JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

AUTOMATED INSPECTION OF CIRCULAR AND NON-CIRCULAR OBJECTS USING VISION ASSISTED ROBOT ARM USING LabVIEW AND RASPBERRY PI

[1]Vanja Aniket, [2] Dr.Y.Ashok Reddy
[1]UG Student, [2]Professor,
[12]Department of Mechanical Engineering,
[12]N.BKR Institution of Science and Technology, Vidyanagar, India.

Abstract: In today's manufacturing world quality has the topmost priority. Automated inspection control has become very popular, which reduces human errors and maximizes the quality of the product. Using a Vision system with a robotic arm is beneficial in many industrial applications, especially in automated object picking and placing tasks. In this project, we are using OpenCV (Open Source Computer Vision Library) it is an open-source computer vision and machine learning software library. The library has more than 2500 optimized algorithms, which includes a comprehension set of both classical and state-of-art computer vision and machine learning algorithms. These algorithms can be used to identify objects, track camera movements and track moving objects, etc., the manipulator's control software was developed using Raspberry pi and the real-time monitoring of the whole system is carried out by using LabVIEW. The LabVIEW and Raspberry pi interfacing is done through MQTT (Message Queue Telemetry Protocol). In addition to that, a vision system was developed and integrated with the manipulator system whereas the camera is used to acquire images, then it transmits them wirelessly to Raspberry pi's vision assistant codes for processing and calibration. The developed vision system allowed the detection of an object within the manipulator's work space. Finally, the automated inspection system was developed for automated Sorting operation of circular and Non-circular objects, the working module is observed and discussed in this paper.

Index Terms **- LabVIEW, OpenCV, Raspberry pi, MQTT, Inspection System**

I. INTRODUCTION

A robotic arm is a manipulator that is built with various degrees of freedom depending on the autonomous application in which it is used. Several types of industrial automation are being used in today's world. Automobile manufacturing companies utilize robotic arms for painting and engine assembly, such as arc welding. In order for a robotic arm to function as a human in an industrial setting, it must have a unique blend of embedded system architecture and mechanical design. Among these, the actuators used in robotic arm designs are more carefully selected. All motors, in general, are considered actuators; however, servo motors are frequently utilized in the building of robotic arms. The robotic arm represents the pinnacle of human efficiency. The number of motors used depends on the application; for example, the system in this proposed work is designed for a pick-and-place application. As a result, high torque motors are installed in the robotic arms, allowing them to pick up and transfer things to new locations. Servomotors are used to build three key elements of the robotic arm: the gripper, wrist, and base. The workings of servomotors and the robotic arm are described. The mechatronic design is fully capable of doing the task on the field, but it must be monitored on a regular basis to avoid problems. The robotic arm is built around a microcontroller (Raspberry Pi), which allows it to communicate with a computer. The microcontrollers connected to the PC operate in a dynamic, bidirectional manner, receiving input from the PC and sending control signals to the servomotors that drive the robotic arm. The user may operate the robotic arm from the PC in an emergency. This has been the case in prior autonomous systems; the suggested method uses a vision sensor and a USB camera to aid the robotic arm in the absence of a person, making the entire system a completely automated closed loop system. The image of the object to be chosen and moved to a new location is captured by the USB camera. Image processing algorithms run on the PC with the NI-LabVIEW Machine Vision tools and function modules further process the recorded image. LabVIEW Machine Vision toolsets offer advanced features for implementing Digital Image Processing algorithms on a computer. Different digital image processing techniques for measuring the exact dimensions of the item are described in this study.

II. WHY IS LABVIEW BETTER?

1. LabVIEW is a powerful, platform-independent, graphical programming development system which is ideally suited for data acquisition, storage, analysis, and presentation.
2. LabVIEW is a programming environment which fulfils industry standards and is widely used for measurement and automation.
3. LabVIEW helped us blend our existing educational hardware inventory with virtual instrumentation in an economical way and with reasonable funds.

III. INSPECTION:

An inspection is a formal examination or examination that is conducted in a systematic manner. Inspection is the process of applying measurements, tests, and gauges to certain qualities of an object or activity in engineering operations. The findings are generally compared to defined requirements and standards to see if the item or activity meets these objectives, and a Standard Inspection Procedure is often used to guarantee consistency. Non-destructive inspections are common.

An inspection is a formal or methodical examination. In engineering operations, inspection is the process of applying measurements, tests, and gauges to particular aspects of an object or activity. To check if the item or activity achieves these objectives, the findings are typically compared to established criteria and standards, and a Standard Inspection Procedure is frequently employed to ensure consistency. Non-destructive testing (NDT) is a popular practice.

