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# Controlling the Speed of Conveyor Belt using Python Raspberry Pi 3B+

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**Abstract**

In food processing industry, there arises a need to control a conveyor belt. currently industries are very necessary to use material handling system for to move materials from one place to another place continuously and to minimize operations time. Stepper Motor is suitable for controlling conveyor because of its high accuracy positioning over a short distance and provide high torque even at low speeds and it is also offer very low vibration and a wide range of features. This paper is focused on controlling the speed of the conveyor belt through the speed of stepper motor using the micro processor namely, Raspberry Pi 3B+'s (RP 3B+) GPIOs (General Purpose Input Output) and it can be generate sequence of control signals on the GPIO pins of RP 3B+. Interfacing the stepper motor with RP 3B+ using python programming language. The method is explained with the results of changing the weights the speed level is reduced through time variation on the conveyor belt and the model of working Conveyor belt with Stepper motor controlled by python and RP 3B+ with Easy Driver(A3967).

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**Keywords**

Conveyor Belt;
Python;
Raspberry Pi 3B+;
Stepper Motor.

## Introduction

In the world of food processing industry, there are still a few areas in which it is quite sufficient to transport manually from one place to another place of the material components, but, for high-unit loads, automated systems have become essential part of it. Conveyors are durable and reliable components used in automated distribution and warehousing, as well as manufacturing and production facilities. In combination with computer-controlled pallet handling equipments, it allows for more efficient retail, wholesale, and manufacturing distribution. It is considered a labor saving system that allows large volumes to move rapidly through a process

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and allowing industries to ship or receive higher volumes with smaller storage space and with less labor expense. With this in mind, Henry Ford deployed belt conveyors for mass production (Wilson, 1996). Priyanka *et al.,* (2019) proposed the system of detecting and automatically sorting the parcels with QR code using QR code scanner on the conveyor belt using micro controller Arduino. Rahul *et al.,* (2018) presents the sorting of objects using Computer Vision techniques with a conveyor belt, stepper, servo motors and mechanical structures.

Ajinkya *et al.,* (2017) illustrated the system of automatic human queue management at public places using conveyor belt with stepper motor and micro controller. It placed two conveyor belt one at the site window and other at the entry window and boom bar as separator to avoid crashes among the people which is controlled by the micro controller. Likewise, it placed the stepper motor to control the conveyor belt for proper direction. Chavhan and Rode (2018) introduced the system to detect the quality of the fruit using raspberry pi with Histogram of Oriented Gradients (HOG) for background removal and Support Vector Machine (SVM) for classification of colour on the conveyor. Akshay *et al.,* (2017) explained the concept of sorting and counting of the object and displayed its quantity by using digital Image Processing, objects were detected and sorted which were passing over conveyor using a micro controller. Jyothi and Harsha (2017) developed the control system to separate different objects with different specification and to locate them in different locations. The product information can be sent immediately and accurately without any wireless to the monitor. It is a valuable method for wireless communication achieving accuracy in data transferring and receiving.

Sheela *et al.,* (2016) presents the sorting of the objects on a conveyor belt depend on its size and colour by using sensors, raspberry pi 3 and linear actuators. It used the low cost automated system with Raspberry pi along with USB camera is to detect of the colour of the object by using python and openCV. If the object is desired colour, it will be carried on the conveyor belt and it will be received at the end of the conveyor belt into the trolley. If it is not the desired colour, it will activate the actuator. Then, the linear actuator will throw away the object into another trolley and the conveyor belt run with another object for the desired colour. Shreeya *et al.,* (2016) developed the design of box sorting machine and used the pneumatic actuation to sort the boxes automatically to reduce cost and time. Automation process read the barcode from the cover of box with the help of camera of the raspberry pi. Raspberry pi decoded the barcode which sorted the boxes and also gives signal to motor driver to stop and start motor accordingly.

