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Design and Implementation of Various Algorithms for Automated Baggage Detection System in Airports for Safety

Kishan K K[1] and Dr. K.V.Mahendra Prashanth[2]
[1]PG Student, Dept. of ECE,SJB Institute of Technology, Affiliated to Visvesvaraya Technological University Bengaluru
e-mail:Kishan2841993@gmail.com
[2]Professor Dept. of ECE SJB Institute of Technology, Affiliated to Visvesvaraya Technological University Bengaluru
e-mail:kvmprashanth@sjbit.edu.in

***Abstract*—Aviation is one of the major means of transportation and baggage handling system at airport is also one of the major security issues. Security is the state of not being menacing, particularly palpably, mentally and vehemently or fiscally. Security is something that assures safety. It is an association or sector in charge of giving security by authorizing laws, standards and controls and in addition looking after request. There are several reasons for our luggage gets lost in transit. Lost during a transfer and missed connection, ticketing errors, bag switches or security issues, postponed because of airplane terminals, tariffs, climate or space/weight restrictions, and failure due to paraphernalia or botching luggages at ingress station, tagging error.**

To avoid the chances of the checked bag getting mishandled or may be lost for security reasons, solutions using automation has to be implemented. The paper describes the Design and implementation of various algorith ms for automated baggage detection system in airports for safety. Different approaches and methodologies are implemented in order to overcome the baggage mishandling issue. Raspberry Pi module is used to achieve the desired objective. To achieve the complete automation of this process, PiCamera, Web camera, LEDs, Buzzers are interfaced with Raspberry Pi module. Image comparison and correlation gives a strong input to understand if there were any changes in the area under observation. Modern prototyping boards and camera support to quickly prototype basic image processing concepts. Mean Square Error (MSE) along with Structural Similarity Index (SSIM) methods was utilized to gauge likeness between the baggage pictures. The programming language used is Python. The results obtained from the algorithms were impressive.

***Index Terms*—Mean Square Error (MSE Structural Similarity Index (SSIM); Raspberry Pi PiCamera; LEDs; Buzzers, Ladder logic.**

I. Introduction

Aviation is one of the major means of transportation and baggage handling system at airport is also one of the major security issues. Security is something that assures safety. It is an association or sector in charge of giving security by authorizing laws, standards and controls and in addition looking after request. There are

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different types of methodologies or the technologies being adopted to check the baggage and humans at the airport. The technologies like Barcode scanning [12], QR Scanning [13], X-ray scanning [14], Puffer machines [15], Magnetometers [16] are presently being used at airports. Here in this project a few methodologies in improving the baggage handling system and the security at the airport are discussed and assessed. A practical method of accomplishing the raison d'être of the Airport Security System is to play out a security control of the people and their stuff before they are boarded on an aero plane. Then again it addition ally includes the alleged ambit security i.e. the avoidance of unlawful access to the security confined zone and its censorious parts (European Commission, 2008).

The security control is a complex process that involves numerous devices whose effectiveness and pace of operation has a big impact on the ability of the ASS to perform its functions [19]. In reference to peripheral security most commonly used are fences that should inhibit or prevent the access to the airport. In case of forcing the entrance or entering the restricted a rea in another way, an aid in detecting the intruders may be: Man or car patrols, underground sensoric cable, fence sensoric cable, CCTV cameras, motion detectors, radars, microwave barriers.

The baggage handling system has major impact on the security; especially in the airports. Improving baggage handling systems helps in many ways; to handle baggage in precise ways, to detect presence of explosives, any destructive materials in the baggage for security purposes. There are several technologies already being implemented in the airports. In our project the different, effective and advanced technologies for detecting and tracking baggages in airports being adopted in the past one and half decade (2000 to 2015) have been studied and being compared. RFID adopts distributed architecture and has advantages like high accuracy, trading of with the cost. The new 3D CT baggage enhancing image algorithm enables to know the contents inside the baggage, providing better security at the airports. Fuzzy system is a low cost high precision system; which also contemplates human role apart from scrutiny of baggage. Though, the complicity in implementing of simulated annealing methodology is less. Comparatively Real time smart tracker consumes low power.

