MATERIAL SORTING AND STAMPING MACHINE
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Abstract— This paper describes the working prototype designed for automatic sorting and stamping of letters using a microcontroller. The purpose of this project is to save the time for inspection and to reduce the efforts of the workers. A sorting and stamping machine have main task of sorting letters according to the pin codes. This also consists of a conveyor belt, which reduces the efforts of material handling. This machine with a conveyor belt will check the two areas of a city and sort the letters in their corresponding boxes with auto stamped on it.

Keywords— Conveyor belt, Arduino UNO, DC motor, Image processing, IR sensor

I. INTRODUCTION

Material sorting and stamping machine designed for automatic sorting and stamping of letters. The purpose of this machine is to save the time for inspection and to reduce the efforts of the workers. A sorting and stamping machine have main task of sorting letters according to the pin codes. A sorting machine is more practical and economical method of automation, which transfers material from one point to another. The design is quite simple and of flexible use, means only conveyor belt can be used for material handling. It shows the concept of a normal conveyor belt, but with some intelligence. We can also call it as an intelligent conveyor belt, as it has the ability to sort the letters of different pin codes. This machine sorts any type of material as per the requirements and then put a stamp on them. It can be used for a variety of purposes and in various places like scrap management in any industry, quality check, packaging etc.

II. DESING

This project basically consists of mechanical part and programming part. The mechanical part includes the designing of the machine, locating the position of sensors, locating the position of the platform, designing the structure of stamping device. And the electronics part includes the microcontroller which controls the motion of conveyor belt, the platform, the stamping machine and the letters.

A. Structure

The material sorting and stamping machine have the following structure. The figure 1 below shows the designed structure of the machine for letter sorting. The description of the complete machine is carried out using this structure. The positioning of the sensors, distribution unit and the conveyor belt can be seen. This machine consists of a conveyor system through which the letters are being transported. This conveyor belt rolls on two rollers. Here we have used 12V DC motor to drive the belt. The motor attached to the driving shaft drives the conveyor belt. The dummy shaft provides support to the belt. Above to the conveyor, we have attached a webcam, a stamping machine, and an IR sensor. The IR sensor attached here is used to stop the conveyor belt for few seconds so that the function of camera and stamp can be done. The webcam attached here is of VGA type and is of 0.8 megapixels and is used to capture the image of the pin code. The stamping device consists of two stamps of two different areas. These stamps are operated according to the output produced by the webcam. This stamping machine uses two servo motors to operate two different stamps attached to it to provide vertical motion. After the stamping, the letter moves forward on the conveyor belt and falls on a platform which is slightly below the belt. This platform is basically a distribution platform.
which separates the letter according to the stamp. This is achieved by the tilting of the platform. The platform is basically a rectangle shaped sheet which is connected to the shaft of a servo motor. The servo motor provides a rotation of 45 degrees from its initial position in either direction.

![Figure 1 – Layout of Material Sorting and Stamping Machine (drawn on power point)](image)

**B. Controlling Scheme**

The prototype of sorting and stamping machine for letter sorting works as the flow chart.

![Figure 2 - Flow Chart of Letter Sorting System [1]](image)

1. Initially, an image of the letter is captured using a webcam and processed individually. The captured image is sent to MATLAB for feature extraction and pattern recognition.
2. After recognition is carried out, it is compared with the database to identify the alphabets and numbers. Here we are only using the extracted six digit number i.e. pin code for further implementation.
3. Once the pin code matches with the database, the motors are actuated the hardware unit using arguing.
4. The stamps are given instructions to stamp the letter according to the output.

III. SOFTWARE WORKING

The hardware works as explained later in the hardware implementation. The main program for the algorithm is written in MATLAB which analyze the pattern comparing with the different pre-loaded images of the fonts in grayscale JPEG format as shown. Using these images, the patterns of the scanned image or the image captured by the webcam is matched to get the required characters present in the image. For an optimum result the captured image in first oriented in such a way that the characters are aligned on to zero degree line [1].

