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An Accurate and Efficient Technique for Envelop Sorting and Stamping

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ABSTRACT

Stamping envelopes is quite a tedious task in the postal services. Human errors and inefficiencies are among the problems related to this service. Most of the countries around the world perform almost all the postal operations manually. This includes manual envelop sorting and stamping. Having automated process to increase the efficiency in envelop sorting and stamping will truly increase the efficiency in the postal service. This paper focuses on a stamping machine which is fully automated, thereby requiring minimal human interaction. The essential part of the work is to design and implement a mechanical system for the stamping process. The major challenge was to produce such an automated stamping machine with low cost and minimal energy consumption, while meeting the requirement of the end users. A conceptual design has been developed, and a prototype has been built. The implemented system is able to detect envelopes and then perform the stamping on the envelope. Image processing techniques play a key role in this project. The stamping is given on top of the stamp which is pasted on the envelope. Statistics show that the functionality of the prototype is satisfactory. Hence, this project successfully converts the stamping process from a manual system to an automated system.

Keywords: Object recognition, Automated stamping

INTRODUCTION

Most of the postal services across the world perform postal operations manually. For example, envelop sorting and stamping, the traditional method is to seal or sort each envelop individually by a person. A particular block/die is first pressed against an inkpad, and then it is pressed onto the envelope. Practical issues such as loss of time efficiency and human errors can occur during this process [1]. High-energy consumption and overall customer dissatisfaction are among the problems that may arise. This manual processing may cause several other issues, such as inefficiency and human errors which, in turn lead to uneven production and the inability to reach target production. All these problems can be solved, at least partially by automating the envelop sorting and stamping process. In the proposed approach, this process is automated. Here, a mechanical system and an envelope processing equipment guide envelopes through a mechanical convey. The full system consists of software and hardware segments. The hardware consists of several components, including a control circuitry, sensors, rubber rollers, DC and servomotors, camera and motor controllers. Several challenges were faced during the design and implementation of the system. One main challenge was to detect the correct placement of the stamp on the envelope and punch the seal on it. For stamp detection, image processing techniques were used. As long as the light intensity is kept constant, the proposed algorithm for object detection was able to detect the stamp. Through the automated stamping, it is possible to make the stamp-sealing task much more time efficient and accurate. The proposed approach is designed to offer many advantages compared to the already existing systems. Two main objectives to be achieved with the proposed approach is as follows-

- The machine should be portable and of light weight compared to larger existing models.
- The machine should be fully automated, and thus requires minimal human interaction.

The proposed machine currently works as follows. When a pile of envelopes is placed in the feeder, the envelopes travel sequentially through the rubber rollers, while a picture of each envelope is taken by the camera. Each picture is then sent to the software program installed on a personal computer for stamp detection. If a stamp is detected, a

processing signal is sent to the controller board, which guides the servomotor to punch the seal. The envelopes travel forward through the rubber rollers with the help of the DC motors.

BACKGROUND READING

The term *automation* means to design, build and implement an automatic machine. A machine that can generate a larger volume of products with required quality and low cost is the ultimate engineering goal. In this aspect, manual and automated processes have significant differences on the final productivity. Each process has its own advantages and disadvantages. The manual process does not rely on power inputs. Hence, it can be operated even during times of power shortage. Furthermore, a manual system could identify deformed envelopes or any other variants of the system. This would allow the system to provide flexible throughput. Disadvantages of the manual system would be, for example, human error and inconsistencies. From this perspective, the automation of such process is very important. Capacity of an automated system could simply outrun the capacity of a manual system. Human resource can be utilized on other useful aspects in postal services. The disadvantages of the automatic process include, for example, the mandatory maintenance, which can be quite complicated and requires special skills. In addition, in case of mechanical breakdown, the whole system will be delayed until the failure is fixed. When it comes to stamping and sticker pasting, a similar approach is described in [2], where a stamping machine was designed to increase the efficiency related to manufacturing a particular food item. The requirement for this stamping machine has been the fact that the demand for this food item was on the rise and manual labour alone could not cater to the demand. Hence, an automated stamping machine has been developed. This machine is based on electro pneumatic control systems [2]. Some of the main components of this system were a PLC controller, compressor and sensors. An LED lighting system has been used to give signals related to machine functions.

A key part of the automated stamping machine is the stamp detection on an envelope. Here image processing techniques are employed. Image processing involves changing the nature of an image in order to either improve its pictorial information for human interpretation or to render it more suitable for autonomous machine perception [3]. In the case here, the latter function is used, and the information in an image of the envelope is used to render it more suitable for autonomous machine perception. According to the [4], a computer system was developed to recognize images of postal stamps using digital image processing. This system is called "System of Recognition of Postage" or "PSRS". It consists of five subsystems, such as acquisition of images, pre-processing of images, and extraction of characteristics, image recognition, and presentation of results. The accuracy of the system was 93.6%, with the average access time of 1.43 seconds per image. In [5] an automatic stamping machine was introduced. The proposed system uses MATLAB for scanning different pieces of postage stamps, detect and recognize the type of the stamp, and move the stamping seal accordingly in X-Y plan.