II. IMPLEMENTATION OF AUTOMATED LUGGAGE MONITORING SYSTEM IN AIRPORT USING VARIOUS ALGORITHMS AND METHODS

A. PLC supported by Ladder logic software

Due to the increase in the number of passengers and hence their luggage day by day, it is difficult to monitor the luggage at every station of airports. One of the method to overcome the problem is to develop a luggage monitoring system which is based on the monitoring the luggage using Infra-Red(IR) sensors,Relays,Solenoids,Adaptors, Programmable Logic Controller(PLC)-Indralogic_L20_DP, real time video and image processing techniques. Initially the different Infra-Red (IR) sensors are arranged in 4X4 matrix on a cardboard. Let the sensors be designated as A, B, C, D and G. If the sensors A, B, C, D and G are ON; then Luggage 1 is detected. If the sensors A, B and C are ON; then Luggage 2 is detected. If the sensors A and B are ON; then Luggage 3 is detected. The delay of 2s is given between two Luggages. At time T1 number of luggage are counted and the information is stored in the processor and at time T2 number of luggage are counted and the informat ion is stored in the processor and they are compared to identify the lost luggage and additional luggage. The Fig 1 shows the screen shot of operation of automated luggage monitoring system using ladder diagram. This ladder diagram needs to be interfaced with the image processing in order to work in real time.

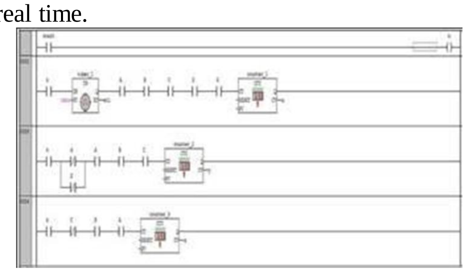

Fig 1: Ladder Logic for Automatic Luggage monitoring system

When the PLC program is executed the timer operation will start. The four IR sensors are scanned sequentially with 4 seconds delay. Initially in the program we assume all the baggages are present. After 4

seconds the result will be the blue line marking appear indicating that there is no change. In the next step when we change the baggage at some position, for instance third position and run the PLC program, result will appear as red line marking indicating that there is change in the third position.
The main advantages of A. PLC supported by Ladder logic software are human intervention is eliminated, the functionality of the prototype can be extended to any extent since the PLC offer extendable I/O and can control any number of processes, the prototype involves the minimum mechanisms. Baggages are identified based on the physical dimension but not on the color. Hence if the baggage is replaced by another baggage of same dimension but with different color, it will not identify.

B. Using Contour technique

As the name implies, contour approximation is used to reduce the number of points along a contour by “simplifying” the contour based on a percentage of the perimeter. The resulting contour approximation is the simplification of the shape by utilizing pixel points that are already part of the shape. The procedure includes the following steps. Import the necessary packages (ShapeDetector, ColorLabeler). Construct the argument parse and parse the arguments. Load the image and resize it to a smaller factor so that the shapes can be approximated better. Blur the resized image slightly, then convert it to both grayscale and the L*a*b* color spaces. Find contours in the threshold image. Initialize the shape detector and color labeller.Loop over the contours. Compute the center of the contour. Detect the shape of the contour and label the colour. Multiply the contour (x, y)-coordinates by the resize ratio, then draw the contours and the name of the shape and labeled color on the image. Show the output image.

Fig 2. Screenshot of the initial status of the cabin.

Fig 3. Screenshot of the cabin after applying shape detector.

Fig 4. Screenshot of the result obtained using Contour technique.

The advantage of Contour technique is that it will identify the missing baggage more accurately. Contour technique will recognize red, green and blue color of the baggages. The major drawback is the Contour technique will not identify the shapes of the baggages other than standard geometrical shapes such as rectangle, square, circle, and pentagon.

