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RESEARCH ARTICLE

DESIGN OF AUTOMATED BIOMEDICAL WASTE SEGREGATION UNIT USING IMAGE PROCESSING

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ABSTRACT

The management of health care waste is a subject of considerable concern to public health and infections-control specialists, as well as the general public. Careless disposal of wastes may lead to transmission of communicable disease spreading through air, water and direct human contact with blood and infections of body fluids. Diseases are spread by improper treatment and disposal of wastes while handling items like needles, surgical gloves, blood bags. This paper is about segregation of medical waste automatically instead of the conventional colour coding method. Colour codes cannot be memorised by any one and interpreted correctly. There is also a possibility of infections when hospital staff try to dispose the waste themselves without the knowledge of becoming infected. So to prevent the disease spreading and color-codes identifications, we have proposed the idea to develop an automated waste segregation unit without human contact.

INTRODUCTION

The aim of this project is to prevent infection that spreads to hospital staffs due to manual and sometimes improper disposal of wastes. Mixing the two color codes wastes to be avoided and also prevent the air pollution and sand pollution of improper segregation of wastes.

HARDWARE COMPONENTS

The hardware used is as follows:

- Arduino Mega
- DC motor
- Relay Circuit
- Transformer
- Voltage regulator
- Interface Max232
- Conveyor belt
- 2x8 Liquid Crystal Display

The Arduino mega is used here for control the dc motor and pusher gun for waste segregation. Initially Biomedical or biological Waste will be placed onto a conveyor belt which is then captured by the camera further there will be image processingprocess involved onto the captured image. Then the captured image is analyzed within the database which then activates the pusher gun. The input wastes is pushed through the gun and are dragged into the color coded waste bag the indication of this process is displayed on the LCD.

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SOFTWARE COMPONENTS

MATLAB software is used in the process of development and integration for the project. The source code for the image acquisition, pusher gun control is developed on the Arduino mega microcontroller board.

HARDWARE SETUP

Camera is mounted in front of the conveyor belt and is connected to the computer.The image processing is widely used in automation of processindustries. The process setup consists of a conveyor belt on which the wastes are moving with a constant speed. The conveyor belt is operated at a speed of 1m/s, making a rate of 3 different color wastes per second. The system used in this paper is that speed of the motor is controlled by the user from the front panel window of the Arduino software. The wastes before being disposed needs to be checked and segregated based on the type of the color code.TheDisposal of wastes is carried out by the conveyor belt running at a high speed making it essential for the proposed process of segregation through automation which avoids the mixing of different color coded wastes.Once the wastes are segregated it is separatedin individual bags. Automation in the waste segregation is a very essential activity of a hospital waste management.

PROBLEM STATEMENT

To achieve the objectives of the proposed work it is required to choose a non-contact method for segregation of biomedical waste. To achieve this objective following steps are involved.

- Capture image of the waste from the conveyor belt.
- Apply image processing technique to analyze the image and identify the color of the waste.
- A technique is used to segregate the waste based on color codes.

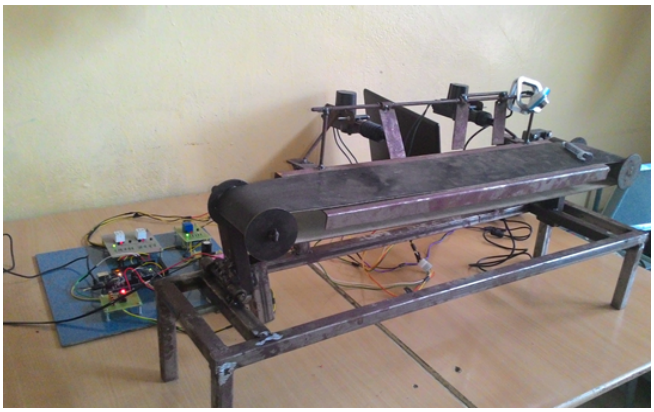

Fig. 1. Biomedical Waste Segregation Proposed System

YELLOW BAGS	RED BAGS	BLUE BAGS	BLACK CARBOY
human anatomical wastes, tissues, placenta, organs and other body parts, solid with blood and body fluids like bandages, cotton dressing, plaster caste and linen clothes.	infected plastic items, solid waste, blood bag, IV set, urinary bag, catheter, drain tube, gloves, cap and mask, syringe without needles, plastic IV bottles, soiled rubber sheet, lab vacutainer and microbiology culture materials.	non-infected glass items, glass bottles, non-infected plastic and bottles.	cytotoxic waste, discarded medicines, cytotoxic drugs and chemical waste.

