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Automation of Railway Yard Container Handling Robotic Hoist

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Abstract: Our life quality today totally is defined by what we produce, and what we consume. This give rise to high volume material – goods movement between places without delay and reaching the destination in time plays an important role of success in industrial management along profit make by the business and over all development of the country. From this need, we derive the inspiration to build a concept trial miniature prototype to address the problem of container management in railway goods handling section which is done with manual hoist controls, where the operator with help of a hand held control panel move the container from parallel parked trains. This process of goods container movement between parked trains is a time consuming a labor intensive. This Paper presented the concept of preprogrammed good container movement based on data good movement control manager computer. This is also coupled with operation by operator from a PC along with manual operation control panel. The basic design of our project will involve 3 axis movement such as X axis, Y axis, Z axis, with a clipper drive, this dynamic real working model design will be accomplished with 4 motors and electronic circuit interfaced with electronic sensor hooked to PC to be controlled with aid of mechatronics based Microcontroller.

***Index Terms*: Material Handling, Hoist, Miniature prototype, MPLAB IDE etc.**

I. INTRODUCTION

In today's global economic development, the material handling system (MHS) is a fundamental part of a Flexible manufacturing system since it interconnects the different processes supplying and taking out raw material, work pieces, sub products, parts and final products. The material handling industry manufactures and distributes the equipment and services required to implement material handling systems. Material handling systems range from simple pallet rack and shelving projects, to complex conveyor belt and Automated Storage and Retrieval Systems (AS/RS). Material handling can also consist of sorting and picking as well as automatic guided vehicles. The MHS is composed of warehouses, buffers, conveyors, transportation vehicles or systems, part sorters, feeders and manipulators [1].

A rail yard, or railroad yard, is a complex series of rail road tracks for storing, sorting, or loading/unloading, railroad cars and/or locomotives. Railroad yards have many tracks in parallel for keeping rolling stock stored off the mainline, so that they do not obstruct the flow of traffic. Railroad cars are moved around by specially designed yard switchers, a type of locomotive. Many railway yards are located at strategic points

On a main line. Main line yards are often composed of an Up yard and a Down yard, linked to the associated railroad direction. There are different types of yards, and different parts within a yard, depending on how they are built.

The goods manufactured in a country are shipped for the entire world through sea routes and rail routes. These two modes of goods transportation form the export and import of all man made goods to be shipped from one location to another destination within the country and as well as neighbouring countries. The mode of transportation on land is preferred and is dependent on railways. This railway division of cargo transport is well connected to harbors where large ships bring in materials from different countries and take back huge quantities of exported goods from a harbor. The goods half loaded from the ship are put on to long freight trains, which play a key role in goods movement within a country.

The systematic planning of export shipment and segregation of imported cargo forms key to success in international trade. This operation of cargo handling consist of segregation and delivery of the right cargo to the right customer is carried out on minute to minute basis at the freight handling terminals which are manned mostly by trained staff with the use of RF ID for cargo identification. The procedure involved is the incoming cargo is stationed at a goods handling railway terminal where the container data is collected by means of RF ID and fed to the computerized cargo sorting section which provides or prepares a detail document of the destination where the cargo has to reach. [2-5].

A. HOIST

A hoist is a device used for lifting or lowering a load by means of a drum or lift-wheel around which rope or chain wraps. It may be manually operated, electrically or pneumatically driven and may use chain, fiber or wire rope as its lifting medium. The load is attached to the hoist by means of a lifting hook. The basic hoist has two important characteristics to define it: Lifting medium and power type. The lifting medium is either wire rope, wrapped around a drum, or load-chain, raised by a pulley with a special profile to engage the chain. The power can be provided by different means. Common means are hydraulics, electrical and air driven motors. Both the wire rope hoist and chain hoist have been in common use since the 1800s. However; Mass production of an electric hoist did not start until the early 1900's and was first adapted by Germany. A hoist can be built as one integral-package unit, designed for cost-effective purchasing and moderate use, or it can be built as a built-up custom unit, designed for durability and performance.

II. RELATED WORK

In 1550 - Hand propelled tubs known as "hunds" undoubtedly existed in the provinces surrounding/forming modern day Germany by the mid-16th century having been in proven use since the mid-15th century and possibly earlier. This technology was brought to the UK by German miners working in the Mines Royal at various sites in the English Lake District near Keswick (Now in Cumbria) [6].

1802 - The Carmarthenshire Tramroad, later the lamely and Mynydd Mawr Railway, located in south west Wales, was established by Parliament. They introduced the drum hoist. Drum hoists are the most common type of hoist used in North America, South Africa and South America. When using a drum hoist the hoisting cable is wound around the drum when the conveyance is lifted. Single-drum hoists can be used in smaller applications; however double-drum hoists easily allow the hoisting of two conveyances in balance (i.e. one skip being lifted while a second skip is being lowered). Drum hoists are mounted on concrete within a hoist room, the hoisting ropes run from the drum, up to the top of the head frame, over a sheave wheel and down where they connect to the conveyance (cage or skip) [7].