C. Using PiCamera,LED and Buzzer

The prototype of the cabin is made using thermocoal sheets.Picamera/web camera ,LEDs,Buzzer and other IO devices are interfaced to Raspberry Pi module. Though Contour technique which is discussed in the previous section identifies the shapes and color of the baggages, it cannot identify the shapes of the baggages other than standard geometrical shapes such as rectangle, square, circle, pentagon,etc. In this method baggage of any shape is detected and missing baggages can also be identified. The prototype of the cabin is made using thermocol box. Eight white LEDs are embedded .This is connected to breadboard having Resistors of

1k,green ,red LEDs and power supply. PiCamera is used to capture image. Initially image of the empty cabin is captured using PiCamera. Then the cabin containing the baggage is captured using PiCamera. Their Mean square error is calculated. If it is less than 100 then the green LED will glow and the message “Cabin is empty is displayed” else Red LED will glow displaying “Cabin is full”. Later cabin image is captured with different baggage. Then Mean square error of them is calculated. If it is 1 then images are same else images are different.

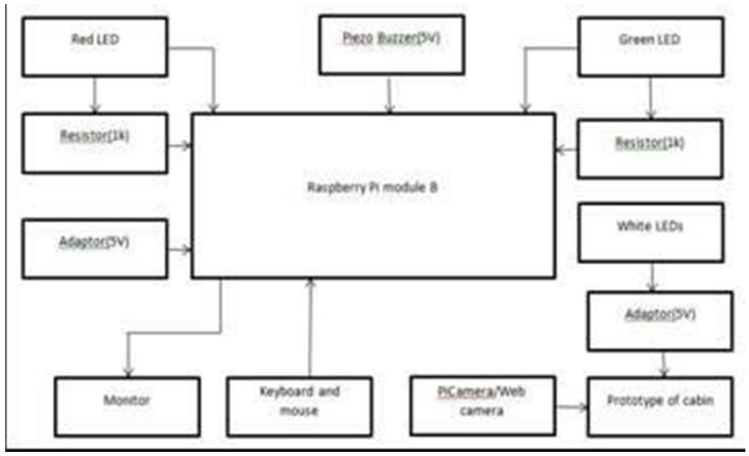

Fig 5. Block diagram of automated luggage monitoring system using PiCamera, LED and Buzzer method

The proposed system block diagram design is as shown in the Figure. The raspberry Pi module B is the microprocessor which is the brain of the proposed prototype that receives/provides the control signals from/to various modules that are being controlled by it. The proposed system consists of one green LED and one red LED which are mounted on the breadboard ,connected through two resistors of 1k ohm.Piezo buzzer of 5V is also mounted on the breadboader.These are connected to Raspberry Pi module through GPIO pins. Adaptor of 5V is used as the source of power supply for Raspberry Pi module. Keyboard and mouse are used as input devices for Raspberry Pi module. Monitor is used as output device for Raspberry Pi module. The prototype of cabin is made using thermocoal sheets. Eight white LEDs are mounted on its inner surface for more luminance. The LEDs are powered by 5V adaptor. Camera is mounted on the lid of the prototype and connected to Raspberry Pi module.

Fig 6. Image of the experimental setup.

Fig 7. Screenshot of the initial status of the empty cabin.

Fig 8. Screenshot of the cabin having baggage

The advantage of using PiCamera is that the image clarity is excellent .The approach used is simple and lucid. The limitations are only single image is compared, more image comparison is not possible, area covered by PiCamera is limited. Baggage colors others than red, green and blue identification is tedious.
This is more effective approach compared to other approaches. PiCamera resolution is good compared to other cameras but PiCamera is costly and highly sensitive to dust. Hence maintaining PiCamera is difficult. Baggages having colors other than Red, Green and Blue identification is very difficult.