In practice, researches use various kind of experiments to recognize postage stamps. In [6] a method based on ink philatelic analysis by Proton Induced X-ray Emission (PIXE) was used to scan the quality of the stamps. This PIXE analysis showed that the control colour chemistry of the stamps of Mexico and reveal the origin use of inks on the European labels of both nations. This technique was used to determine the variations in paper types in the seals of China and Taiwan and how original is the stamp. In addition, it controlled the actual colour of the stamp, directly or indirectly, with bluish inks having relatively more zinc and lead and greenish inks that have relatively more titanium. And sometimes in conjunction with other analytical methods, to differentiate philatelic printing techniques, such as in order to quantify the differences between different shades, varieties and reprints of seals to separate genuine postage stamps.

METHODOLOGY

The proposed system consists of two main parts, namely hardware and software. The hardware section contains of number of sub modules, for instance envelop feeding, stamping, and envelop sorting. According to the given instructions, the software section controls all the hardware modules. Stamp detection is one of the key parts in this work. Image processing techniques were heavily used to tackle this problem. Fig. 1 shows the overview of the proposed approach. Here, all the envelopes which need to be stamped are first put into a pile and placed at the entrance point of the machine. Once the pile is placed, the first rubber roller pushes one letter at a time onto the next rubber roller as shown in Fig. 2. When the envelope reaches the third roller, the IR detector senses the presence of the envelope and send this information to the controller. An image of the envelope is then taken by the camera and sent back to image processing section. Through this process, the proposed algorithm was able to detect the presence of a stamp on the envelope. If there is no stamp on the envelope, a trap door controlled by the small server motor is opened and the envelope is pushed off the system, hence discarded.

If a stamp is detected as present, the envelope continues to travel through the system till it reaches the second IR sensor. Once this sensor detects the envelope, a signal is sent to the controller that stops the movement of the envel-

op. As shown in Fig.3 the controller then activates the large server motor, which the seal is firmly placed on the top right hand corner of the envelop (over the stamp).

A specific method to identify the stamp on an envelope is required. As noted in [3], a simple method in background subtraction was used in the proposed approach. This method ensures that the background of the envelop was not selected but small regions with different threshold saturations were selected. In the same article, the importance of edges in a certain image was highlighted. Edges of an image help to signify the boundaries of the stamp. Edges can also be used to determine the size of the object/stamp to isolate the particular object from their background. In [7-8], it was mentioned that there were various types of pictures on postage stamps, which might be difficult to identify. Therefore, there have been attempts to develop the software system, which can recognize postage stamps on envelopes using image processing technologies. An image of the envelop is captured using an ordinary web camera. The captured image is then converted to its grey scale as shown below in Fig. 4.