In 2001 August - Northeast China first electrified railway opens for business between Shenyang and Harbin [8].

In 2007 - Heavily modified train set of France's TGV had beaten its original world record when it travelled from Metz-Reims at a speed of 574.8 kilometers per hour (357.2 mph) [9].

In 2010 - Shanghai Metro overtakes London Underground as the world's largest urban transit system (now serving: 420 km (260 mi) with 278 stations (235 not including stations served more than once) [10].

III. PROPOSED WORK

The work proposes an automated container handling system put in space reads the RF Identification code and decides the destination instantaneously and the container is picked and placed in the suitable freight trains marked to different destinations. The large ports which handle containers in the order of millions have benefitted mainly due to the system efficiency where the cargo does not lie in a yard unattended for more than 2 hours. These sorts of systems are yet to be developed for our railway system. A PC based container handling 4-axis hoist would the RF ID located in each container if put in place where any freight train brought in to the container-handling yard is automatically segregate a beneficial solution. This RF ID data provides all information of the container and its final destination. A PC controlled hoist would identify the container and with the help of the software in the computer network instruct the hoist to pick and place it in the respective designated freight trains.

The automated PC controllable four axis container model hoist can be realized to demonstrate the entire pick, move and place the freight container with the aid of embedded system and mechatronics based system design.

Fig -1: Block Diagram of a system

The system we wish to design the above utility is based on a hoist bed where a Y-axis movement is developed with motor and a gearbox to role on Y-axis guide rails. This movement carried overhead where an X axis dual rail motorized gear box moves the container clipper pick –drop mechanism made to move freely in the X axis direction. Thus an area of length and breadth is achieved to accommodate multiple parallel railway tracks where the freight trains are brought in from the sea port and their cargo is segregated and new flight trains to particular destinations are loaded with the aid of hoist. The Z axis movement mechanism mounted on the X axis movement platform can move horizontally in board directions. Similarly the Z axis system moves forward and reverse carrying the X axis mechanism. The Z-axis where their lift and drop is achieved, the fourth axis being the gripper or the container latching mechanism is also rotary card based. So the entire four axis can be controlled with the aid of 4 motors to be managed by mechatronics based embedded hardware coupled with a graphic user interface located in the personal computer. Thus our project can be totally controlled from the PC. In this we have two major parts:

A. *Mechanical System*

Figure 2 shows top view of mechanical model, it explains the Design & fabrication of mechanical system.

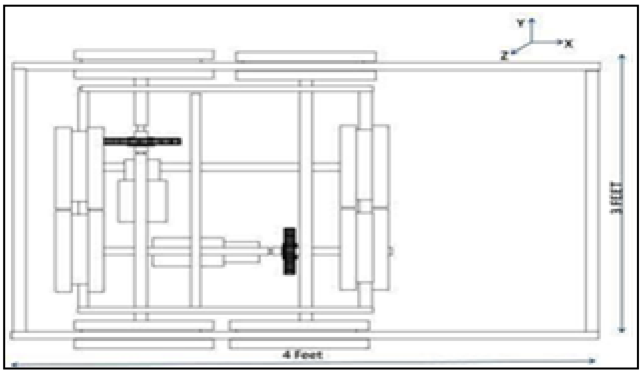

Fig -2: Top view of mechanical model

1) Role of X- Axis:
- This is dual rail motorized gear box moves the controller container in the x-axis direction
- This provides a platform for the mounting of z-axis
- For this polycarbonate plastic is used for the construction of gearbox
- The gear material is nylon with the gear to pinion ratio 3:1

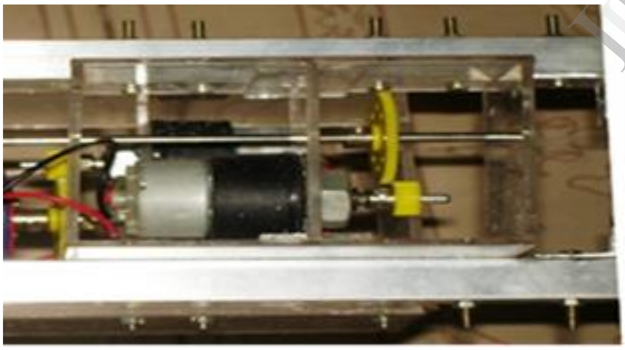

Fig -3: X – Axis

2) Role of Y- Axis:
- This is dual rail motorized gear box moves the controller container in the Y-axis direction.
- For this polycarbonate plastic is used for the construction of gearbox.
- The gear material is nylon with the gear to pinion ratio 3:1.