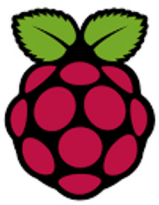

**Fig.1: Raspberry pi logo**

Sanjay and Rohan (2015) designed the automated sorting machine using conveyor belt. It is mainly to avoid the size malfunctioning in production industry. It has the ability to sort the object of different sizes so it is called as the intelligent conveyor belt. Different size objects are passed through the sensors and the specific size object is sorted. The controller is controlled by the circuit which drives the belt. This system will also help to segregate heavy and bulk objects. Karthik Kumar and Kayalvizhi (2015) presents the real time application for object, colour, shape and size detection on the conveyor belt. OpenCV is used at real time is used to determine the colour of the object placed over a moving conveyor belt. While passing over a conveyor belt serially, this system will differentiate various different types of packages at the real time. Manasa *et al.,* (2015) developed and implemented the object counting

**Table1: The details of major components**

| | |
|---|---|
| **Belt** | Tractive element used for moving and supporting |
| **Pulley** | To move the belt and control its tension |
| **Drive** | Impart power to the pulley to move the belt and its load |
| **Structure** | Support and maintain the alignment of the pulley, idlers and driving machinery |

algorithm based on real time by using Raspberry pi with image processing.

From the above literature is based on controlling the conveyor belt with many other drivers and micro controller. But, A3967 easy drive with RP 3B+, no one is tried to control the speed of conveyor belt using a stepper motor and interfacing with python language. This paper is focused on controlling speed of conveyor belt connects with 12v bipolar stepper motor then it is controlled by the Raspberry PI 3B+ along with easy drive (A3967).

**Material and Methods**

The following materials (including Hardware and Software) are used to controlling the speed of converyor belt

**Raspberry pi 3B+**

Raspberry Pi was developed in February 2012 in UK by the Raspberry Pi Foundation to promote basic computer science education in schools and colleges. The original model is becoming much more popular than expected and is selling for robotics outside its market. There are no peripherals and cases (e.g. mice and the keyboards). However, certain accessories were included in several official and unofficial bundles. The Raspberry Pi Foundation has developed the first two models. After releasing the Pi model B, the Raspberry Pi Trading Foundation set up a third model, B+ and the logo is shown in Figure 1.

**Models In Raspberry Pi**

(1). Model A; (2). Model A+; (3). Model B; (4).Model B+.

