

# Sorting and Stamping System Using Pneumatic Cylinders

Saranya M\*

Assistant Professor, Dept.of ICE, PSG College of Technology, Coimbatore 641004, India.

Aishwaryaa R

Assistant Professor, Dept.of ICE, PSG College of Technology, Coimbatore 641004, India.

Madhumidha S

Assistant Professor, Dept.of ICE, PSG College of Technology, Coimbatore 641004, India.

Palaniappan C

Assistant Professor, Dept.of ICE, PSG College of Technology, Coimbatore 641004, India.

Uthaman G\*

Students, Dept.of ICE, PSG College of Technology, Coimbatore 641004, India

## Abstract

**In product manufacturing industries the end product requires sorting and stamping as a last step to brand the finished product. Different types of products are sorted according to various parameters then labeling or stamping mechanisms are done on the product. Here we demonstrate a complete system which combines stamping and sorting process of the object as it moves on a conveyor. The system consists of a conveyor driven by a motor, pneumatic cylinders, proximity sensors and Raspberry Pi. The conveyor is used to guide the product to the stamping and sorting base. The pneumatic cylinders do the sorting and stamping operation. The proximity sensors detect the product. The system is controlled by Raspberry Pi. The product reaches the stamping base and after stamping is done, the product is sorted according to its shape.**

**Keywords: Proximity Sensors;Raspberry Pi;Pneumatic cylinders;Sorting;Stamping;Conveyor.**

## 1. Introduction

In our day to day life many products are manufactured in large and small-scale industries. Usage of these products are getting increased which results in increased productivity. After manufacturing, arrangement of these products is a hectic task which further increases the product completion time. The main difficulty faced after the manufacturing is sorting the manufactured product. It is done according to the weight, size, colour, shape, etc of the project. Another time-consuming process is providing identification to the product which is called stamping or labelling. The stamping is also done to provide product information like price, quantity, mechanical

and electrical parameters. This project work focuses on the study of product sorting and stamping using pneumatic cylinders. The purpose of this process is to save the time for inspection and to reduce the effort of the workers. The stamping and sorting process can be more economical when it is automated. This system also transfers the product from one point to another. The design is quite simple and of flexible use, which indicates a single conveyor belt is sufficient for material handling. The conveyor has sensors and actuators to make it an intelligent conveyor. Packaging is an essential step in production processes. It provides basic safety to the products and also adds value for marketing the product. The stamping and sorting process are incorporated in packaging operation to identify and to confirm some important data like product registration number, manufacturing date and expiry date that meets all legal and statutory requirements of the food industries [1]. In this modern era of advanced technologies, every process needs to be highly perfect and should be produced in less time. The present practice in food packaging industries is that, stamping and sorting is done separately by operators and may require up to seven operators per line to achieve a higher productivity. This separated action is time consuming, generates higher expenditure and also results in poor finishing. In order to achieve higher productivity in small scale industries there is a need for automatic stamping and sorting. Automation has been defined as the use of various systems such as pneumatics, hydraulics, electrical, electronics and computers to control industrial machinery and processes, thereby reducing the use of human intervention [2].

### 1.1 Sorting

Sorting refers to the process of arranging data in an increasing or a decreasing fashion according to some linear relationship among the data items. Sorting makes product searching much easier. There are many techniques for sorting. Implementation

of particular sorting technique depends upon the requirements. Sorting may be regarded as a separation operation based on the differences in physical properties of the products. Separation is based on properties like colour, size, shape or weight of products. It is an important operation in controlling the effectiveness of other processes in industries. For example, sorted vegetables and fruits are better suited for mechanized operations like peeling, pilling and coring or blanching. Similarly, products of uniform size or shape are better suited for efficiency. The various sorting methods are listed below:

- Weight sorting
- Size sorting
- Shape sorting
- Photometric or Color sorting

### 1.2 Proposed Method

The products which are in different shapes are fed into the conveyor. The proximity sensor senses when the product fed is near to the stamping base and stops the conveyor. First stamping operation is done using the pneumatic cylinder irrespective of the shape and the product again starts to run in the conveyor belt. Then the products are identified by its shape through the Pi Camera and then sorted to separate bins through the cylinders. The shape detection algorithm is incorporated in Raspberry Pi. The simplified block diagram about the project is illustrated in figure 1.1.