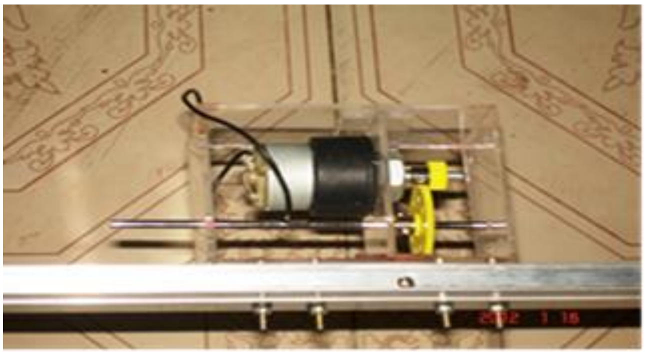

Fig - 4: Y – Axis

3) Role of Z – Axis:
- This is dual rail motorized gear box moves the controller container in the x-axis direction
- It is mounted on the x-axis platform
- It consists of rolling arrangement in which gripper is mounted.
- For this the rolling arrangement is mounted on the z-axis shaft.
- For this polycarbonate plastic is used for the construction of gearbox.

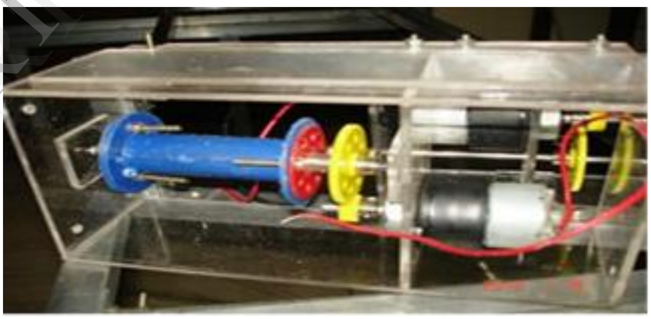

Fig -5: Z – Axis

4) A view on gripper:
- This arrangement is used for the pick and place mechanism.
- It is built by using L angle aluminum as the base, aluminum rods as the shaft, and the plastic material for holding the container and actuator assembly for pick mechanism