3) Types of Inspection:

3.1) Inspection for variables: - In which, appropriate measuring instruments or sensors are used to measure one or more quality characteristics.

3.2) Inspection for attributes: - Where the parts or products are inspected to conform to the inspected quality standard. The determination is sometimes based simply on the judgment of inspector. Attribute inspection involves counting the number of defects in a product.

IV. HARDWARE DESCRIPTION:

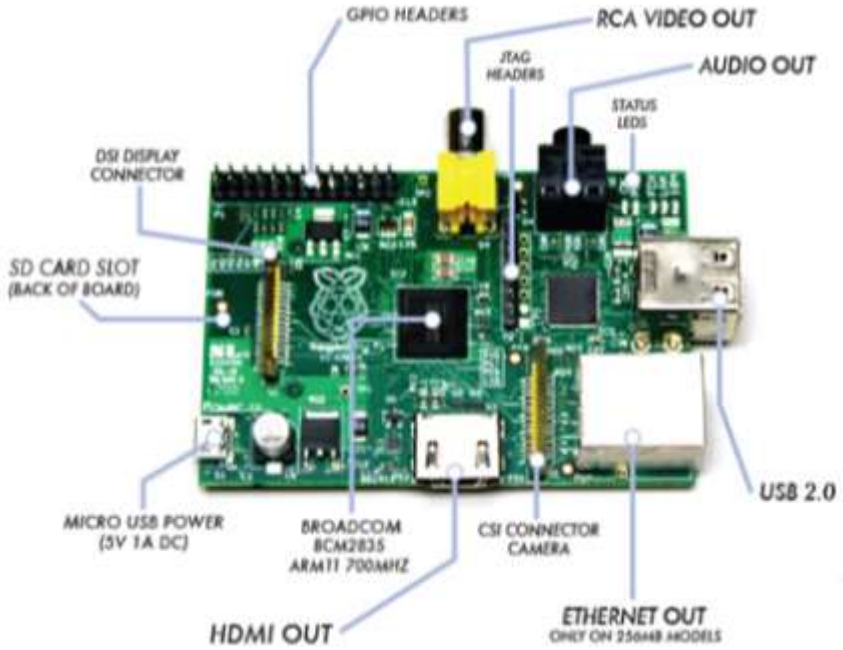

Fig: Raspberry pi

The raspberry pi board comprises a program memory (RAM), processor and graphics chip, CPU, GPU, Ethernet port, GPIO pins, Xbee socket, UART, power source connector. And various interfaces for other external devices. It also requires mass storage, for that we use an SD flash memory card. So that raspberry pi board will boot from this SD card similarly as a PC boots up into windows from its hard disk.

Essential hardware specifications of raspberry pi board mainly include SD card containing Linux OS, US keyboard, monitor, power supply and video cable. Optional hardware specifications include USB mouse, powered USB hub, case, internet connection, the Model A or B: USB Wi-Fi adaptor is used and internet connection to Model B is LAN cable.

4.1 Model A Raspberry Pi Board

The Raspberry Pi board is a Broadcom (BCM2835) SOC (system on chip) board. It comes equipped with an ARM1176JZF-S core CPU, 256 MB of SDRAM and 700 MHz, The raspberry pi USB 2.0 ports use only external data connectivity options. The board draws its power from a micro USB adapter, with min range of 2. Watts (500 MA). The graphics, specialized chip is designed to speed up the operation of image calculations.

4.2 Model B Raspberry Pi Board

The Raspberry Pi is a Broadcom BCM2835 SOC (system on chip board). It comes equipped with a 700 MHz, 512 MB of SDRAM and ARM1176JZF-S core CPU. The USB 2.0 port of the raspberry pi boars uses only external data connectivity options. The Ethernet in the raspberry pi is the main gateway to interconnect with other devices and the internet in model B. This draws its

power from a micro USB adapter, with a minimum range of 2.5watts (500 MA). The graphics, specialized chip is designed to speed up the manipulation of image calculations.

V. Software Description:

5.1) Machine Vision:

When it comes to industry and research, one of the most commonly utilized technologies is machine vision. NI Vision supports low-cost USB cameras as well as wireless webcams, which can be purchased separately. Ni provides programmers three separate software packages, which feature world-class image processing algorithms as well as tools for acquiring images.
As part of LabVIEW's Vision Development Module, you'll find all of the sub-VIs and functions you'll need to capture pictures from a camera and analyses them. It is a standalone programme with a configuration-based interface.

