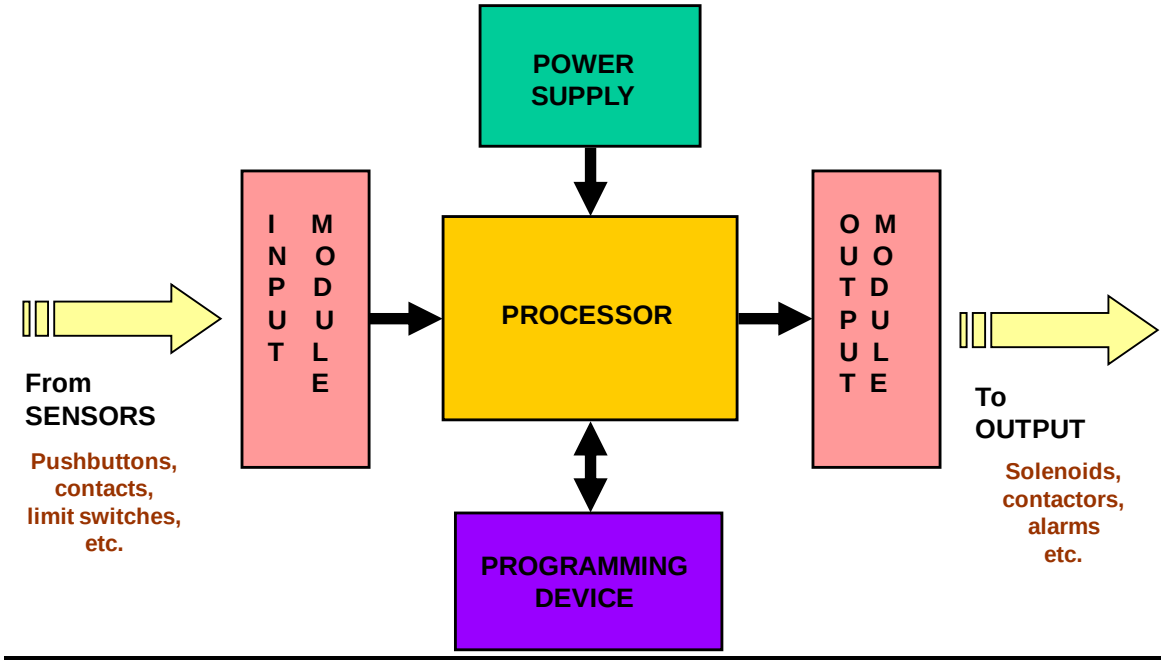

Figure 3. 11 Block Diagram of PLC

Processor, Controller, or CPU

- Stores the control program and data in its memory
- Reads the status of connected input devices
- Executes the control program
- Commands connected outputs to change state based on program

Programming Device

Used to enter the desired program that will determine the sequence of operation and control of process equipment or driven machine.
Software that runs on a PC is required to configure and program PLCs
• Different products may require different programming software
• Software allows programs to be written in several different languages

3.5.3 Programming Software

Software that runs on a PC is required to configure and program PLCs

- Different products may require different programming software
- Software allows programs to be written in several different languages

3.5.4 Network Interface

Most PLCs have the ability to communicate with other devices. These devices include computers running programming software, or collecting data about the manufacturing process, a terminal that lets an operator enter commands into the PLC, or I/O that is located in a remote location from the PLC. The PLC will communicate to the other devices through a network interface.

3.5.5 PLC Programming

Every PLC has associated programming software that allows the user to enter a program into the PLC.

Software used today is Windows based, and can be run on any PC.

Different products may require different software: PLC5, SLC, and ControlLogix each require their own programming software. In our system we are going to use Siemens software for the programming purpose.

Before a PLC can perform any control task, it must be programmed to do so. The most popular language used to program a PLC is ladder logic. In a conveyor system, we have several “requirements” to accomplish; for example, timing and counting parts on the conveyor. Each of these requirements must be programmed into the PLC so that it knows how to respond to different events. The programmer develops the program, and connects their personal computer to the PLC through a network or cable and then downloads the

Program to the PLC.PLC programs are typically written in a special application on a personal computer, and then downloaded by a direct-connection cable or over a network to the PLC. The program is stored in the PLC either in battery-backed-up RAM or some other non-volatile flash memory. Often, a single PLC can be programmed to replace thousands of relays. PLCs can be programmed using standards-based programming languages. Currently there are five programming languages for programmable control systems:

Function block diagram (FBD)

Ladder diagram (LD)

Structured text (ST)

Instruction list (IL)

Sequential function chart (SFC).

We are going to use **'Ladder Diagram'** for programming.