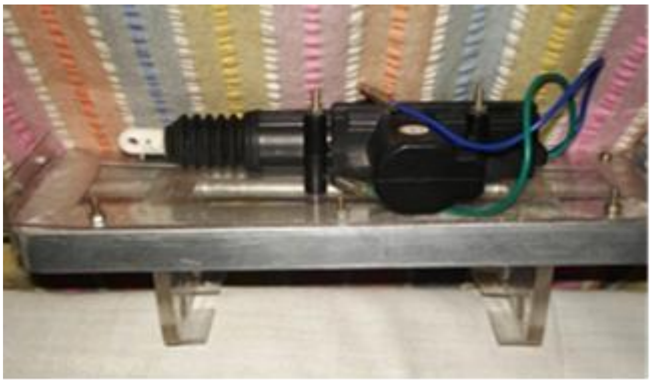

Fig -6: Gripper

B. *Electronic System*

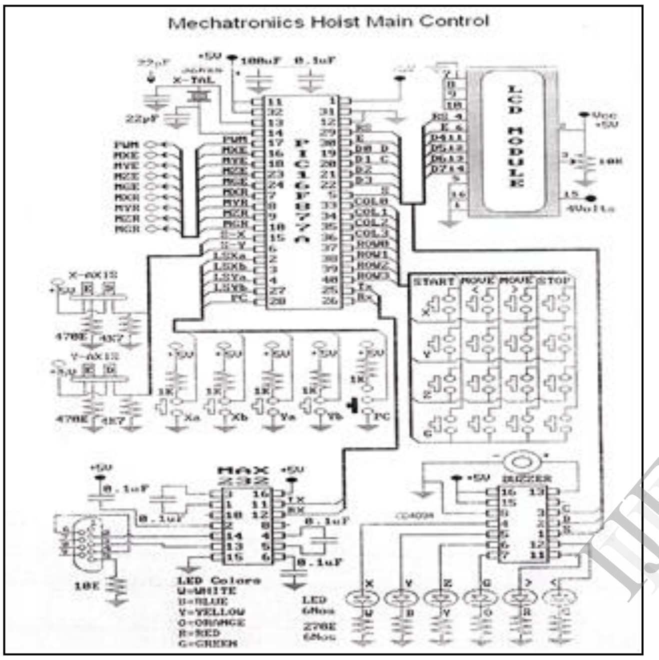

Fig -7: Electronic Block Diagram

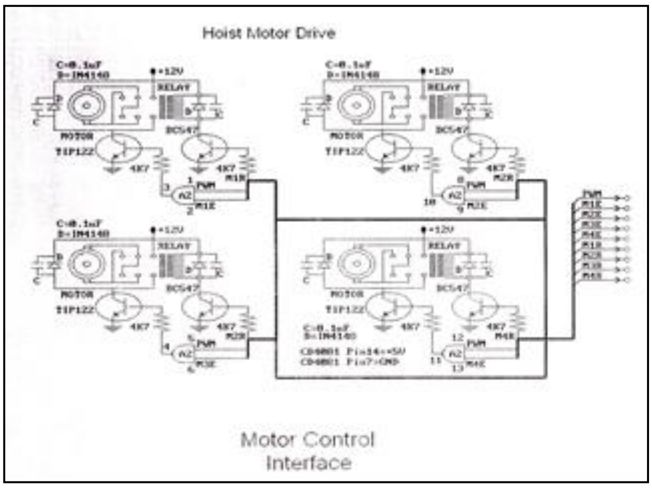

Fig -8: Diagram for Motor Control Interface

The mechatronics based hoist can be described with the above diagram where the architecture of embedded electronics is based around an industrial microcontroller specifically chosen to handle the motors, which from the core of the machine this design requires four motors to be independently controlled with a PWM Motor speed control. This PWM forms a system block within the microcontroller and the communication for the commend control is design from graphic user interference. A high level user interference program specifically windows platform. These environments provide great facility for the user, who enter can control by using mouse and keyboard buttons. In case of desired manually control a local key board of 4 axes as a matrix key board. The local display near the keyboard provides which axis is moving and thus the direction of movement. The buzzer and visual indicators (LED) provide a visual clue for operator as a feedback to monitor and observe whether the commands are executed in the right order. The limit switches provide all safety measures to make it secure from operator point of view. The sensors also provide a close loop control for a fail proof operation.

C. *Software Requirements*

MPLAB IDE is a software program that runs on a PC to develop applications for Microchip microcontrollers. It is called an Integrated Development Environment, or IDE, because it provides a single integrated "environment" to develop code for embedded microcontrollers.

An embedded system is typically a design making use of the power of a small microcontroller, like the Microchip PICmicro® MCU or dsPIC® Digital Signal Controller (DSCs). These microcontrollers combine a microprocessor unit (like the CPU in a desktop PC) with some additional circuits called "peripherals", plus some additional circuits on the same chip to make a small control module requiring few other external devices.

This single device can then be embedded into other electronic and mechanical devices for low-cost digital control.

IV. RESULT ANALYSIS

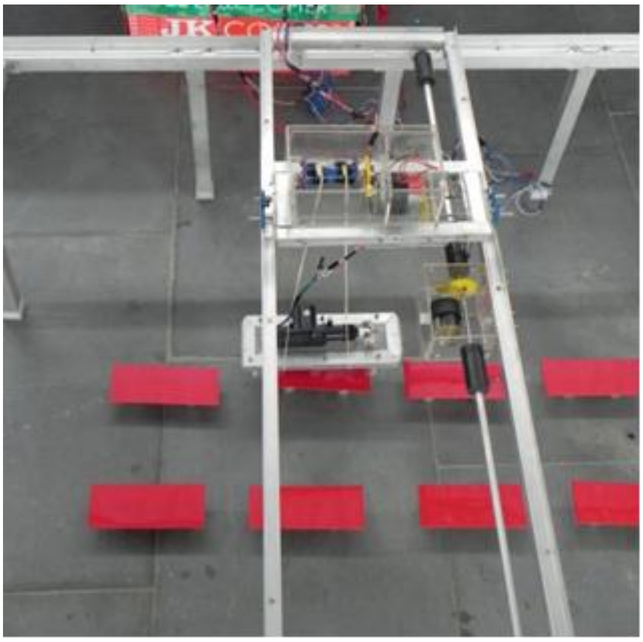

Fig -9: Complete Integration

A. *Unique features of this Project:*

- Complete automation of material handling.
- Single operator controls multiple units.
- Distance between workstation to control station does not matter.

B. *Output:*

- Complete auto-handled system.

C. *Abbreviations and Acronyms*

- Manual labour is replaced by the machine there by reducing the regular labour cost as well as output rate is improved.
- The lead time for manufacture i.e., the time between the order acceptance and delivery is least, with automation.
- Safety of both labour and product is achieved.
- Reduces the inventory and WIP ratio.
- Increases the velocity of the job, since non-value added activities in the process are reduced.
- Material handling time can be reduced up to 55%-60% and hence handling cost reduced to 25%-30%.

V. APPLICATIONS

- Railway yard.
- Mining places where the poisonous gases and men cannot enter.
- Nuclear power plant to check the position of the moderators, electrodes & fuel rods.
- Loading and unloading from ships.
- Marine industries.
- Good container management.
- Material handling in Heavy & small scale industries.

VI. CONCLUSION

This work is a trial miniature prototype, if it designed to full scale reality and implemented to the railway yard container handling, then we can see a great change in container handling with respect to both time and accuracy.

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