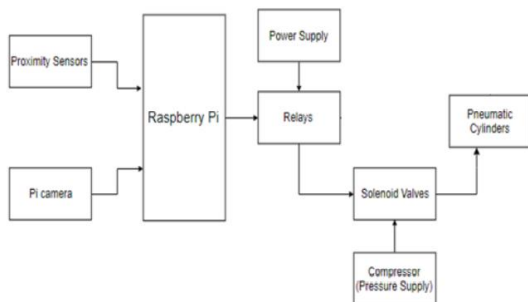


Fig. 1. Simplified Block diagram

### 1.3 Applications

- To identify rotten fruits and vegetables in food industry.
- To categorize the products manufactured based on the colour, shape in small scale and large-scale industries.
- To scan and identify the defects in raw materials in storage units of production industries.
- To segregate different clothes, toys, bags etc in shopping malls.
- In fruit harvesting and vegetable harvesting places where installation of expensive sorters is very difficult.

## 2. Overview of Components

This session briefs about the electrical and mechanical components used in the proposed method.

### 2.1 Electrical Components

The electrical components used in the proposed method are as follows:

- Raspberry Pi 3
- Raspberry Pi camera module

- 4 channel relay modules
- 12V DC geared motor

#### 2.1.1 Raspberry Pi

The Raspberry Pi was developed in the United Kingdom by Raspberry Pi foundation to promote the teaching of basic computer science in schools and developing countries. It is a series of single board computer. The original model has become more popular and strikes a high rate of selling in areas such as robotics. It excludes keyboard and mouse. However, some accessories have been included in the further updated versions of the Pi board. Here Raspberry Pi 3 version is used. Raspberry Pi board and the connectors have been shown in figure 2.



Fig. 2. Raspberry Pi 3 [9]

#### 2.1.2 Raspberry PI Camera Module

The camera module shown in figure 3 connected with Raspberry Pi 3 module will capture the pictures or record videos and send it to the Pi module for processing.

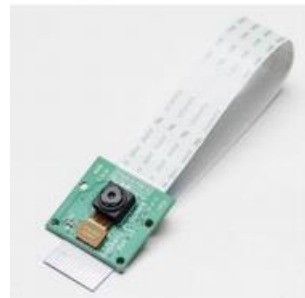


Fig. 3. Raspberry Pi camera module [11]

#### 2.1.3 Four Channel 12V Relay Module

4-channel relay interface board is depicted in figure 4. It amplifies current to provide control over various appliances. Microcontrollers like Arduino, raspberry Pi 8051 etc., can be used to directly control the relay module. The specifications are

- 4-channel relay interface board requires 15-20mA driver current for each channel
- It can be controlled by either 12 V or 5V input voltage
- Equipped with high current relay, AC 250V 10A; DC 30V 10A
- Standard interface that can be controlled directly by microcontroller
- Opto-isolated inputs
- Indication LEDs for relay output status



Fig. 4. Four channel 12V relay module [12]

#### 2.1.4 12V DC Geared Motor

A gear motor is a typical type of electrical motor which produces high torque. A 12V DC geared motor is shown in fig 3.5. Its applications include lifting, rotating conveyor belt etc.



Fig. 5. 12V DC relay module [13]

### 2.2 Mechanical Components

The various mechanical components used are

- Conveyor
- Pneumatic Cylinder
- Compressor

#### 2.2.1 Conveyer

Conveyors are mechanical devices or assemblies used to move items or packages with minimal effort. They usually consist of frames that are supported by rollers, wheels, or belts and may be powered up by motors. They are also used to move bulk materials. They include belt conveyors that use moving belts, bucket and vertical conveyors that lift materials. There are different types of conveyors like vibrating, overhead, screw, chute, drag or tow and walking beam. Vibrating conveyors use vibratory motion to move material, and from overhead conveyors the items hang during transport. Screw conveyors for moving bulk material, chute conveyors rely on smooth surfaces and gravity, and drag or tow conveyors use cables to drag objects. Walking beam conveyors move objects to predetermined positions for manufacturing operations. Conveyor selection depends on product type, throughput or speed, elevation change, and in some cases industry focus.

