SIMULATION OF ROBOTIC ARM BY USING NI-LABVIEW FOR THE INDUSTRIAL APPLICATION OF BIN PICKING

N.P.PATIL[1], RAHUL SHELAR[2], PARVEZ SAYYAD[3], PRANAV WATILE[4], ANKUSH PATIL[5], LAXMIKANT JATHAR[6]

[1,6]*Assistant professor in Mechanical Engineering Department, Imperial College of Engineering & Research, Pune, India*

[2-5]*UG Students, Mechanical Engineering Department, Imperial College of Engineering & Research, Pune, India*

Abstract - *Bin Picking is a very popular topic in the scope of robotic applications. It usually involves components that require effective sorting. For many years, R&D facilities as well as the industries work on Bin Picking solutions. However, it is challenging to bring such systems into industrial shop floors mainly due to the design and economical calculability accompanied by the acceptance of stable Bin Picking systems without any downtime. This article presents a versatile interface-based framework for the designing and in particular for the simulation of various Bin Picking applications. For that, the term 'Virtual Bin Picking' has been introduced, which associates the simulation of Bin Picking scenarios in a virtual environment without the need for hardware components. Thus, it enables the design of Bin Picking work cells and it allows predicting the quality of such cells in an early virtual commissioning stage.*

Key Words: **Bin Picking, Robotics, Simulation, Material Handling.**

1. INTRODUCTION

Robotic bin picking is incredibly important as it is able to take the tedious, monotonous tasks off of workers hands [1]. It is able to effectively handle bulk parts sorting, dangerous operations, and/or labor-intensive order fulfillment. Because of its complexity, random bin picking has yet to be perfected or completely grasped by automation systems. However, visionaries are pioneering their way into that uncharted territory. Many experts predict that robotic random bin picking will become mainstream by 2023 as there are a variety of subsets of bin picking are already commonplace.

In general, bin picking can be divided into three different categories [2]. Each contains a special amount of considerations based on the part position that results in is a different level of complexity, cost, and time. As one may guess, the characteristics of parts often determine how easily they will be picked from a bin. The parts that have the greatest success in Bin Picking are geometrically symmetric parts. These parts don't have strange features, are not too heavy, and have some sort of sufficient planar surface in all of their random orientations. These few geometric surfaces are very easy to pick up with a robot and very easy to grip.

1.1 Robotic arm and Vision based Checking and Sorting system

Recently, Innovative machine vision technologies have helped increase productivity and efficiency in many different industries, while allowing human workers to perform more meaningful work elsewhere within a company [3]. In manufacturing and e-commerce settings, to deploy robotic bin picking solutions to automate material handling tasks such as pick, hold and release object, also the movement of robot respective of taught positions [4]. Doing so presents challenges but also adds tremendous value when successfully implemented. This article looks at the some of the latest advancements in bin picking, object checking and sorting.

2. PROBLEM STATEMENT

This project was motivated by a problem that Royal Enfield Auto has faced in one of its factories. They are facing some issues while using wrongly dimension parts with vehicle. Hence, they want system such that it will sort vehicle parts according to its Height, width, color, Barcode (Unique Identity) also system should work independently without human intervention.

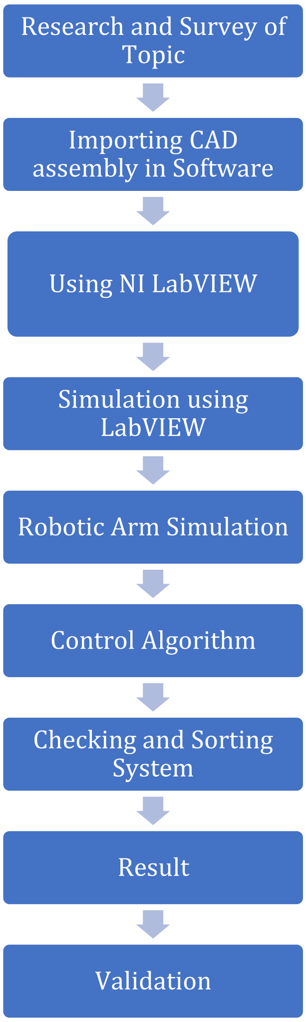
Solving this task required collaborative effort from several industrialist in order to create a functional bin picking system with automation of sorting materials according to its Height, Width, Color, Barcode, which required building and connecting various hardware and software components. Our commitment to this project was simulating the 'brain' of this system, which is the simulation of visual recognition system, and simulating the behavior of the robotic arm. In this project, the developed components are described, implemented and tested.