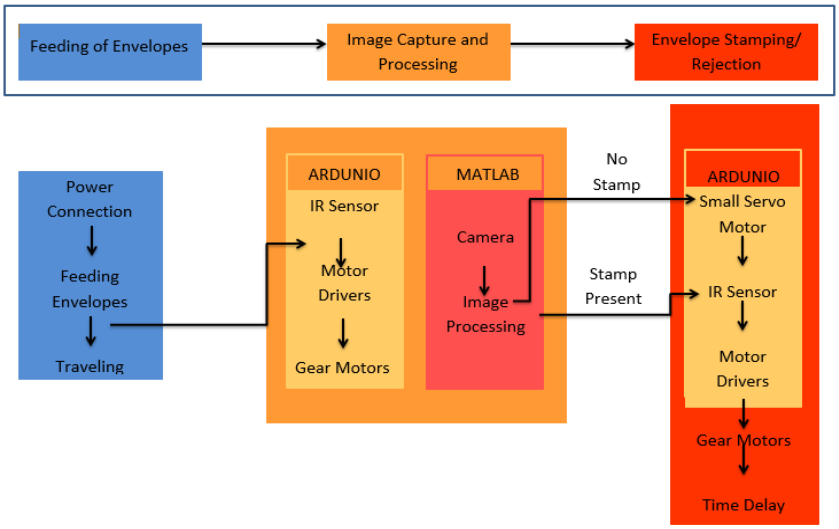

Fig. 1 Overview of the proposed system

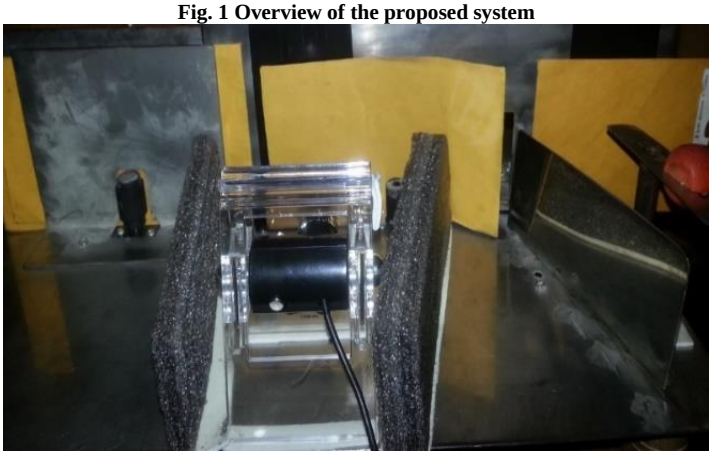

Fig. 2 The trap door opens to push the envelope away

Fig. 3 IR sensor detects the envelope and the stamp is sealed

Fig. 4 Original image and the converted grayscale image

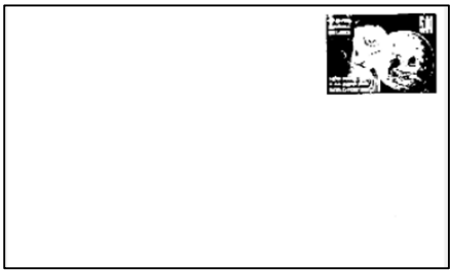

Fig. 5 Threshold value set and applied

Fig. 6 Image negative is taken

The gray scale ranges from value 0 (black) to value 255 (white). Therefore, 255 different intensities can be represented by the gray scale. A threshold value is then set. As shown in Fig. 5 this value is used to convert the gray scale image to a black and white image. The negative of the image is obtained. This means that the two colors are complemented as shown in Fig. 6. Noise in the image is cancelled. Borderline pixels and Unnecessary white parts are removed and the image is made clearer.

RESULTS AND DISCUSSION

Largest white region is recognized and the boundary is drawn across the region. In practice, multiple/several boundaries were marked. These multiple white regions occur due to irregularity of light intensities as shown in Fig. 7. Hence, the algorithm is written to pick the region area that is very much equal to a standard stamp. Here, also the height to width ratio of the selected region is checked to verify the highlighted region is truly representing a stamp in practice.

Stamp Detection

In order to determine the accuracy of stamp sealing, 10 piles of various envelopes (each pile included 10 envelopes) were sent through the machine. The envelopes were of various colours, sizes and some of them included stamps while others didn't. Here the stamp detection by the proposed system was 100% accurate as shown in Fig. 8.

Accurancy in Stamp Sealing

Here a few failures were observed due to the various sizes of the envelopes. In addition, failures in envelop feeding mechanism also cause a drop in accuracy in the sealing process. Since the stamping seal is fixed and could not move, was unable to place the seal in the correct place (over the stamp) and this too causes a drop in accuracy in stamp sealing as shown in Fig. 9.