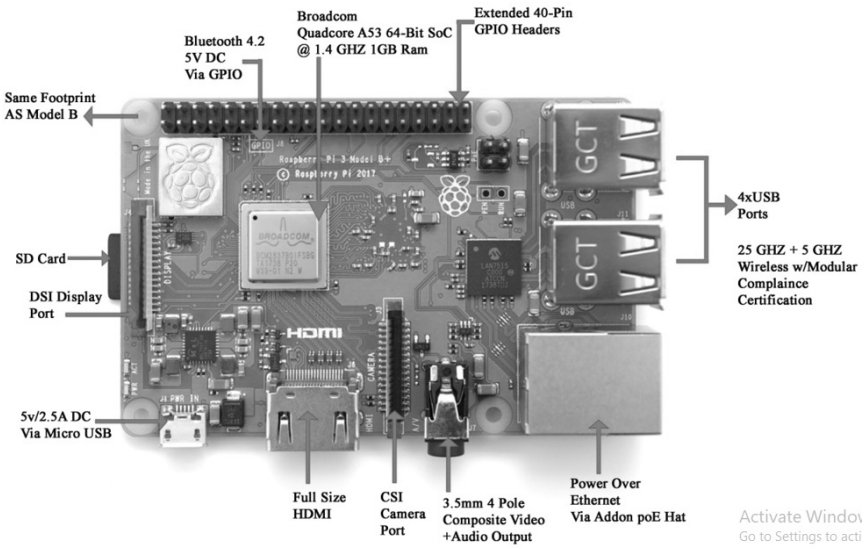


**Fig.2: Raspberry pi 3B+**


**Fig.3: stepper motor**

**Specifications**

Model B+ of the Raspberry Pi 3 is the newest Raspberry Pi of single computer board. Developed from the previous Raspberry Pi 3 Model B, it offers enhanced speed and performance. RP 3B+ is more faster than previous models and the features is Broadcom BCM2837 Processor, Quad core ARM Cortex-A53, 64 bit CPU cor, 1.2GHz (Roughly 50% faster than Pi2) Clock speed, 400 MHz video core IV® GPU, Ethernet (RJ45 Port) Network connectivity, 802.11n wireless LAN (Wi-Fi) and Bluetooth 4.1, four USB 2.0 ports,40 Pin Header of GPIOs, 15-pin MIPI Camera interface, DSI 15 Pin/ HDMI Out/ Composite RCA Display interface, 2.4 APower supply alongwith Raspbian operating system (similar to linux operating system) is shown in Figure 2. There are many advantages of RP 3B+: Trouble shooting tool, Efficient energy, Cheap to purchase, Easy operation and connectivity, Low energy consumption, No need of external energy and Easily access to any applications

**12v Bipolar Stepper Motor**

Figure 3 shows the model of stepper motor, and it is a type of control motor which can be used to control speed and positioning without using a feedback loop, which is the so-called open-loop motor control. Bipolar stepper motors there is only a single winding per phase. The driving circuit needs to be more complicated to reverse the magnetic pole, it is done to reverse the bipolar stepper motor - circuit specialists blogcurrent in the winding. it is done with a H-bridge arrangement, however there are several driver chips that can be purchased to make this a more simple task. Because windings are better utilized, they are more powerful than a unipolar motor of the same weight. This is due to the physical space occupied by the windings. A unipolar motor has twice