2.1 OBJECTIVES

Performance: To increase the pick and package global performance in terms of flexibility, dependability and error reduction.

Working Condition: Improvement of the working conditions of operators by a proper layout design and task allocation between worker and robot.

3. METHODOLOGY



3.1 SIMULATION USING NI LabVIEW

Laboratory Virtual Instrument Engineering Workbench (LabVIEW) is a system- design platform and development environment for a visual programming language from National Instruments.

The graphical language is named "G"; not to be confused with G-code. The G dataflow language was originally developed by LabVIEW, which is commonly used for data acquisition, instrument control, and industrial automation on a variety of operating systems (OSs), including Microsoft Windows as well as various versionsof Unix, Linux, and macOS.

3.2 LabVIEW KEY CONCEPTS

- **LabVIEW environment:** The LabVIEW environment consists of LabVIEW VI manager (project explorer), the programming tools, debugging features, templates and ready built sample examples, and an easy interface to the hardware drivers. Read more about LabVIEW environment.

- **LabVIEW VIs:** The LabVIEW VI is a "Virtual Instrument" that enables a user interface to be built and it contains the programming code. Read more about LabVIEW Virtual Instruments, Vis.

- **LabVIEW G programming:** This is the graphical programming language where the functional algorithms are built using "drag and drop" techniques. Read more about LabVIEW programming.

- **LabVIEW dataflow:** This is the core concept that determines the runningorder for the program

This system has certain advantages and disadvantages which are listed below:

Graphical interface is flexible and simple to use. Most engineers and scientistscan learn to use it quickly.

LabVIEW provides a universal platform for numerous applications in diversefields.

LabVIEW is single sourced and some companies may not like to use a productthat is single sourced and not standardized by the industry.

Cost of ownership – although in line with many other industry products of a similar nature, its cost should be considered before it is introduced.

4. WORKING PRINCIPLE OF LABVIEW:

LabVIEW is a graphical programming environment. Each LabVIEW program is called a VI, or Virtual Instrument. The programming language is called "G". The G language is similar to BASIC and C, in that it is intended for a wide variety of programming tasksand so it is considered general purpose.

4.1 LabVIEW Front Panel

The front panel is the graphical user interface (GUI), comparable to an HMI. It is the front end of the program. Here, various controls and indicators can be added depending on the application. The icons and graphical representations emulate those of the physical instrument counterparts as much as possible.

4.2 LabVIEW Block Diagram

The block diagram is, to put it simply, the source code of the VI. All the elements added in the front panel are included in the block diagram as terminals. Each terminal has the possibility to be connected (wired) to other terminals in the VI using nodes to form the program

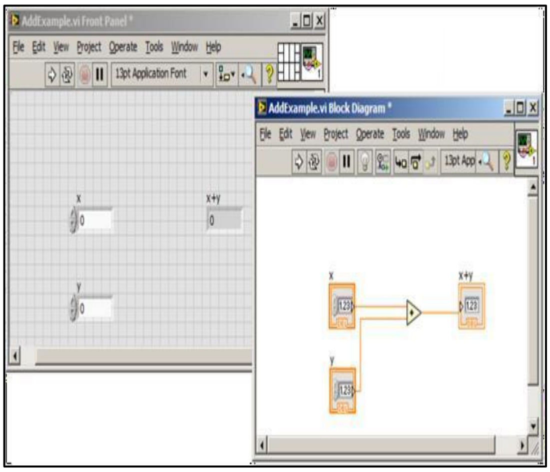


Fig -1: LabVIEW Front panel and Block Diagram

4.3 Checking and sorting system simulation

In Fig-2, Number of jobs are stacked at left side with different colors and barcodes. Robotic arm is used to pick different jobs and inspect its dimensions under vision camera. After inspection it decides whether the job is accepted or rejected on the basis of required dimensions and places it accordingly as Fig-3, shows the saved path result in form of excel sheet. Parameter selection also available in Set Sort Parameters such that user can select any parameter and work pieces will be sorted according to selected parameters.