#### 2.2.2 Pneumatic cylinder

Pneumatic cylinders are the mechanical devices which produce force in a reciprocating linear motion. It is actuated by the electro-pneumatic solenoid shown in fig 3.6 and 3.7. The parts of the cylinder are 1. Piston 2. Piston ring 3. Piston rod 4. Cushioning systems Piston is the major part of the cylinder. Pressure is created on the surface of the piston and it is used to push the piston forward. Piston is also used for the balancing of the cylinder. Piston ring is used to avoid the leakage of the

pressure created on the surface of the piston entering into the spring section. Because it will ruin the life of the spring. Piston rod is the delivery system of the cylinder. The energy is delivered through the piston rod of the cylinder. Cushion bushings are used for the smoothness in the end of the strokes. Cushion bushings are used to prevent the shock hit with the barrier of the cylinder. Barrier is nothing but the outer frame which covers the parts of the cylinder. The frame is manufactured using the material like silicon steel. Rust formation inside the cylinder is restricted with the help of FRL unit. The different types of cylinders are 1. Single acting cylinder 2. Double acting cylinder 3. Magnetic cylinder. Single acting cylinder has only one port. The port has been named as Extension port. Because this port is used for extension stroke of the cylinder. The retraction of the cylinder will be controlled by the weight of the load or spring or gravity.

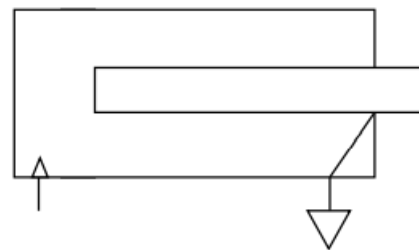


Fig. 6. Circuit symbol for single acting cylinder [14]



Fig. 7. Single acting cylinder [15]

#### 2.2.3 Compressor

A compressor is a device used to compress air from a low pressure inlet to a higher desired pressure level. In regard to the laws of perfect gas, the compressor increases the pressure of air by reducing its volume. It is used to supply high pressure clean air to fill gas cylinders and also used to supply a large amount of moderate pressure clean air to power pneumatic tools. Most air compressors will have either a reciprocating piston type or rotary vane. For very large applications centrifugal compressors are commonly used. There are two types of air compressor pumps which are oil-lube and oil-less. The oil-less system is more technically developed, more expensive, louder when compared to oil-lube pumps. It also delivers air of better quality. A typical compressor is depicted in figure 8.

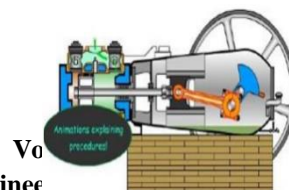


Fig. 8 . Compressor [16]

There are two different types of compressors which are 1. Positive displacement compressors 2. Negative displacement compressors.

### 2.3 Electro-mechanical Components

#### 2.3.1 Solenoid valve

Solenoid is used to actuate the cylinder whenever the signal comes from the relay switch. It converts electrical signal into pneumatic signal. When the signal comes to the solenoid, it cuts the air supply into the output port. Initially air supply flows into the pressure port of the solenoid and it will magnetize when the electrical signal comes. So, the air supply shifted to the port. Figure 9 shows an electro pneumatic solenoid.



Fig. 9. Solenoid valve [17]

### 3. Overview of software components

The programming language used in the proposed method is Python. It is an interpreted high level programming language for general-purpose programming and advanced programming. Python features a dynamic type system. One of the main advantages in python language is that it supports multiple programming paradigms including object oriented, imperative, functional and procedural. It has a large and comprehensive standard library. Python interpreters are available for many operating systems. It is freely available open source software and has a community-based development model. Python IDLE is an integrated development environment used for writing, editing, debugging and running Python programs. IDLE is included with all 2.x and 3.x versions of the software. Each version of Python comes with its own unique version of Python IDLE with many Linux distributions. The version used here is Python 2.7. The features include:

- Shell window the interactive interpreter with colorizing of code input, output, and error messages
- Text editor with multiple undo, multiple tabs, colorizing, smart indent, call tips, auto completion, and other features
  - Search and replace within editor windows, and search through multiple files
- Intelligent debugger with persistent breakpoints, stepping, and viewing of global and local namespaces IDLE has two main windows they are the Shell window and the Editor window.

