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DESIGN AND SIMULATION OF ROBOT BASED MATERIAL HANDLING SYSTEM IN INDUSTRY – A REVIEW

Varit Gupta[1], Vidyottam Semwal[2], Shubham Tyagi[3], Vipul Agarwal[4], Shubham Gupta[5], Varun Punjani[6]
[1-6]Department of Mechanical Engineering, College of Engineering Roorkee, Roorkee
Email id: [1]varitgupta@gmail.com, [2]vidyottamsemwal@gmail.com

Abstract **- The benefits of robot simulation technology have been recognized by engineers, with applications ranging from simple robot path simulation to complete robotic cell layout simulation. Robot simulation is one of the essential elements of modern and agile manufacturing plants, as it allows visualizing and testing a robotic system, even if it does not exist physically. High-growth industries and emerging manufacturing process will increasingly depend on advanced robot technology such as robotic simulation. Robot path simulation is a very useful process to predict and pre-evaluate performance of robot programs generated off-line. The main aim of project is to present a robotic system simulation which is designed to perform the task of robot motion/path simulation for a material handling process, more specifically the movement of objects from one location to another which are defined as loading and unloading stations. This material handling system or cell consists of an articulated standard available robot of ABB, loading and unloading stations, input and output conveyers, sensors, Barcode reader, Safety fences with gates etc. In This project we are using ABB simulation software for creating and designing of cell. Other accessories like gripper, conveyors and fabricated items will be created in cad software like CATIA, Solid works, Cero etc**.

KEYWORDS: Robot, Design and Simulation, Gripper, material handling.

I. INTRODUCTION

In recent years, there has been a tremendous growth of material handling technology and equipment types; robots, automated guided vehicles (AGV), high-rise storage retrieval systems, computerized picking, systems and computer controlled conveyor systems. Material handling systems have been accepted as an integral part of today's manufacturing systems and are increasingly playing an important part in the productivity of the plant. Closely correlated to the development of this material handling equipment, we see a corresponding increase in deployment of integrated material handling environments with sophisticated planning and operational rules to achieve Just-In-Time and Agile/Lean manufacturing systems. Material handling projects are often costly ventures with many potential risks. There are many complex designs, operational and scheduling, issues that need to be addressed for successful implementation. Simulation technology can be used as a test-bed to better understand the system before its implementation. This understanding helps engineers design the best possible, lowest cost automation solution for their manufacturing, system. Simulation can be used as an affective analysis tool in the conceptual, detailed design, launching, and full operation phases of a project to avoid costly mistakes.

One can classify the application of simulation according to the four phases of a material handling project. The conceptual phase refers to the initial phase where alternate material handling systems and concepts are tested by the engineers. Simulation packages with 3D animation capabilities are the popular simulation tools at this phase. Simulation studies done at this stage are generally used to test operational policies(e.g., test different lane selection rules, dispatching rules, vary the number of carriers and of the carriers) and integration of material handling with other system such as other material handling systems and operators. The simulators with user-friendly features are the Most Popular packages used at this phase is ABB Robot Studio. The fully operational phase refers to the phase where the plant is operating under full capacity conditions. The simulation studies done at this phase consider the impact of factors such as product mix decisions, new product introduction, new operational policies, and line modifications on the throughput of the existing material handling system.

II. SIGNIFICANCE OF MATERIAL HANDLING SYSTEM IN INDUSTRY

Material handling is an essential and significant component of any productive activity. It is something that goes on in every plant all the time. It is simply picking up, moving, and lying down of materials through manufacture. It applies to the movement of raw materials, parts in process, finished goods, packing materials, and disposal of scraps. 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 recent period of competition, this has acquired greater magnitude due to growing need for reducing the manufacturing cost. The significance of material handling function is greater in those industries where the ratio of handling cost to the processing cost is large. Today material handling is rightly considered as one of the most potentially lucrative areas for reduction of costs.

III. FACTORS AND CONSIDERATIONS FOR DESIGN OF MHS

It is usually difficult to identify and quantify the benefits associated with MH; it is much easier to identify and quantify the costs of MH (e.g., the cost of MH equipment, the cost of indirect MH labor, etc.). MHS cost as the sole criterion to select a MHS design depends on the degree to which the other aspects of the production process are able to be changed. If a completely new facility and production process is being designed, then the total cost of production is the most appropriate criterion to use in selecting a MHS—the lowest cost MHS may not result in the lowest total cost of production. In actual practice, it is difficult to consider all of the components of total production cost simultaneously. If it is too costly to even consider changing the basic layout of a facility and the production process, then MHS cost is the only criterion that need be considered.

As per our project the movement of material that is washing machine from the place where it is to the place where it is needed can be time consuming, expensive, and troublesome. The material can be damaged or lost in transit. It is important, therefore, that it be done smoothly, directly, with the proper equipment and so that it is under control at all times. The several factors that must be known when a material handling system is designed include:

1. Form of material at point of origin, e.g., LG washing machine.
2. Flow demands, e.g., amount needed, continuous or intermittent, timing, etc.
3. Handling equipment available, e.g., devices, prices, reliability, maintenance needs, etc.