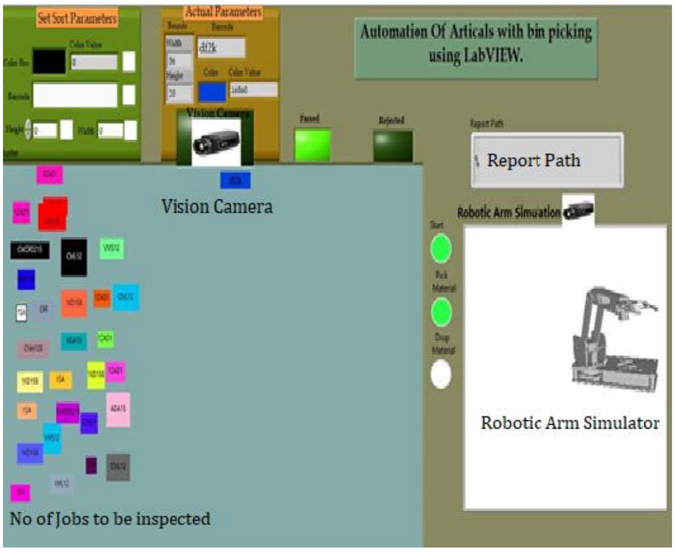
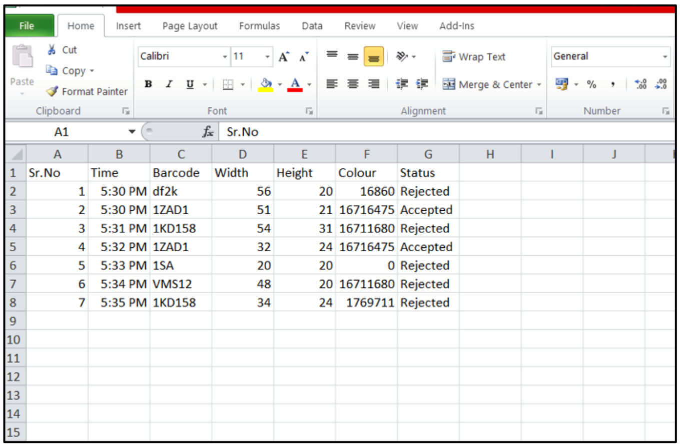


Fig -2: Checking and sorting system simulation



Sr.No	Time	Barcode	Width	Height	Colour	Status
1	5:30 PM	df2k	56	20	16860	Rejected
2	5:30 PM	1ZAD1	51	21	16716475	Accepted
3	5:31 PM	1KD158	54	31	16711680	Rejected
4	5:32 PM	1ZAD1	32	24	16716475	Accepted
5	5:33 PM	1SA	20	20	0	Rejected
6	5:34 PM	VMS12	48	20	16711680	Rejected
7	5:35 PM	1KD158	34	24	1769711	Rejected

Fig-3: Saved path Results (in excel)

5. CONTROL ALGORITHM

In this section, a control algorithm for Automation of article is explained. The main objective of bin picking is to recognize and acquire a part and sort it. In this framework, this procedure is done in multiple iterations, during which the part pose is determined more precisely.

There are two main processes which run parallel.