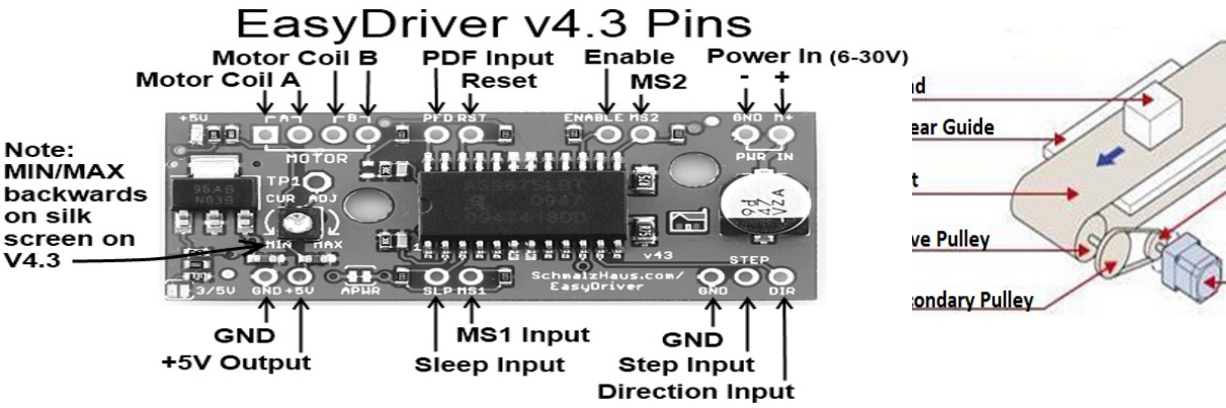


**Fig.4: A3967 Easy Driver**

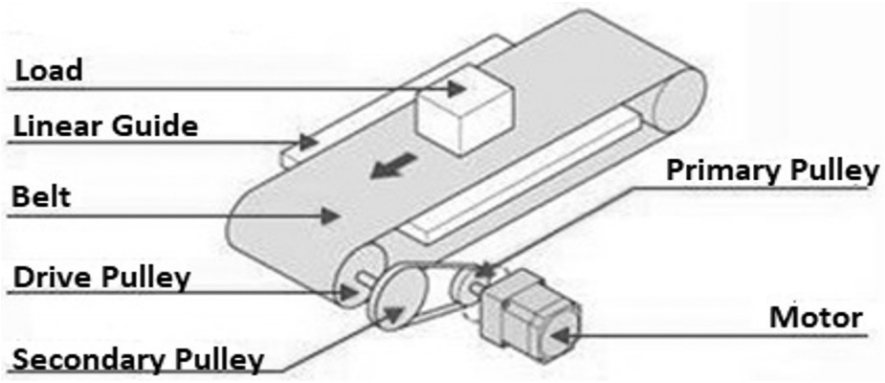


**Fig.5: Model of conveyor belt**

the amount of wire in the same space, but only half used at any point in time, hence is 50% efficient (or approximately 70% of the torque output available). Though bipolar is more complicated to drive, the plenty of driver chip means it is much less difficult to achieve. An advantages of 12v bipolar Stepper Motors is high accuracy positioning over a short distance and provide high torque even at low speeds. Stepper motors also offer very low vibration and a wide range of features. The motor's life depends therefore on the shaft bearing's life. Good choice for high-precision low-speed applications. It has Low-speed Synchronous Rotation. Angle of the rotation is proportional to the input pulse.

**A3967 Easy Driver Circuit**

It is a complete micro stepping motor driver for easy operation built with translator and minimal control lines. Its design is basically to operate bipolar stepper motors in full, half, quarter and eighth-step modes. Figure 4 shows the A3967 easy driver and it is easy-to-use stepper motor driver, compatible with anything capable of delivering a digital 0 to 5V pulse. It requires a power supply between 6V and 30V for the motor and can power supply for any stepper motor in this voltage. A digital interface voltage control unit can be set to 5V or 3.3V on the Easy driver. Connect a 4-wire stepper motor and a microcontroller with precise motor control. An advantages of this driver is made up of Fibre class material and no battery required to operate this easy driver, also can provide any external power voltage up to 30v.

```
import RPi.GPIO as GPIO, time
GPIO.setmode(GPIO.BOARD)
GPIO.setup(GPIO No.,GPIO.OUT)
GPIO.setup(GPIO No.,GPIO.OUT)
p=GPIO.PWM(GPIO No.,frequency)
FUNCTION SpinMotor(direction, number_steps):
ENDFUNCTION
        GPIO.output(GPIO No.,direction)
        while number_steps>0:
 ENDWHILE
                p.start(1)
                time.sleep(0.01)
                number_steps -=1
        p.stop()
        GPIO.cleanup()
        return True
SpinMotor(True,number_steps)
```

**Fig.6: Python pseudo code for controlling Stepper Motor**

**Conveyor Belt**

Basically it is very wide belts attached in a loop to two or more turning rotors driven by stepper motors and it is an endless belt moving over two end pulleys of a length of belt either by vulcanized splicing or by using mechanical fasteners at fixed positions. It is mainly used for transporting material horizontally or at an incline up or down. The loop is the actual conveyor belt, and is generally made of two or more layers of rubber, one layer to give shape and structure to the belt and one to allow it to transport its load safely. This conveyor loop is generally attached to two wheels, called rotors, which are spun by stepper motors.

The extra length is to make the belt endless to required size can be calculated by the following formula

$$\text{Splice Length} = W + 150\,(N-2) + 25\text{mm} \quad \ldots(1)$$

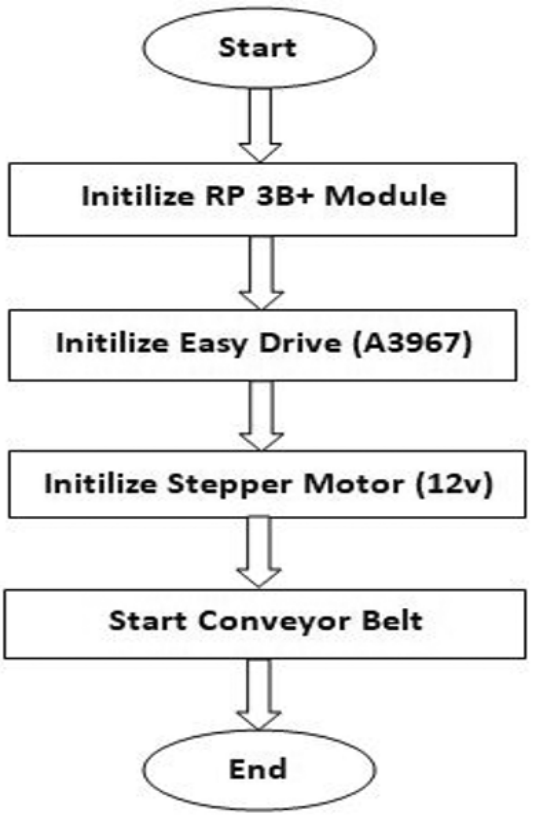


**Fig.7: Flow Chart for controlling conveyor belt**

where, W is width of belt (in mm), N is the number of plies.