The detailed software working is explained below.
1. The input image is given to the MATLAB and is stored in terms of a matrix in it.
2. The image is then processed to align the characters to zero degrees line using the page alignment algorithm.
3. After the alignment process, each character is segmented in the image by analyzing the intensity levels between the characters and also by comparing with the images of the characters loaded into the database.

![Grayscale Images](image.png)

**Figure 3 - Grayscale Images [1]**

4. After recognition of all similar patterns and assigning the characters to it, the extracted text is stored in a text file. This can be also seen in the Command Window of MATLAB.
5. Each Pin code is assigned a value based on the sub-divisional zone it belongs. If the Pin code doesn’t match with the database of the mentioned subdivisions, it is considered that the pin code belongs to other regions.
6. The target device is programmed to read the transmitted data and control the motors attached to it to sort the letters. Here the target device used is Arduino.
7. The microcontroller controls the rotation of the servomotor connected to the sorter by giving a required pulse width modulated (PWM) signal so that the servo rotates to the particular angle and the conveyor belt drops the letter into the box located at that particular angle. When the data is received from MATLAB, the controllers generate a pulse signal to rotate the motor present below the rotating plate to align to the particular angle. For each value received the sorter positions to the assigned value.
8. The complete system has two more separate models, a conveyor belt and a sliding unit. The sliding unit is where the letters or letters are placed. Here the images of letters are captured and
they are made to side down to the conveyor belt. The conveyor belt drops each letter to the sorter. During this movement on the belt, the servo aligns [1].

IV. CONTROLLER HARDWARE AND IMPLEMENTATION
The detailed description of controller hardware that has been used in it’s working. The hardware includes the Arduino UNO controller and L293D motor driver.

A. ARDUINO UNO
An Arduino is actually a microcontroller based kit which can be either used directly by purchasing from the vendor or can be made at home using the components, owing to its open source hardware feature. It is basically used in communications and in controlling or operating many devices [2].

![Figure 4 – Diagram of Arduino UNO (google)](image)

Arduino’s processor basically uses the Harvard architecture where the program code and program data have separate memory. It consists of two memories- Program memory and the data memory. The code is stored in the flash program memory, whereas the data is stored in the data memory. The Atmega328 has 32 KB of flash memory for storing code, 2 KB of SRAM and 1 KB of EEPROM and operates with a clock speed of 16MHz. A typical example of Arduino board is Arduino Uno. It consists of ATmega328- a 28 pin microcontroller. Arduino Uno consists of 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

B. L293D A motor driver IC is an integrated circuit chip which is usually used to control motors in autonomous robots. Motor driver ICs act as an interface between microprocessors in robots and the motors in the robot. The most commonly used motor driver IC’s are from the L293 series such as L293D, L293NE, etc [3]. These ICs are designed to control 2 DC motors simultaneously. L293D consist of two H-bridge. In single L293D chip there are two H-Bridge circuits inside the IC which can rotate two dc motors independently. Due to its size, it is very much used in robotic application for controlling DC motors. An H-Bridge is an electronic circuit that enables a voltage to be applied across a load in either direction. These circuits are often used in the robotics and other applications to allow DC motors to run forward or backward. In the given diagram, the arrow on the left points to the higher potential side of the input voltage of the circuit. Now if the switches $S1$ & $S4$ are kept in a closed position while the switches $S2$ & $S3$ are kept in an open position meaning that the circuit gets shorted across the switches $S1$ & $S4$. This creates a path for the current to flow, starting from
the V input to switch $S1$ to the motor, then to switch $S4$ and then the exiting from the circuit. This flow of the current would make the motor turn in one direction.

![Figure 5 – Pin Diagram of L293D (google)](image)

The direction of motion of the motor can be clockwise or anti-clockwise this is because the rotation of the motor depends upon the connection of the terminals of the motor with the switches.