D. Using pixel identification algorithm

MSE is a signal fidelity measure. The goal of a signal fidelity measure is to compare two signals by providing a quantitative score that describes the degree of similarity/fidelity or, conversely, the level of error/distortion between them. Usually, it is assumed that one of the signals is a pristine original, while the other is distorted or contaminated by errors . The SSIM method is clearly more involved than the MSE method, but the gist is that SSIM attempts to model the perceived change in the structural information of the image, whereas MSE is actually estimating the perceived errors. There is a subtle difference between the two, but the results are dramatic.
Furthermore, the SSIM is used to compare two windows (i.e. small sub-samples) rather than the entire image as in MSE. Doing this leads to a more robust approach that is able to account for changes in the structure of the image, rather than jus t the perceived change. The parameters to SSIM include the (x, y) location of the N x N window in each image, the mean of the pixel intensities in the x and y direction, the variance of intensities in the x and y direction, along with the covarian ce. Unlike MSE which takes 0 values for perfect similarity, the SSIM value can vary between -1 and 1, where 1 indicates perfect similarity.
The method includes the following procedure. Image 1 of the cabin is taken as original image and image 2 of the cabin is taken as modified image. Both the images are cropped in terms of pixels according to the baggage size. Then corresponding cropped images MSE and SSIM are calculated. If MSE is less than 100 and SSIM is equal to one then the result is displayed as “No change detected” else “Change Detected”.
The pixel identification algorithm displays owner information, identifies the changes in the cabin, takes into account of baggages of different sizes and colours,SSIM provides more flexibility than singlescale approach in incorporating the variations of image resolution and viewing conditions, with appropriate parameter settings, the SSIM outperforms the best single-scale model as well as state-of-the-art image quality metrics,SSIM has been used for evaluating image processing results in a rapidly increasing number of exciting applications. Such as wireless video streaming, visual surveillance, radar imaging ,digital camera design, infrared imaging , MRI imaging, chromosome imaging, remote sensing ,target recognition, image fusion , image compression, image watermarking ,chromatic image quality ,retinal and wearable displays, Video hashing. The major limitation is that the pixel identification algorithm cannot detect white baggages.
The pixel identification algorithm uses a pixel as a reference pixel. This pixel is used to detect the presence/absence of the baggages of different shapes, colors and sizes. The information of the baggage owner is stored in the data base. In the result along with the baggages, the owner information such as name, ticket number, boarding at, destination place and also whether change in the baggage is position or any baggage is missing or not. The major drawback of the Pixel identification algorithm is it cannot detect the white baggages.

III. CONCLUSION

Various algorithms for automated baggage detection system for applications like airports for safety has been designed and implemented.. The different algorithms and methods used in airport for automated baggage monitoring such as using PLC supported by ladder logic, contour technique,MSE and SSIM technique using pixel identification method were implemented. The image synthesis approach to calibrate the parameters that define the relative importance betwee n scales has been used. The improvement from single-scale to multi-scale methods observed in the methods, proposes the effectiveness of this idiosyncratic approach. The prototype though it is designed for airport security applications, the same may be used for other security applications such as harbors,dockyards,railways,roadways and it can also be used in the domestic and medical fields,etc. The impimented algorithms showed the best results under suitable conditions. The prototype was observed to be working satisfactorily and effectively with good accuracy and precision.

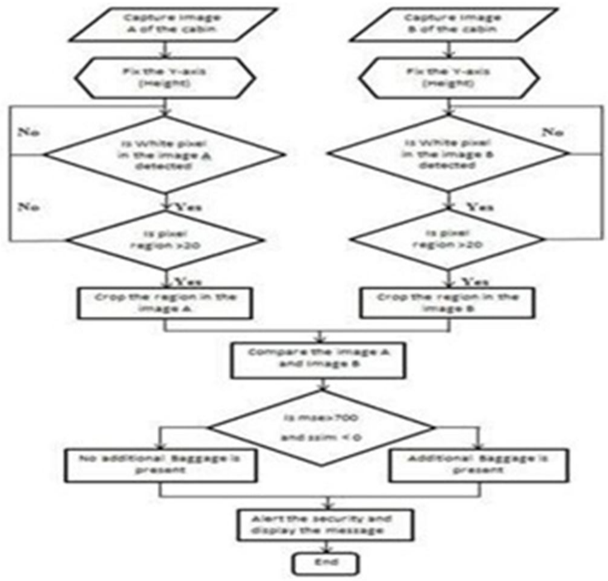

Fig 9. Flow Chart of automated luggage monitoring system using pixel identification algorithm.

Fig 10. Screenshot of the initial status of the cabin.

Fig 11. Screenshot of the changes observed in the cabin.

Fig 12. Screenshot of the result obtained using pixel identification algorithm.

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