5.2) Algorithms Used:

5.2.1) OpenCV:

Software library for computer vision and machine learning, OpenCV (Open Source Computer Vision Library) is available as a free download from the Internet. In order to offer a standard infrastructure for computer vision applications and to expedite the usage of machine perception in commercial goods, the OpenCV project was developed. BSD licensing makes it simple for companies to use and change OpenCV's source code. There are about 2500 optimized algorithms in the library, which contains both traditional and cutting-edge computer vision and machine learning algorithms, as well as a complete range of machine learning and computer vision algorithms, There are algorithms that can be used to detect and recognize faces and objects, classify human actions in videos and extract 3D models from stereo cameras, stitch images together to create a high-resolution image of an entire scene, find similar images from an image database, and remove red eyes from images taken with flash cameras, just to name a few of the applications.

5.2.2) MQTT:

In short, MQTT is an acronym for MQ Telemetry Transport (MQTT). For devices with limited bandwidth and latency or unstable networks, it's a publish/subscribe messaging protocol that's simple and lightweight. According to design principles, network bandwidth and device resources should be kept as low as possible, while striving to provide dependability and some degree of delivery assurance.

The first step in starting a MQTT session is to set up certain connection settings with a broker. There is a fixed header in every control packet that tells the server how to handle the client's request, and a variable header that identifies the type of action authorised by the protocol.

MQTT session connection scenarios follow a simple request/response structure consisting of two packets of data. An established client can then send PUBLISH requests, SUBSCRIBE requests, or any other control packets to the server after the connection has been established.

5.2.3) NUM PY:

Scientific computing using Python relies on NumPy, which is a key module. In addition to a powerful N-dimensional array object, it has complex (broadcasting) functions, tools for integrating C/C++ and Fortran code, and linear algebra, Fourier transform, and random number algorithms. NumPy may be used as a multi-dimensional container for general data in addition to its apparent scientific applications. Data types can be defined in any way. This enables NumPy to effortlessly and quickly connect with a broad range of databases, including MySQL, Oracle, and SQL Server. Licensed under the BSD licence, NumPy allows for re-use of its code without many limitations. To install NumPy, we strongly recommend using a scientific Python distribution. See Installing the SciPy Stack for details. Tutorial.

VI. Specifications of Components:

S. No.	Name of the Component	Quantity	Characteristics
1)	Raspberry Pi Model – B	1	256 MB Memory
2)	PI Camera Board Module	1	5 MP
3)	Power Supply (SMPS)	1	12V, 5 Amps
4)	IR Sensors	2	Range 10-15 cm
5)	DC Gear Motor (Conveyor)	1	12V, 10 rpm
6)	DC Gear Motor (Robot Base)	1	12V,30 rpm
7)	DC Motor (Robot Arm and Gripper)	2	12V,60 rpm
8)	L293D DC Motor Driver	2	16 pin, each can control 2 motors
9)	ADXL345	1	3-Axis Accelerometer
10)	Conveyor	1	45 cm