In python it is possible to have multiple editor windows simultaneously. Output windows that are used for Edit / Find in Files, are a subtype of edit window. The currently available windows have the same top menu as Editor Windows but a

different default title and context menu. The modules used in the proposed method are:

1. Opencv
2. Numpy
3. GPIO
4. PiCamera
5. Time

#### 3.1 Putty

PuTTY is a terminal which is versatile, free and open-source software. It provides emulation, serial console and network file transfer application available for windows. Many network protocols like SCP, SSH, Telnet, rlogin, and raw socket connection are supported by it. Serial port can also be used. At first, PuTTY was written for Microsoft Windows, later it has been ported to various other operating systems. PuTTY supports many variations on the secure remote terminal, and provides user control over the SSH encryption key and protocol version, alternate ciphers such as 3DES, Arcfour, Blowfish, DES, and Public-key authentication. Here the IP address of the Raspberry Pi is entered and it is emulated.

##### 3.1.1 SSH

Secure Shell is a network protocol for operating network services. It uses cryptographic approach and provides a secure connections channel over an unsecured network in a client-server architecture model. It helps in connecting an SSH client application with an SSH server. The applications include remote command-line login and remote command execution, but any network service can be secured with SSH. The specification of protocol distinguishes between two major versions, referred to as SSH-1 and SSH-2. In this project the Raspberry Pi terminal window is accessed remotely via SSH.

##### 3.1.2 VNC Viewer

VNC viewer is used to provide more interaction with the pi board. The purpose is to provide Interactive User Interface or the remote connection. Virtual Network Computing is a graphical desktop sharing system or technique that uses the Remote Frame Buffer protocol (RFB) to remotely control another computer. As the Raspberry Pi cannot be used as a single dedicated computer with desktop, keyboard and mouse the VNC Viewer software is used to transmit the keyboard and mouse events from the host computer to the Raspberry Pi, providing the graphical screen updates back in the other direction, over a network. It also allows file transfer between the two devices.

### 3.2 Proposed Algorithm

The proposed algorithm for sorting and stamping using pneumatic cylinder is depicted as flowchart in figure 10.

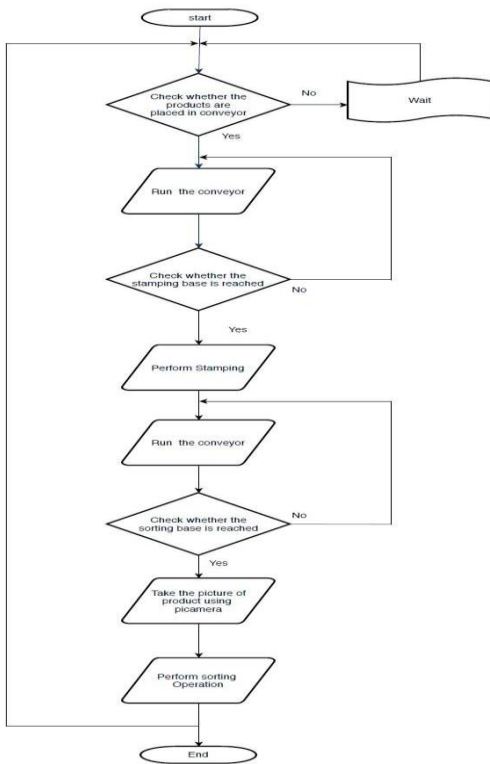
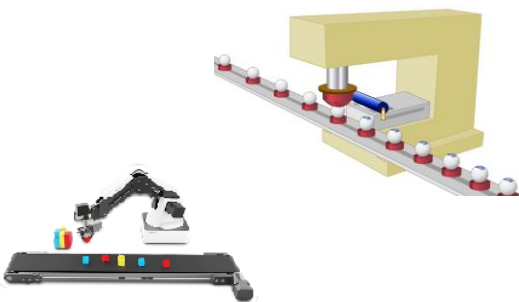


Fig. 10 Algorithm of the proposed method

### 4. Real Time Implementation of the proposed algorithm

The 3D view of the proposed system is modelled and it is projected in figure 11.