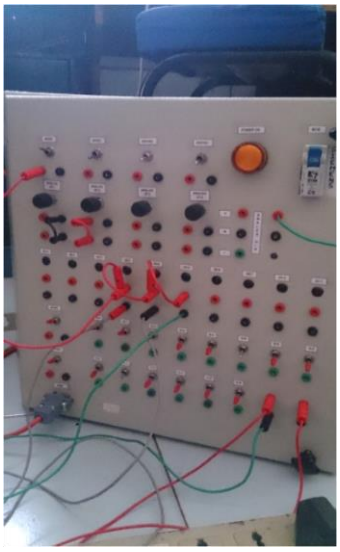

Figure 3. 12 Programmable Control Logic

3.6 SCADA (Supervisory Control and Data Acquisition)

3.6.1 Introduction of SCADA

SCADA systems are used in industrial processes like steel making, power generation (conventional and nuclear) and distribution.A Supervisory Control and Data Acquisition (SCADA) system is a widely distributed computerized system primarily used to

Remotely control and monitor the condition of Field - based assets from a central location. Field based assets include wells, pump stations, Valves, treatment plants, tanks, and reservoirs.

3.6.2 Components of SCADA System

SCADA encompasses the transfer of data between a SCADA central host computer and a number of remote sites (Remote Terminal Units or RTUs), and the central host and the operator terminals. Figure 1 shows a generic SCADA system that employs some form of data multiplexing (MUXs) between the central host and the RTUs. These multiplexers serve to route data to and from a number of RTUs on a local network, while using one or very few

physical links on a Wide Area Network (WAN) backbone to pass data back to the central host computer.

SCADA Systems Consist of One or more field data interface devices usually called Remote Stations, Remote Terminal Units (RTUs), or Programmable Logic Controllers (PLCs), which interface to field sensing devices and local control switchboxes and valve actuators. A communication system used to transfer data between field data interface devices and control units and the computers in the SCADA central host.