Other factors to be considered include:

1. Labor skills available
2. Degree of mechanization desired
3. Capital available
4. Return on investment
5. Expected life of installation

Type of conveyor	Dimensions (cm) (L*B*H)	Roller dimensions(cm)
Input roller conveyor	390*130*100	Outer diameter- 6 inner diameter - 4
Output roller conveyor	390*130*100	Outer diameter- 6 inner diameter - 4
Bypass roller conveyor	750*130*100	Outer diameter- 6 inner diameter - 4

Since material handling adds expense so it should be reduced as much as possible with respect to time, distance, frequency, and overall cost. A straight steady flow of material is usually most efficient. The use of mechanical equipment rather than humans is usually, but not always, desirable—depending upon the duration of the job, frequency of trips, load factors, and characteristics of the material. Cellular manufacturing is a process of manufacturing which is a subsection of just-in-time manufacturing and lean manufacturing encompassing group technology. The goal of cellular manufacturing is to move as quickly as possible, make a wide variety of similar products, while making as little waste as possible. So cellular manufacturing can lead to proper follow up above mentioned factors.

III. Elements of material handling system

- Conveyors
- Grippers
- Robot(IRB6640-235kg, 2.55m)
- **Conveyors**

A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries. There are a variety of options available for running conveying systems, mechanical and fully automated systems, which are equipped to fit individual needs. Convey or systems are commonly used in many industries, including the automotive, agricultural, computer, electronic, food processing, aerospace, pharmaceutical, chemical, bottling and canning, print finishing and packaging.

The type of conveyor used in our project is a live roller conveyor system and the data for that is given bellow in the table.

Design of all the conveyor is marked safe in accordance to our research paper used as for design by the condition that four roller together with outer diameter 60mm and thickness 5mm can take load up to 3500N and as per our design we have outer diameter 60mm and thickness 20mm with more number of rollers and mild steel being used as one of the materials in research paper with a total load of 3400N.

2. GRIPPERS

A gripper is the mechanical interface between the robot and its environment. Without it, the robot cannot perform the pick-and-place functions .In industrial applications it is common to handle objects with different geometries and weights. Varieties of robotic grippers are developed highly flexible and multi functioned.

The design guidelines may be as follows

1) Gripper weight should be minimized. This favors the robot to accelerate more quickly
2) Grasping of objects should be secure: This allows the robot to run at higher speeds in zig-zag profile thereby reducing the cycle time.
3) Grip multiple objects with a single gripper. It helps to avoid tool changes hereby reduce idle time.
4) Completely encompass the object with the gripper: This is to help hold the component securely.

IV. OPTIMALITY CRITERIA-

In general, an optimum design procedure can be considered by means the followingsteps:

1) Identification of design constraints and performance characteristics for a given application
2) Formulation of basic performances;
3) Analysis of optimality criteria through numerical algorithms;
4) Formulation of a single and/or multi-objective optimization problem for design purposes;
5) Numerical solution of the multi-objective optimization and interpretation of results;
6) Determination of a design solution through a suitable model.
7) Mechanical design of all the components and details.

Software used:

- CATIA- For designing
- ANSYS- For analysis
- ROBOSTUDIO- For simulation

Parts designed in CATIA:

a) Input roller conveyor
b) Output roller conveyor
c) Bypass conveyor
d) Gripper

3. ROBO STUDIO:

Robot Studio is a PC application for modeling, offline programming, and simulation of robot cells.

III. Objectives and Scope of Paper.

Main objective of this paper is to develop a prototype of industrial conveyor belt for detecting fault and saving energy and time. Being cost effective and flexible this prototype could be used to detect fault automatically by using various sensors with indication.

Literature Review

- J. S. Noble and C. M. Klein, A. Mid ha have examined several aspects of the integrated material flow system design problem. ; However, as problem complexity has increased the ability to obtain solutions to the more integrated problem formulations has become more difficult. They present a model which integrates material handling equipment selection and specification (including interface equipment between different types of equipment), and path/load dependent unit load size and variable unit load size. The formulation is solved using the meta-heuristic procedure of tabu search to find a "good" solution to a more integrated formulation.

- Ramazan YAMAN develops a knowledge-based system for material handling equipment selection and pre-design of thisequipment in the facility layout is discussed. The study comprises two sections. In first section author explained the selection of material handling equipment for related product requirements and in second section decision making for equipment between departments. However, it is defined more comprehensively as using the right method to provide the right amount of material, at the right place, at the right time, in the right sequence, in the right position, in the right condition, and at the right cost (White and Apple, 1985). Author compared

the selection of equipment and design of MHS by means of traditional selection and using analytical method with knowledge based approaches. In traditional selection, the designer relies principally on handbooks and experience and also may not be cost-effective because of the limitation of personnel experience

- J. D. Tew, S. Manivannan, D. A. Sadowski, and A. F. Seila were illustrate the simulation methodologies used in the design of Automated Material Handling Systems (AMHS) at Intel wafer fabs for semiconductor manufacturing. The models used in AMHS design has categorized as AMHS models and production models. The AMHS models support the design of Interbay and Intrabay systems. This de-coupling approach typifies the general philosophy to using simulation in design. Authors review the general model structures and simulation examples under these categories used in actual system implementations. In this paper the main purpose of using simulation is to ensure that the material handling system design meets material storage and transport requirements.

CONCLUSION

From the above study it is observed that the material handling is important activity in manufacturing industry. The selection of the most appropriate MH equipment for any particular application can be influence the profit of any manufacturing company. The literature review has shown that researchers have consider the design problems in material flow system and overcome with adequate knowledge base approach, properly design, 3d modeling ,analyzing and using simulation model to validate the system performance for acquiring the MH equipment selection. Thus it concludes that MH system plays a major role in productivity. Distribution, manufacturing, and warehousing and helps to give the best optimization to increase the productivity, reduced cost and idle time, proper utilization of labor, product quality and safety.

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