1. Robotic arm movement
2. Checking and sorting of work-piece

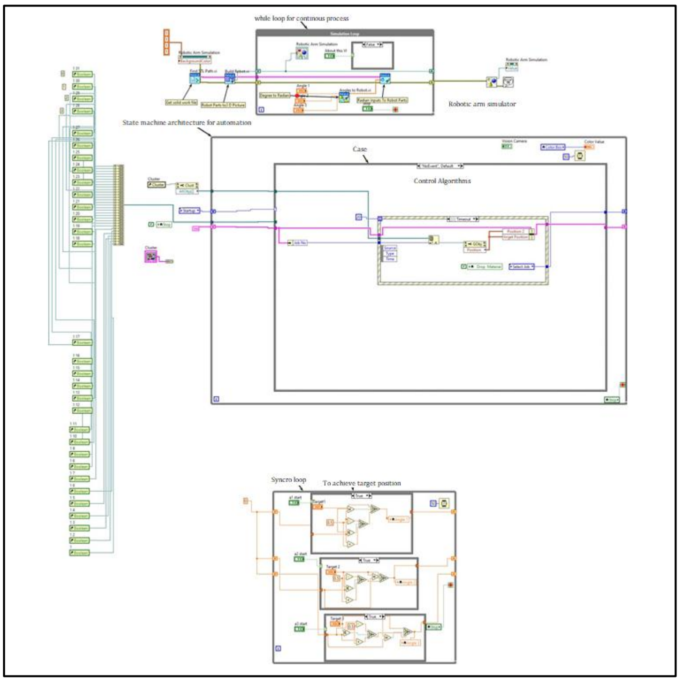


Fig-4: Control Algorithm

- In Block diagram whole control algorithm is written.
- State machine is used as Control Algorithm.
- While loop used is to run process continuously
- Case Structure is used to operate specific logic from program
- E num is used to operate cases
- Local variables are used to transfer data between two loops.
- Sub VIs are created to reduce complex logic into simple one

Checking and sorting of work piece control algorithm is made by combining various cases.

1. Startup
2. No Event (Default)
3. Select job
4. Check Job
5. Sort job
6. Report generation
7. Exit

6. RESULTS AND DISCUSSION

As shown in Fig-5, work pieces will be sorted in two areas. work piece which matches selected sort parameters it gets passed of any parameter does not matches it will be rejected. It shows Excel sheet where result is stored. Result consists of Job number, Date and Time of checking, Value of color, Height, Width, Barcode. By referring this sheet operator can easily understand parameters whenever required.

From Fig-6, we can understand that robots are more efficient than humans. Robots have better specialty, accuracy, exposure, and performance. Robots have heavy load lifting capacity and is more reliable than humans. Table-1, shows the data comparison between Human and Robot.

Fig-5: Results of sorted articles

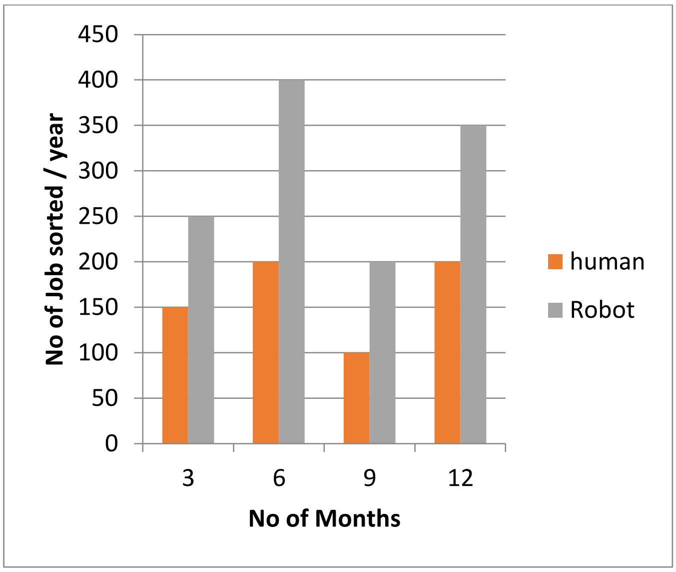


Fig-6: Efficiency of Robot to Human

Table-1: Comparison between Human and Robot

Parameter	Human	Robot
Adaptivity	Medium as compared to robots	High as compared to humans on selective designs
Specialty	Generic (depending on training)	Specialized for certain parts and industry
Accuracy	Might be work error as compared to robots	High accuracy and more efficient
Exposure	Workers might get affected to radiation and moving parts	Unsusceptible to environmental hazards and radiation
Performance	The efficiency of some parts may be more than robot but in long term the robot is more efficient	The efficiency of the robot is more as compared to humans and can literally work 24hrs compared

7. CONCLUSIONS

This article represents simulation study of industrial bin picking application. The developed framework includes simulation models for estimation of position and orientation and for occlusion detection

The part that has been used for testing the system was a geometrical square work piece. However, the proposed system does not require hard-coded knowledge of the part, and uses trained models to determine key attributes of the object, and the application of the proposed system is not limited to the tested part. These models are based on automation and their implementation and testing procedure were described.

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