![Figure 6 Working Mechanism Using H – Bridge (google)](image)

For simplicity, let’s assume that in this condition the motor rotates in a clockwise direction. Now, when $S3$ and $S2$ are closed then and $S1$ and $S4$ are kept open then the current flows from the other direction and the motor will now definitely rotates in counter clockwise direction. When $S1$ and $S3$ are closed and $S2$ and $S4$ are open then the ‘STALL’ condition will occur. Now depending upon the values of the Input and Enable the motors will rotate in either clockwise or anticlockwise direction with full speed (when Enable is HIGH) or with less speed (when Enable is provided with PWM) [4].

Let us assume for Left Motor when Enable is HIGH and Input 1 and Input 2 are HIGH and LOW respectively then the motor will move in clockwise direction. So the behavior of the motor depending on the input conditions will be as follows:

<table>
<thead>
<tr>
<th>INPUT 1</th>
<th>INPUT2</th>
<th>ENABLE 1,2</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>Stop</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>Anti-clockwise rotation</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>Clockwise rotation</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Stop</td>
</tr>
</tbody>
</table>
The motor driver IC deals with heavy currents. Due to so much current flow, the IC gets heated. So, we need a heat sink to reduce the heating. Therefore, there are 4 ground pins. When we solder the pins on PCB, we get a huge metallic area between the grounds where the heat can be released. The DC motor is an inductive load [2]. So, it develops a back EMF when supplied by a voltage. There can be fluctuations of voltage while using the motor say when suddenly we take a reverse while the motor was moving in some direction. At this point, the fluctuation in voltage is quite high and this can damage the IC. Thus, we use four capacitors that help to dampen the extreme variation in current.

V. FUTURE SCOPE

Automatic letter sorting operation opens a wide scope for future development. The technique can be extended to read handwritten letters using neural networks and fuzzy logic. Owing to the fact that every individual in the world has unique handwriting, setting the character training for every handwriting is beyond our imagination. Neural network and fuzzy logic work on artificial intelligence [1]. The algorithm behind this will identify any type of handwriting. So this method can be extended from printed official letters to any handwritten unofficial letters. If trained further, fuzzy logic can help identify and read different languages so that language will not be a barrier to receiving the messages from the loved ones.

VI. CONCLUSION

Application of modern control mechanism on letter sorting system may be an efficient approach to reducing the delays and mismanagements, experienced in our traditional postal system. Since the existing postal system is time-consuming and prone to human errors, it is high time that the Indian Postal Department is upgraded to new technology as soon as possible. Adoption of the evolving technology will find India a place in the list of fast developing countries, with a highly efficient and fast postal system in India.

Hence material sorting and stamping machine for letter Sorting is the first step towards such technological advancement. Letter sorting segregates printed letters on zonal division basis by using the advanced technology of image processing and software MATLAB powered by MATHWORKS. It is gaining popularity because of its flexibility in programming approach and hardware simulation. This method is highly efficient in sorting printed letters. Hardware that comprises this project is extremely sturdy, occupies very little space and is a one-time investment that provides invaluable future returns. Thus we have devised an efficient and smart letter sorting machine using image processing and MATLAB technology along with a well-equipped and modernized hardware structure consisting of the conveyor belt, stamps, and distribution Unit. Integration of above software and hardware provides us with the “Material Sorting and Stamping Machine for Letter Sorting”.

The major importance and advantage of this system are that it is small and compact and space occupied by the setup is very less of few meters square feet. This also avoids human intervention since the sorting is done by the program, thus preventing damages to the human eye. It also errors like misreading the pin code, misplacing the letters are impossible. The major constraint is the time which is overcome using this as machine oriented tasks are always fast, faster than the man can think of. Unlike the bar code method, there is no 2-step procedure: bar code generation and sorting according to the generated barcode are the 2 steps in barcode process, which is absent, in this...
operation. Any color envelope can be used: unlike the bar code method, envelope color requirement is not an issue.

REFERENCES