Fig. 2. Different Types of Color Codes for Biomedical Wastes

PROPOSED SOLUTION

Having obtained the image of conveyor belt on which the biomedical wastes are moving it is processed to identify the color coded wastes.Once the segregation of wastes is made based on the color coded wastes, it is subjected to avoid the mixing of two different color code wastes.The whole process is divided into two stages a. color coded waste identification b. Segregation.

COLOR CODED WASTE IDENTIFICATION

The color coded wastes which are moving on the conveyor belt needs to be first identified. For identification of color coded wastes the following process are incorporated

- Selection of region of interest
- Edge detection
- Identification of color coded waste

REGION OF INTEREST

Rectangular type of ROI with coordinate values for left, top, right, bottom is created from the entire image. Also we can use different types of ROI like point, line, oval, annulus etc. The inspection will automatically pass if measurements necessary to determine the ROI are available and the coordinates of the ROI are valid. ROI is drawn on top of an image using the operation ImageGenerateROIMask.

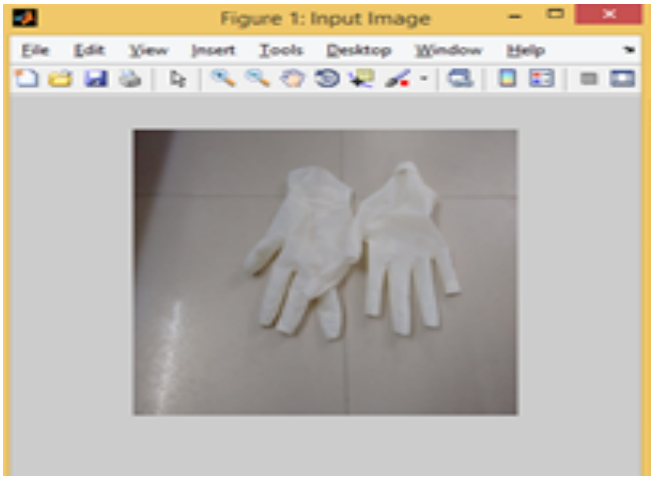

Fig.3. Region of Interest in the Input Image

EDGE DETECTION

Edge detection refers to the process of identifying and locating sharp discontinuities in an image. The discontinuities are abrupt changes in pixel intensity which characterize boundaries of objects in a scene. Classical methods of edge detection involve convolving the image with an operator (a 2D filter), which is constructed to be sensitive to large gradients in the image while returning values of zero in uniform regions.

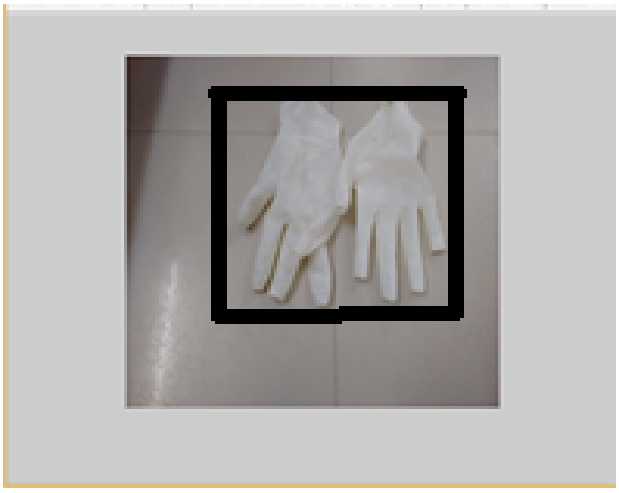

Fig. 4. Edge Detection of Input Image

IDENTIFICATION OF COLOR CODED WASTE

Having obtained the region where the color detection should be carried out the edge detection algorithm is used to identify the borders of images. The acquired biomedical waste image is subjected to various processes like image segmentation, feature extraction, threshold image for saturation plane, histogram image, median filtering, Gaussian image, homogenized image, HSV image, hue image, saturation image. These image processing steps used to identify the type of color coded waste.

SEGREGATION OF BIOMEDICAL WASTE

Once the color coded biomedical waste image is identified, segregation of wastes is to be done. For segregation in the proposed work three solenoid trigger guns are used.