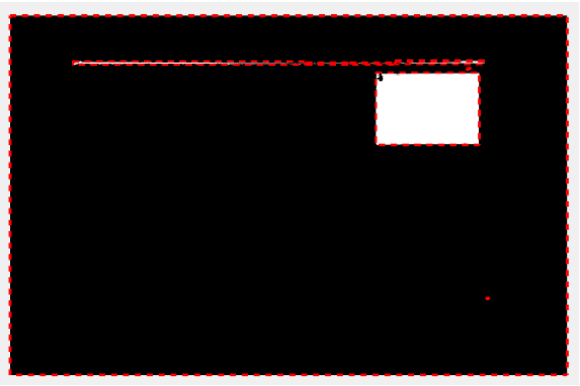

Fig. 7 Multiple white regions occur due to irregularity of light intensities

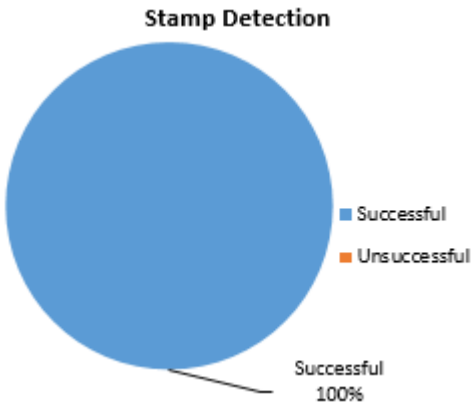

Fig. 8 Stamp detection

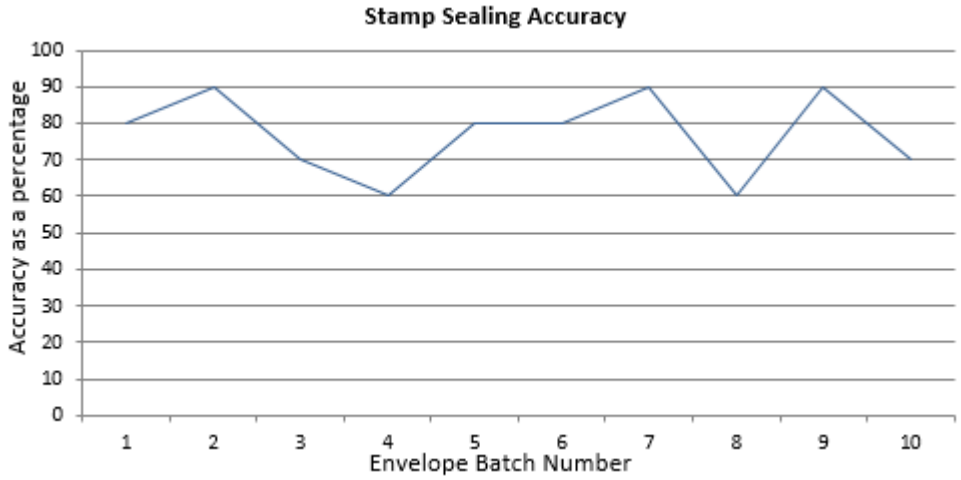

Fig. 9 Stamp sealing accuracy

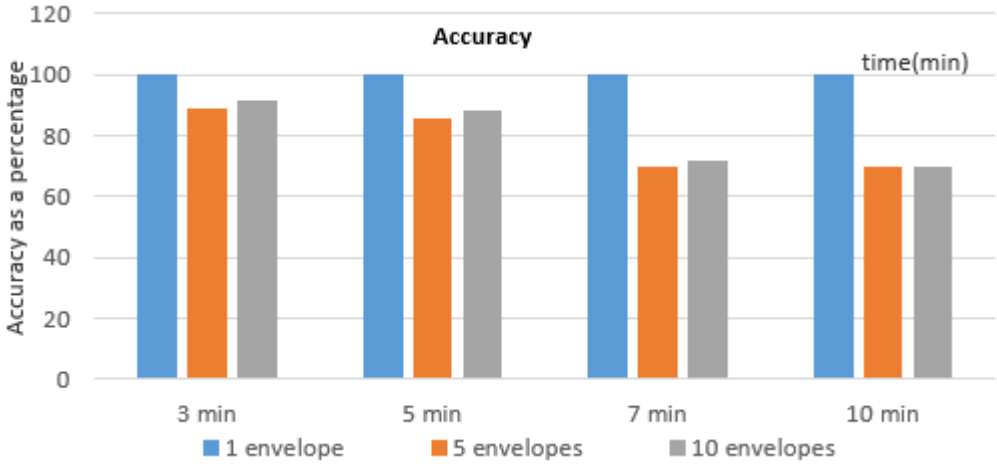

Fig. 10 Sealing accuracy

In order to further determine the accuracy of stamp sealing, envelopes were directed one by one and 5 piles (each pile included 5 envelopes) and 10 piles of various envelopes (each pile included 10 envelopes). They were sent through the machine within 3min, 5min, 7min and 10mins time intervals.

Fig. 10 shows that if we feed envelops one after the other the entire system works 100% accurately. Hence, mechanical failures are the main causes for dropping the accuracy of the stamp sealing process. Having a reliable and solid mechanical framework will improve the system accuracy and the efficiency as expected.

CONCLUSION

This work describes the key design methodology and implementation issues of an automated stamping machine. Here image-processing techniques were successfully used to detect the presence of a stamp. Hardware and software components were also designed and implemented to improve the efficiency in envelop stamping. This machine makes the process of stamp sealing much more effective when compared to a traditional manual method. All components and methods used to build this system was discussed and some failures are highlighted. Although the image processing section comes with 100% accuracy, there were some failures in the mechanical section. Hence, this research shows that having a solid mechanical system will yield 100% accuracy in the envelope sorting and stamping. This particular system could be improved in several ways. Further research is required to overcome the shortcomings of this machine and to develop the system further. For example, having multiple cameras or sensors can be used to identify any mechanical failures. Since stamps can be placed in any place on the envelope, it is better to have a special mechanical device to move the seal across the envelope, hence, improving the accuracy and efficiency in envelop sealing. Furthermore, some controlling mechanisms can be introduced to control the speed of the system. Thereby, an optimal speed for the system can be observed. In addition, text detection can be introduced to detect the address of envelops and to sort them accordingly.

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