Fig. 11. 3D view of the system



The proposed algorithm is developed as python program and implemented as real time sorting and stamping process in Raspberry Pi 3. On real time implementation of the proposed algorithm using LED and Motors, the following results are obtained in the sequential order.

1. Turning ON the motor to start the conveyer belt
2. Clamping Process
3. Stamping Process
4. Turning ON the motor again
5. Sorting Process
6. Turning OFF the motor to stop the conveyer belt.

The above results are depicted in the figure 12 to 16.

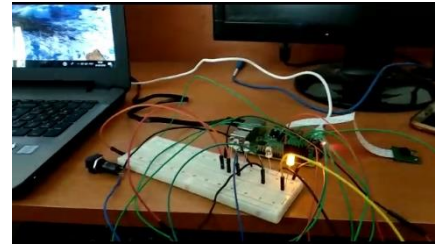


Fig 12. Turning ON the Motor to start the conveyer belt.

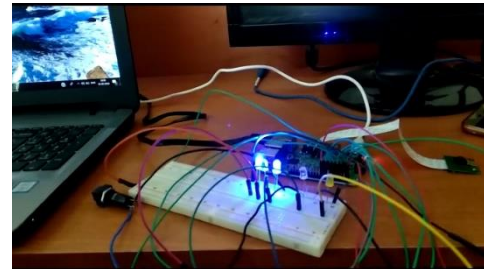


Fig 13. Clamping Process

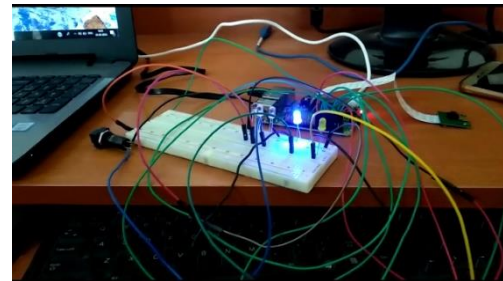


Fig 14. Stamping Process

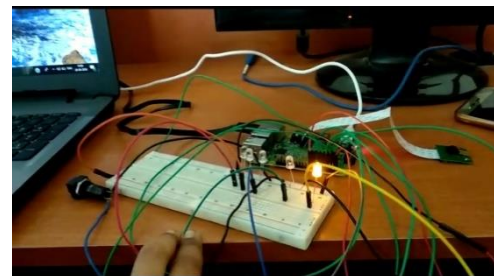


Fig 15. Turning ON motor again

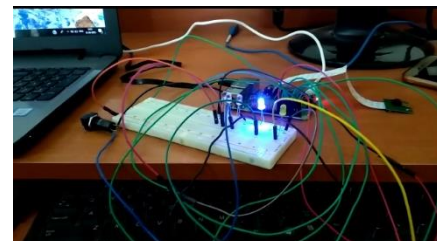


Fig 16. Sorting Process

## 5. Conclusion

Here, the two-conveyor belt system has been replaced with a single conveyor belt system which serves the purpose of both stamping and sorting. As microcontroller is used, the implementation cost is minimum when compared to the existing solutions that uses PLC. This increases its usage in small scale industries. All the modules were built individually, integrated and tested. The product through the conveyor is stamped and sorted according to their shape. The need for big machines to sort and stamp in small scale industries can be replaced with this system. In this method due to time constraints only one shape has been detected and sorted. In future more than one product can be sorted based on their need. It can also be extended to sort based on their size and color. Also, here only one type of stamp is being imposed on all the products. In future two or more stamps can be incurred for different products moving over a single conveyor.

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