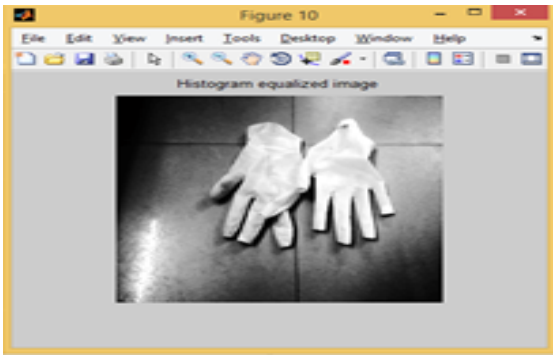

Fig. 5. Histogram Equalized Image

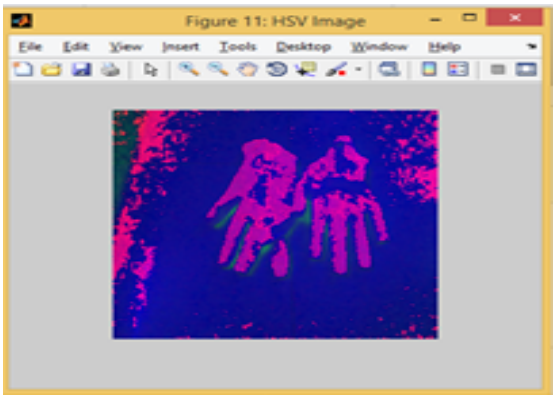

Fig. 6. HSV Image

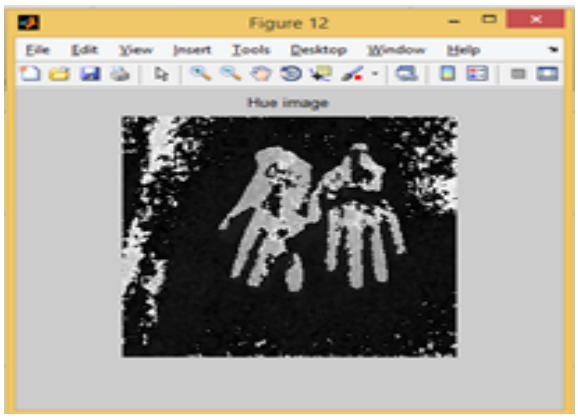

Fig. 7. Hue Image

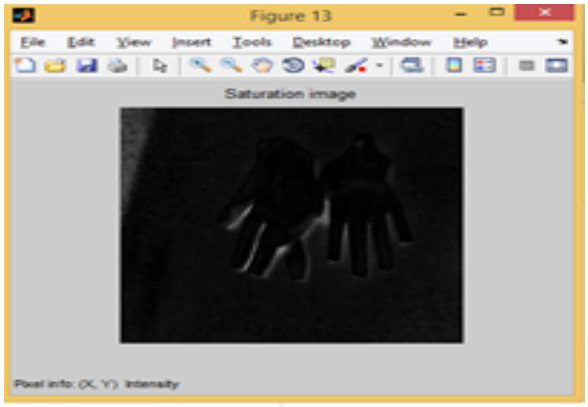

Fig. 8. Saturation Image

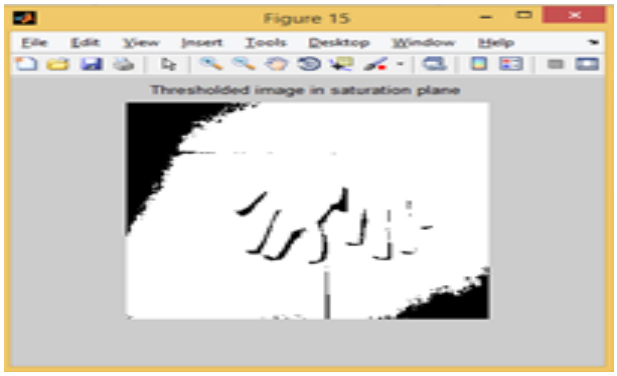

Fig. 9. Theshold Image

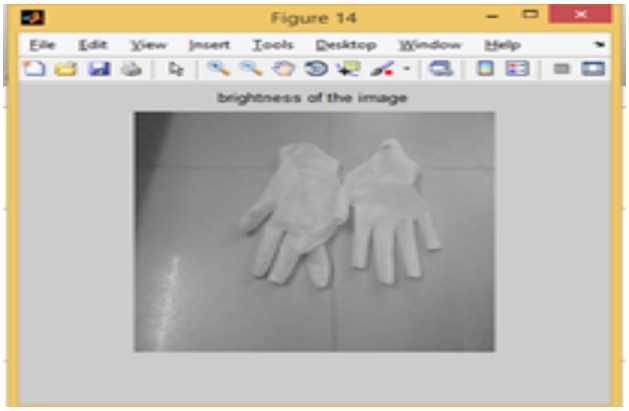

Fig.10. Brightness of the Image

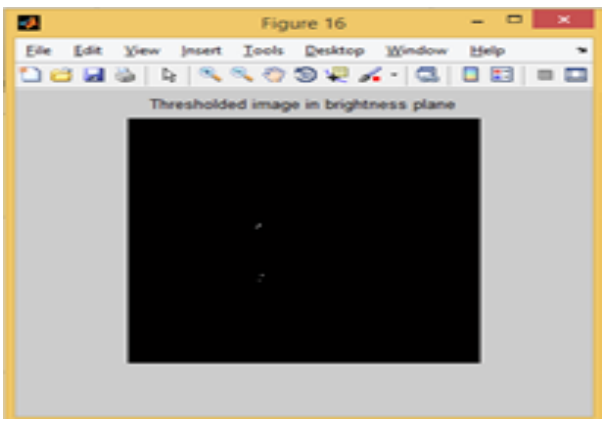

Fig.11. Threshold Image in Brightness Plane

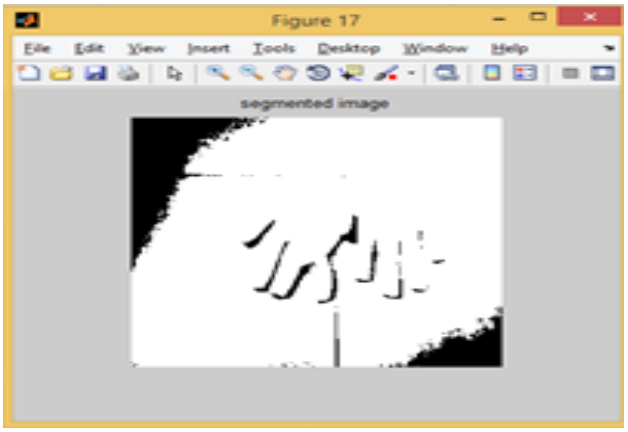

Fig.12. Segmentation Image

Fig. 13. Result displayed in the message box

Based on a particular biomedical waste color codes, respective trigger is initialized to trigger the biomedical wastes out of the conveyor. The conveyor belt consist of three trigger guns of different tension levels so as to shoot the biomedical wastes to different conveyors running in parallel, which carry 3 different colors yellow, green and blue respectively. (But in the proposed setup we have placed three baskets. Since, it was not economical to fabricate three conveyors in the facility. The distance between the camera and the trigger guns are fixed.

METHODS

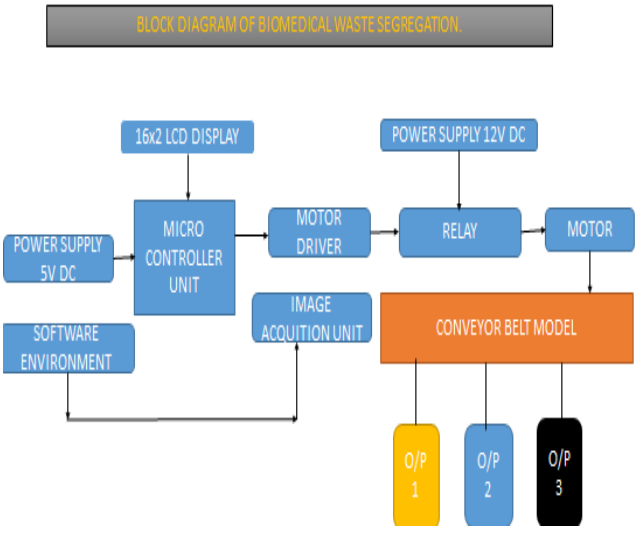

Fig.14.Block Diagram of Biomedical Waste Segregation Unit

Since the speed of the conveyor is controlled by the program based on user inputs, the time required for a biomedical waste to travel from camera to trigger gun can be computed.