VII. Experimental Setup and Working:

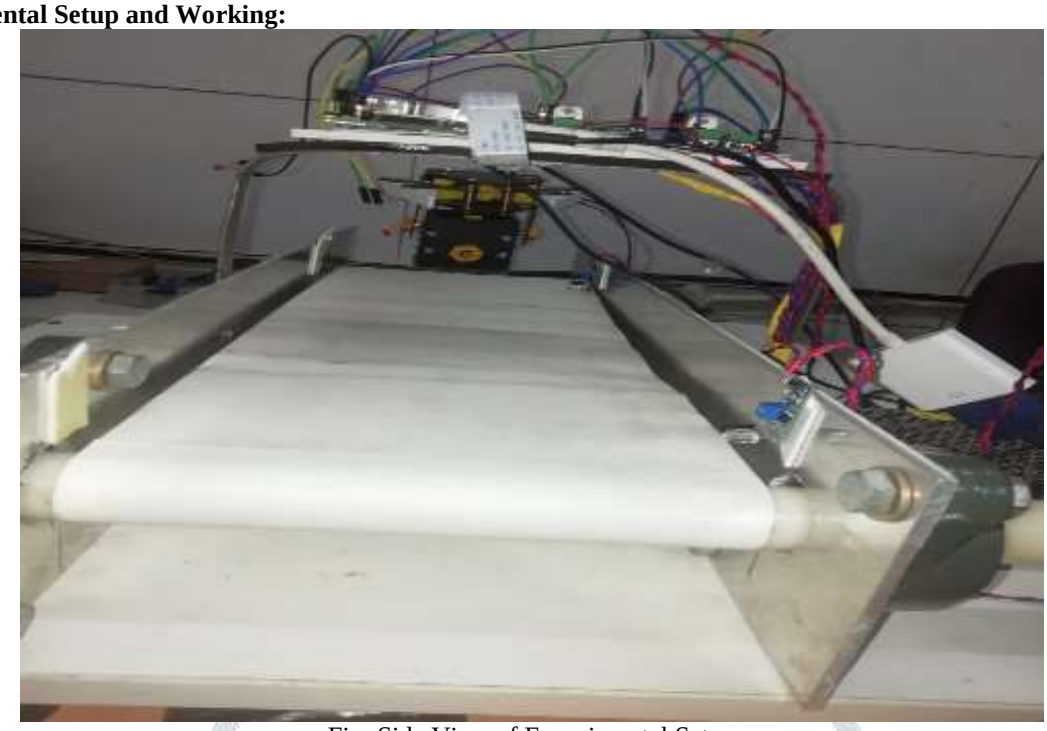

Fig: Side View of Experimental Setup

The components specifications are as shown above. The Working of this Automated Inspection system is as shown below:

The power supply is given to the SMPS, Raspberry Pi Board and Desktop as well. For Initial programming USB Mouse, keyboard and LAN cable is connected to the Raspberry Pi board. After Running the Program. The object is placed in the starting position at IR sensor1, now the conveyor motor starts running. Assume it as a CIRCULAR object, the object travels in the conveyor. The Pi camera detects the Circular cross section and sends the signal to the robot arm. After the object reaches the IR sensor2, now the conveyor motor stops and robot arm starts working, the robot arm at the end of conveyor picks the object and place it in Left side tray. In the similar manner, if we place the Non-circular object in the conveyor. The Pi camera detects it as Non-circular and sends the signal to the robot arm. Now the robot arm picks the object and place it in Right side tray.