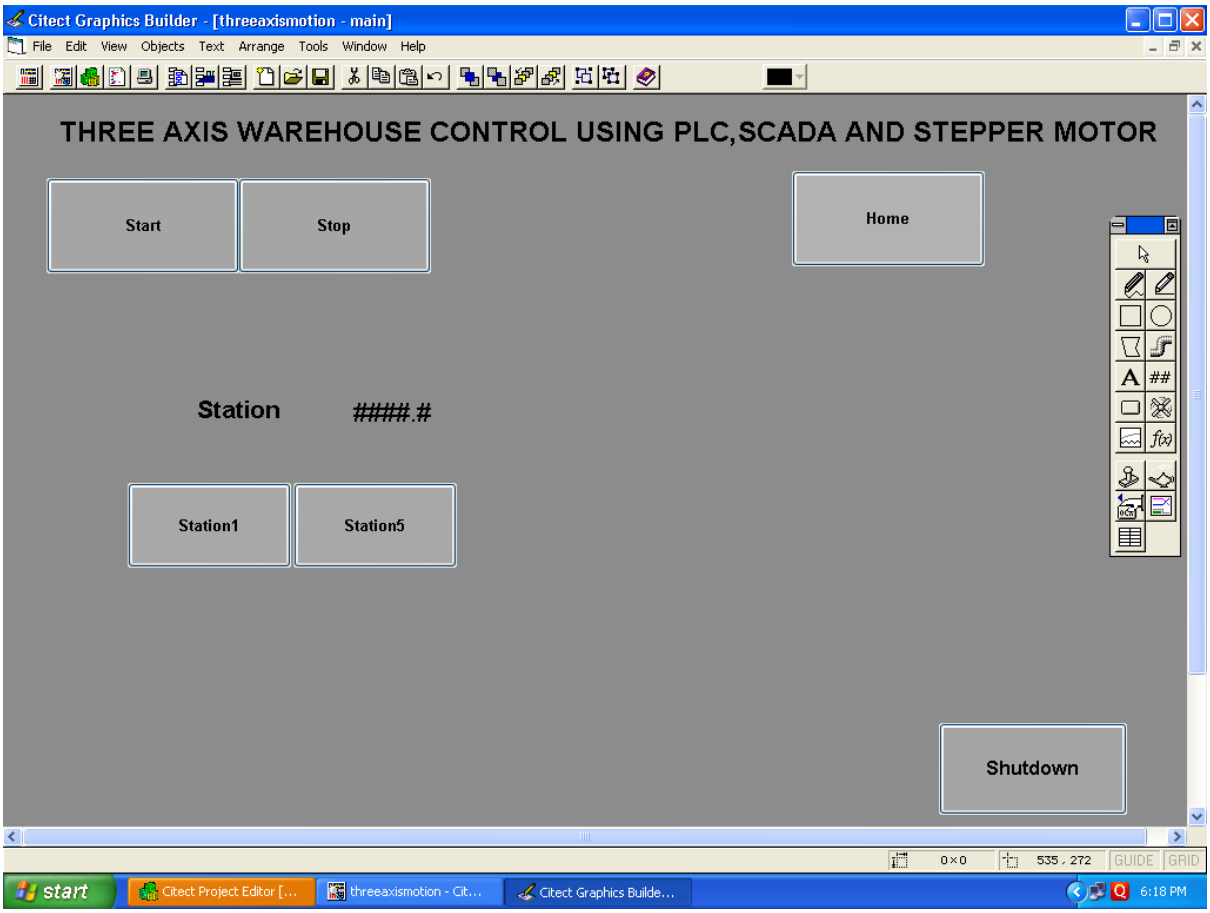

Figure 3. 13 SCADA Graphics

3.6.3 Advantages of SCADA systems

Easily programmed or reprogrammed Easy maintained (self diagnostic) Capability to do arithmetic function. The ability to communicate with other controller or a master host computer. PLCs were able to move past simple on/off control to more complex schemes.

3.6.4 Applications of SCADA

Almost every business in the manufacturing sector and many in the service sector, Aerospacee, Bottling and Canning, Chemicals Plants, Petroleum, Petrochemical.

3.7 Proximity Switch

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors. For example, a capacitive photoelectric sensor might be suitable for a plastic target; an inductive proximity sensor always requires a metal target. The maximum distance that this sensor can detect is defined "nominal range". Some sensors have adjustments of the nominal range or means to report a graduated detection distance. Proximity sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between sensor and the sensed object. Proximity sensors are also used in machine vibration monitoring to measure the variation in distance between a shaft and its support bearing. This is common in large steam turbines, compressors, and motors that use sleeve-type bearings. Proximity switches open or close an electrical circuit when they make contact with or come within a certain distance of an object. They are most commonly used in manufacturing equipment, robotics, and security systems. There are four basic types: infrared, acoustic, capacitive, and inductive.

3.7.1 Types of Proximity Switch

Inductive

Inductive proximity switches are similar in principle to metal detectors. Coil of wire is charged with electrical current, and an electronic circuit measures this current. If a metallic part gets close enough to the coil, the current will increase and the switch will open or close accordingly. The chief disadvantage of this type is that they can only detect metallic objects.

Acoustic proximity sensor

Acoustic proximity sensors are similar in principle to infrared models, but use sound instead of light. They use a transducer to transmit inaudible sound waves at various frequencies in a preset sequence, and then measure the length of time the sound takes to hit a nearby object and return to a second transducer on the switch.

Capacitive proximity switch

Capacitive switches sense distance to objects by detecting changes in capacitance around it. A radio-frequency oscillator is connected to a metal plate. When the plate nears an object, the radio frequency changes, and the frequency detector sends a signal telling the switch to open or close. These switches have the disadvantage of being more sensitive to objects that conduct electricity than to objects that do not.

Optical proximity switch:

Beam of invisible pulsed modulated infra-red light is produced by emitter. This beam is sensed by receiver at another end (in through beam version) or reflected by object and received by receiver placed near emitter (in diffuse version). When this beam is interrupted by object, the receiver signal gets changed and signal is produced.

Optical proximity switches are used where higher sensing distance is required with noncontact operation.

Diffusive reflective type

This is a fixed focused type of switch. Transmitter and receiver enclosed in one housing. Transmitted beam strikes on the object (when the object enters the scanning range) and gets reflected by object surface. Receiver detects these rays and output signal is produced. These are used to sense dark colour marks on packaging material. Transmitter and receiver are housed in single housing and beam is focused to a spot. In normal condition receiver receives reflected light. When dark register mark is entered, the receiver senses change in signal level. Thus output signal is initiated.

3.7.2 Working of optical proximity sensor:

Infrared proximity switches work by sending out beams of invisible infrared light. A photo detector on the switch detects any reflections of this light, which allow the device to determine whether there is an object nearby. As a switch with just a light source and

photodiode is susceptible to false readings due to background light, more complex models modulate the transmitted light at a specific frequency and have receivers which only respond to that frequency. Even more complex sensors are able to use the light reflected from an object to compute its distance from the sensor.

Proximity switches are used in manufacturing processes, to measure the position of machine components, for example. They are also used in security systems, in applications such as detecting the opening of a door, and in robotics, where they can monitor a robot or its components' nearness to objects and steer it accordingly.