Calculation of Belt Roll Diameters (meters)

$$D = \frac{4d.L}{\rho} + K^2 \quad ...(2)$$

Where D = Roll Diameter (m); d = Belt Thickness (m); L = Belt Length (m);K = Diameter of Core (m); ρ=Density of Belt (kg/m³).

The conveyor belt has enough friction between it and the rotor that it sticks to this rotor. As a rotor turns, the conveyor belt will turn as well due to the intense friction between the rotor wheel and the belt. This turning motion of the rotor causes one side of the belt to move in one direction, while the other moves in the opposite direction. This means that both wheels must always be moving in relatively the same direction, either clockwise or counter-clockwise. Application of conveyor belt is to convey products or raw materials through the use of either friction or mounts on the belt meant to hold the product in place as the belt moves. Figure 5 show the model of conveyor belt and Table 1 gives the details of major components of conveyor belt.

**Controlling Speed of Stepper Motor and Conveyor Belt**

The hardware materials (given in above) and softwares are mainly used for controlling the speed of conveyor belt. The details of software were discussed below

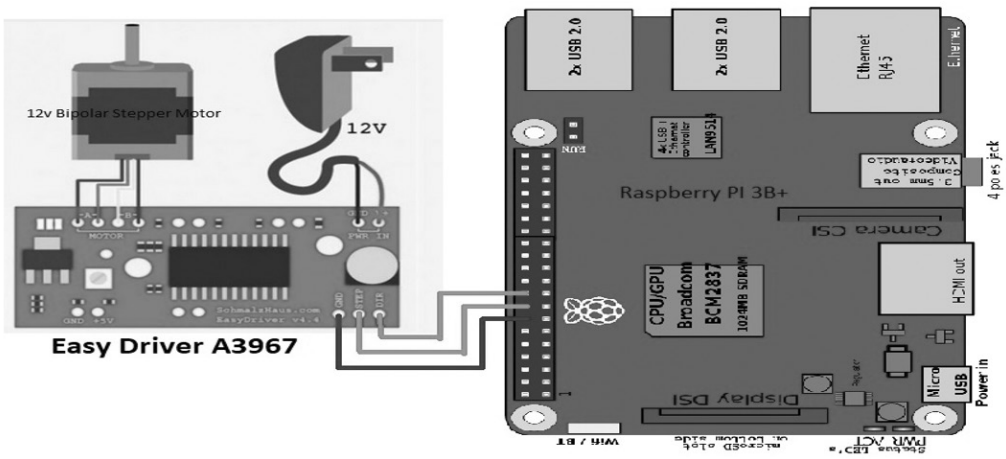


**Fig.8: The circuit diagram to control the Stepper motor with RP 3B+, Easy Driver(A3967)**

**(A)**

**(A)**

**Fig.9: The model of working Conveyor belt with Stepper motor controlled by RP 3B+ with Easy Driver(A3967)**

**Python**

Since 1991, Guido van Rossum developed the hign level programming language is known as Python. The benefits of using Python codes over other language codes for object detection are more compact and readable code. It is free and open source and has a multiple functions that can be packaged in one module. This compact modularity has made it particularly popular as a means of adding programmable interfaces to existing applications.

Figure 6 describes the pseudo code of python programming language for interfacing 12v bipolar stepper motor and RP 3B+. From this programme, the speed, number of steps and direction of stepper motor is fully controlled by RP 3B+. Two GPIO pins of RP 3B+ are used and connected with A3967 easy driver, one is for number of steps and another one is direction for stepper motor. If the spinmotor command of direction is true the stepper motor is rotating clock-wise otherwise the motor is rotating counter-clockwise. If reducing the values of time sleep the speed of stepper motor is increase.