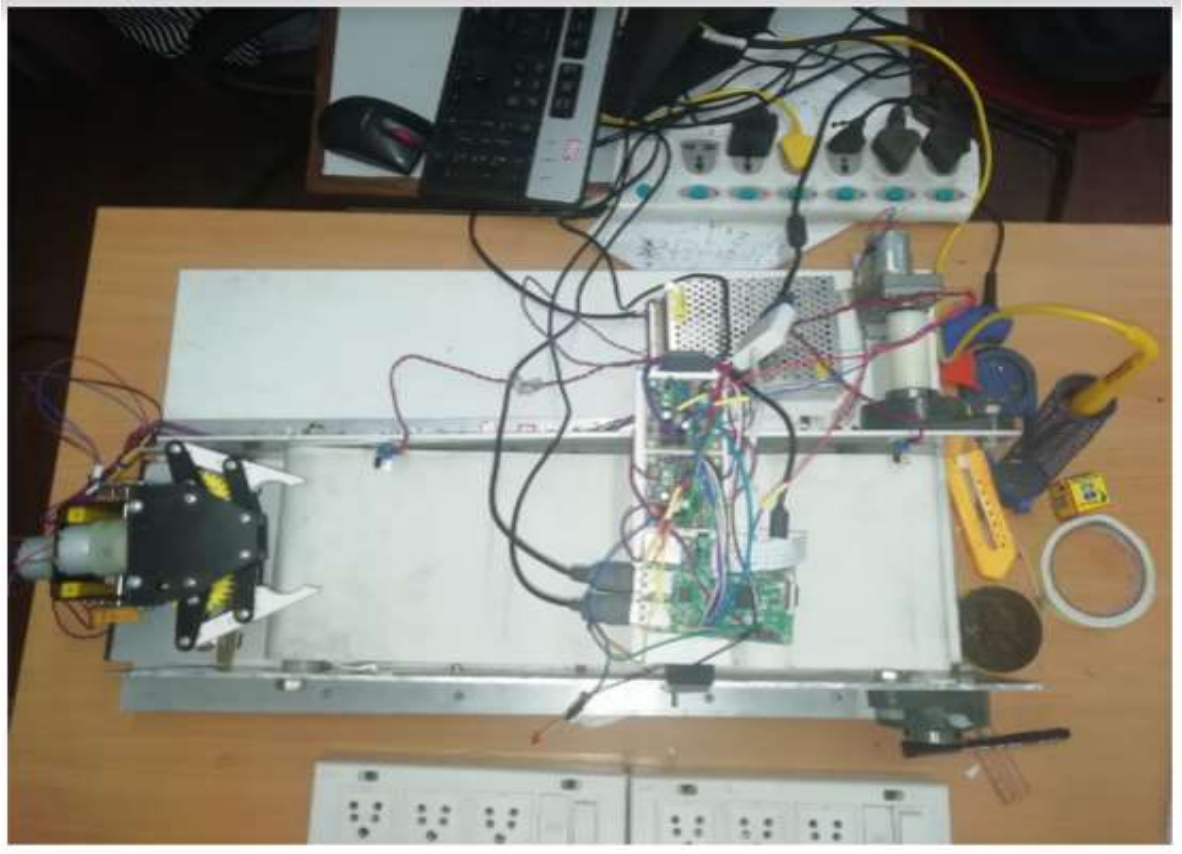

Fig: Top View of Experimental Setup

VIII. LabVIEW Coding:

LabVIEW Front panel and Block diagram were designed as shown below:-

8.1) Front Panel:

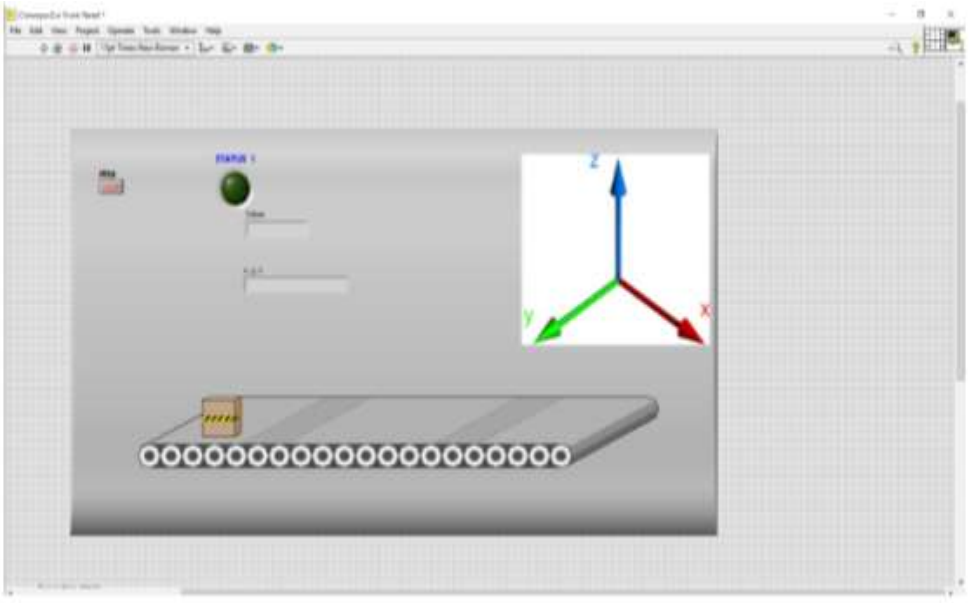

Fig: Experimental LabVIEW Front Panel

Front panel is created, with controls and indicators which are the interactive input and output terminals of the VI respectively. Controls are knobs, push buttons, dials and other input devices. Indicators are graphs, LEDs, and other displays. Controls simulate instrument input devices and supply data to the block diagram of the VI. Indicators simulate Instrument output devices and display data the block diagram acquires or generates.

In the Front panel we can observe, the following:-

- Object movement on the conveyor.
- Status of the Automated Inspection System.
- Robot Arm Movements (in all X, Y, Z co-ordinates).
- Value of the Present System.
- Stop button.

Front panel and Raspberry Pi is connected through MQTT protocol.