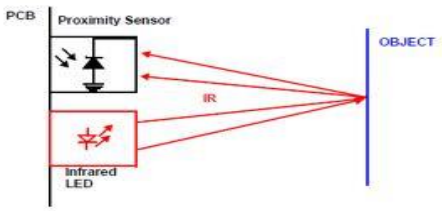

Figure 3. 14 Proximity Switch

Chapter 4:

Software Implementation and Result

4.1 Algorithm of the system:

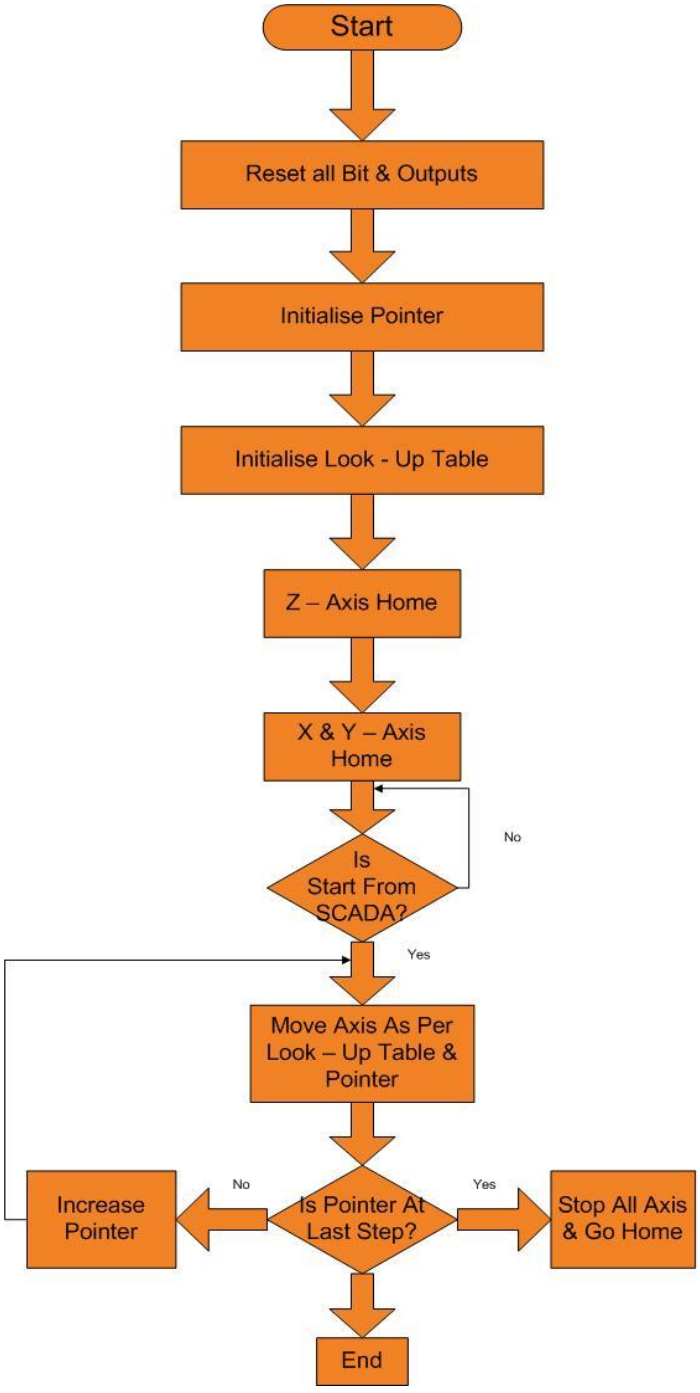

Figure 4. 1 Algorithm of Invention

4.2 LOOK UP TABLE FOR SCADA GRAPHIC

BOX-5:

X	Y	Z
0	0	1
0	900	0
0	0	-1
18378	0	0
0	0	1
0	-900	0
0	0	-1

BOX-1:

X	Y	Z
0	0	1
0	900	0
0	0	-1
4594	15454	0
0	0	1
0	-900	0
0	0	-1

CHAPTER 5

CONCLUSION

- Age old conventional methods used in the logistics industry have been eliminated.
- Complexity of production logistics has been modelled, analyzed, visualized and optimized by this proposal.
- After completing analysis we can conclude that simens A4988 preferable PLC because it has enough I/O port and programming is easily understand. Simens A4988 has inbuilt analog input so there is no need to connect other digital to analog converter.
- IN TOUCH is easy to access SCADA software as supervisory control. The complicity is very much reduces when we creating communication path through this software.
- After the study of literature, we can conclude that **"Three axis warehouse control using PLC, SCADA and stepper motor can be effectively done and satisfy the challenges and need of customer. It reduces the man power but it can't be completely autonomous".**