Figure 7 illustrates that the flow chart for controlling speed of conveyor belt. Initially A3967 easy driver with connected RP 3B+ module GPIOs (General Purpose Input Output) and it can be generate sequence of control signals on the GPIO pins of RP 3B+. Then the control signals are passing from this easy driver to 12v bipolar stepper motor. Based on the control signals the conveyor belt is rotated continuously along with the stepper motor.

**Results and Discussion**

The hard connects with 12v bipolar stepper motor then it is controlled by the RP 3B+ along with easy drive (A3967). As per instruction of python coding the stepper motor is running at the allocated speed and rotation. Figure 8 shows that the circuit diagram to control the Stepper motor with RP 3B+, Easy Driver(A3967). GPIO pins 14, 16 and 18 of RP 3B+ are connected with ground, steps and direction pins of A3967 easy driver respectively. In this work, 12v bipolar stepper motor (4-wire) are to be used for the conveyor belt. Upto 5v stepper motor can get the power signals from the RP 3B+ itself because, Rp 3B+ used to get from 5v micro USB power supply. In this case, 12v bipolar stepper motor are used and can get the power signals from the external 12v DC power charger.

Figure 9 explained the model of working Conveyor belt with 5v Stepper motor controlled by RP 3B+ with Easy Driver(A3967). Figure 10 illustrates the time varying with weight changes based on various speed (Time Sleep) level of conveyor belt. It shows that the changing of weights as per the speed level and it is reduced through time variation on the conveyor belt.

The multiple regression analysis is a statistical analysis for estimating the relationship between various weights (y) in kilograms and time ($x_1$, $x_2$, $x_3$ & $x_4$) for the data shown in the Figure 10.

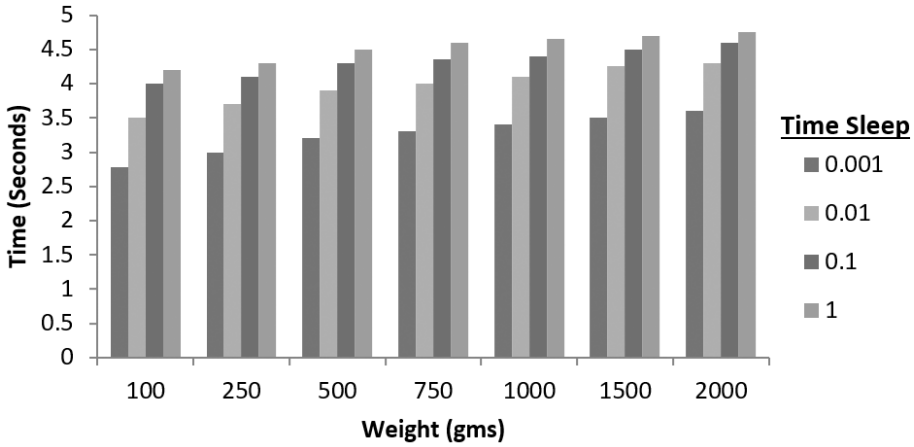


**Fig.10: Time varying with weight changes based on speed (Time Sleep) of conveyor belt**

$y = -2038.964182\, x_1 + 3204.259439\, x_2 + 6103.581801\, x_3 - 4785.575992\, x_4 - 9900.169409$ ...(3)

where, $x_1$, $x_2$, $x_3$ & $x_4$ are the values of corresponding time sleeps with Residual Sum of Squares: RSS = 125986.2052; Coefficient of Determination: $R^2 = 9.553127217 \cdot 10^{-1}$

**Conclusion**

In this paper, a brief description of hardware materials (like, RP 3B+, Stepper Motor, A3967 Easy Drive) is presented to construct the converyor belt. The controlling Stepper Motor is described through an illustration for a python pseudo code. The circuit diagram and working model is presented to control the Stepper motor with RP 3B+, Easy Driver. The working model is explained for Conveyor belt with Stepper motor controlled by python and RP 3B+ with Easy Driver(A3967) The working method is explained with the results of changing the weights the speed (Time Sleep) level is reduced through time variation on the conveyor belt.

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**Conflict of Interest of this Article**

No

**Reference**

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