Fig: Connection Details

Server address - broker.hivemq.com
Server port - 1883
Keep Alive Time – 60

8.2) Block Diagram:

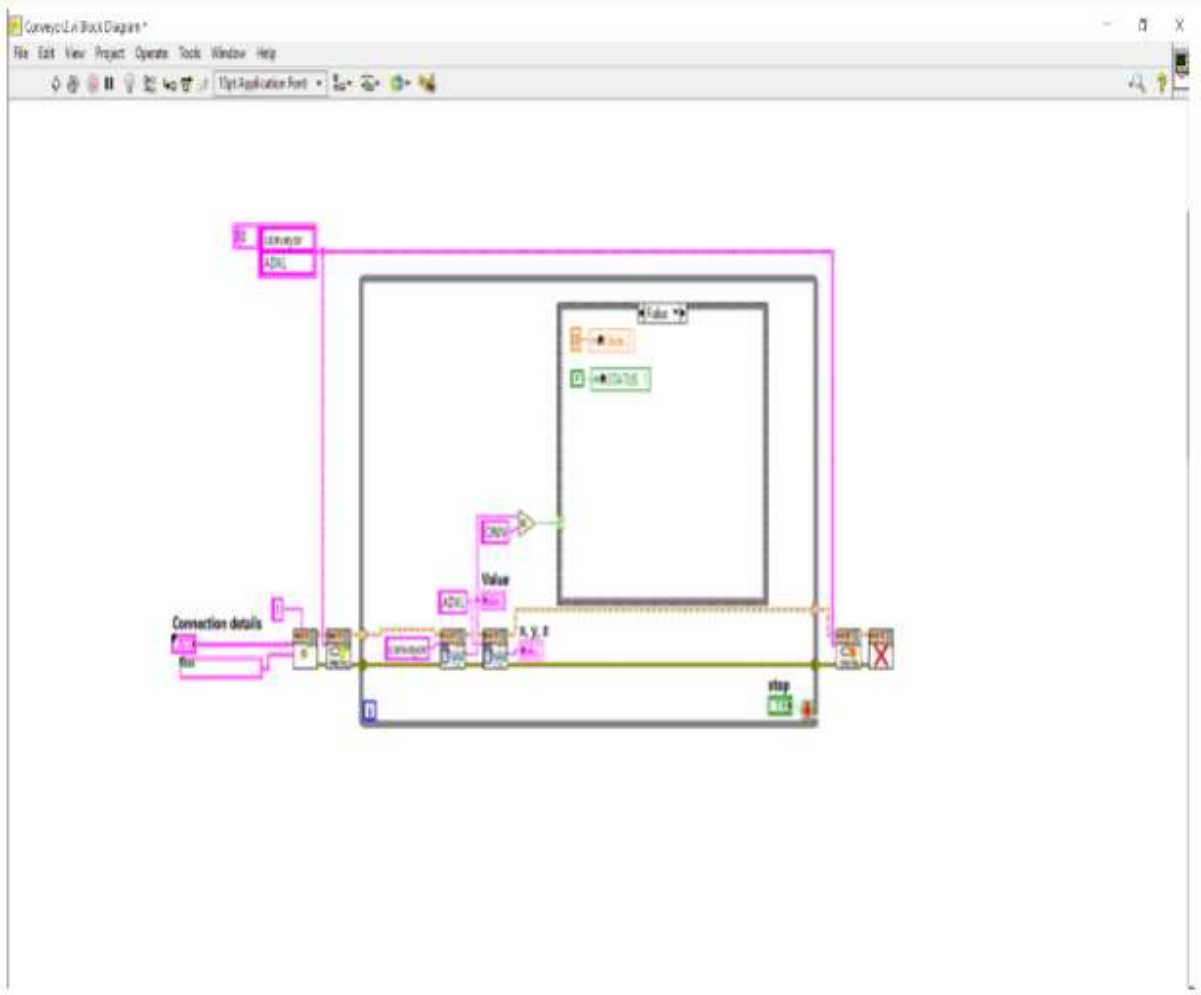

Fig: Experimental LabVIEW Block Diagram

IX. Result and Discussions:

These are the following results obtained while working with Automated inspection of Circular and Non-circular shapes Experimental setup:-

9.1) when Circular Object enters into the Conveyor:

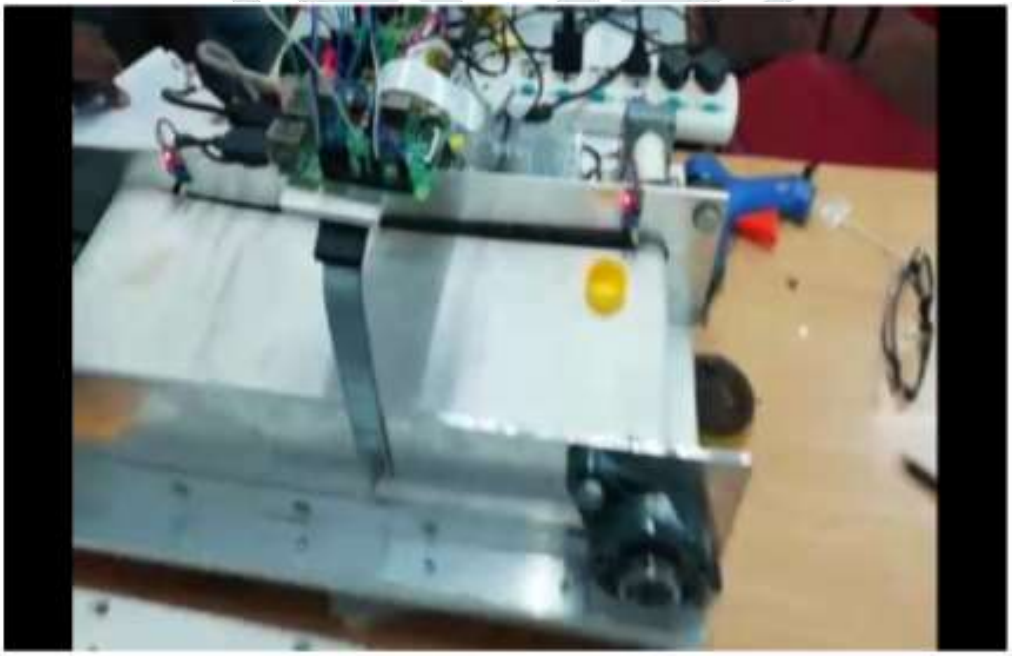

Fig: Circular object is placed at Conveyor Starting position

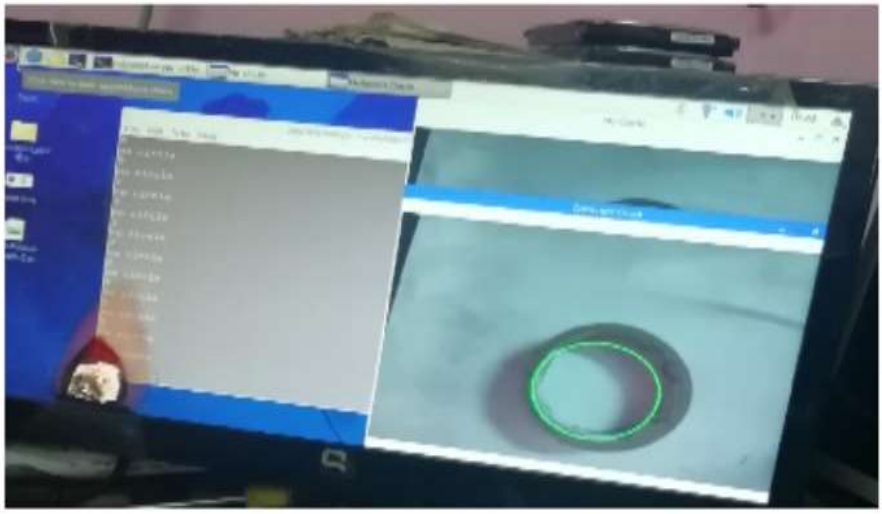

Fig: When system detected Circular shape

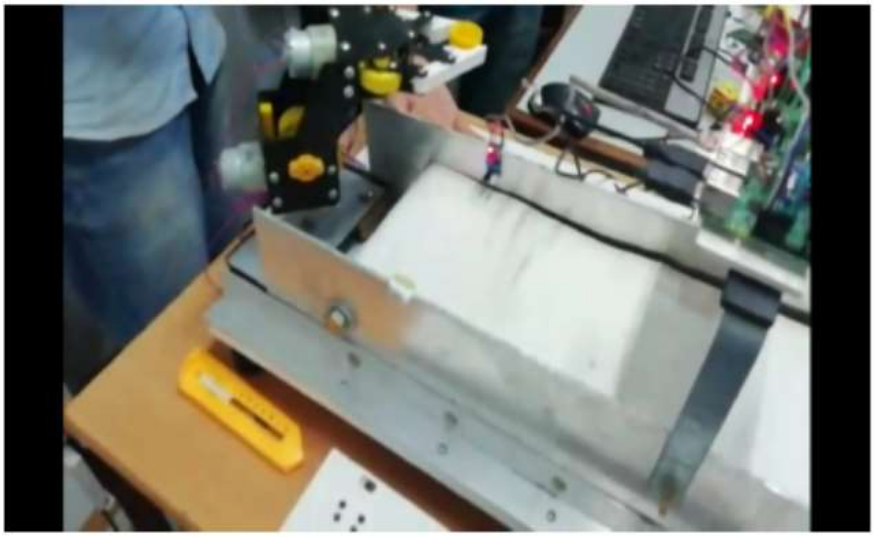

Fig: Robot Pick and placing operation of Circular shape

9.2) When Non-Circular Object enters into the Conveyor:

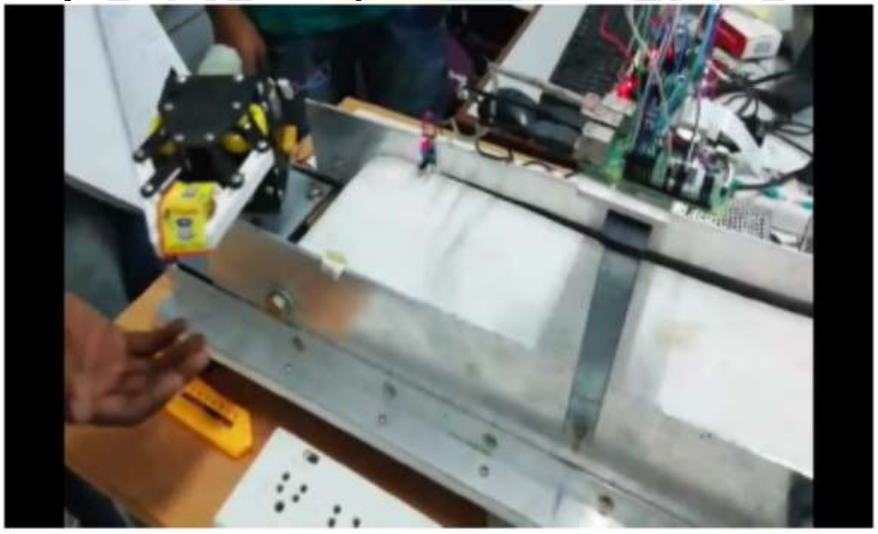

Fig: Robot Pick and Placing of Non-Circular shape

X. Conclusion：

Nowadays, robotic arms are used in a variety of logistics applications for transporting goods from one end to the other, as well as in some sectors for defect detection applications with sophisticated designs. In this paper, a USB camera-based Vision Assisted Robotic Arm system is successfully built using commercially available parts to pick and place an object from one location to another with 2 degrees of freedom. The LabVIEW Machine Vision toolsets are used to implement the digital image processing algorithms on the practical design. The USB camera is utilized as a sensor in this system to capture the picture of the item, and the object's dimensions are measured after processing the image in LabVIEW API. Edge detection and pattern matching algorithms using Machine Vision software tools are used to calculate the object dimensions. The robotic arm requires a full-fledged working in pick and place applications, based on the results of the real-time test and measurement. As a result, by increasing the number of servomotors in the robotic arm's body and employing a high-resolution 3D camera, the task may be further advanced.

XI. Acknowledgement :

I sincerely express gratitude to my supervisor Asst. Prof. Dr. Y. Ashok Kumar Reddy for his guidance, invaluable input, generous help, suggestions and inspiration in all stages of my work. I was introduced about very interesting topic of Automated Inspection of Circular and Non-Circular Objects using Vison Assisted Robot ARM using LabVIEW and Raspberry PI, which is of high practical importance in Indian education field. His intellectual abilities have always rescued me in the difficult situations. It would not have been possible for me to complete this thesis without the guidance and support of him

XII. Reference :

[1]. RO Thomas et.al, remote monitoring and control of robotic arm with visual feedback using Raspberry Pi International Journal of Computer, 2014 – Cite seer
[2]. R Tiwari et.al, vehicle control using Raspberry Pi and image processing – Intelligent Communication, Control and Devices, 2018 – Springer
[3]. P Hemalatha et.al, real time Image Processing based Robotic Arm Control Standalone System using Raspberry pi - International Journal, 2015 - researchgate.net
[4]. V Pereira et.al, low cost object sorting robotic arm using Raspberry Pi - 2014 IEEE Global, 2014 - ieeexplore.ieee.org
[5]. Raspberry Pi Forum and Discussion page http://www.raspberrypi.org/phpBB3.
[6]. Programming the Raspberry Pi: Getting Started with Python - Book by Simon Monk.
[7]. https://wiki.eprolabs.com/index.php?title=Raspberry_Pi_Camera_Module
[8]. LabVIEW for Everyone: Graphical Programming Made Easy and Fun by Jeffrey Travis and Jim Kring.
[9]. www.ni.com/discussion forum.