Once the program identifies the color coded of biomedical wastes, respective trigger gun is initialized to trigger so as to move the biomedical waste to its respective conveyor. In the proposed model, only three color coded biomedical wastes are considered so we use three trigger guns. This can be increased or decreased based on the application.

PROPOSED SOLUTION IMPLEMENTATION

Implementation in the proposed work, MATLAB platform is used for programming. The MATLAB window shows the image on which segregation and its analysis are done. Arduino mega is used to control the trigger guns and operating the whole setup. Control board consists of transformer, regulator circuit, three relay circuits, Arduino mega board, interface circuit (max232 IC, capacitor). Once the program is executed the camera capture the images and the MATLAB used for image processing works such that the time reference image and captured images are compared then pusher guns used to move the wastes out of the conveyor belt. The corresponding waste is segregated by the appropriate waste box.

ANALYSIS

The proposed technique for segregation of biomedical wastes using image processing is programmed by using the block diagram of MATLAB. Three different colors coded biomedical wastes are classified by this proposed technique. If a scenario wherein unwanted waste are placed on the conveyor belt then the three pusher guns will not work and finally the waste drops straight into the non-color coded waste bag.

DISCUSSION

An automated technique for classification and segregation of biomedical wastes based on color codes is reported in this paper using image processing techniques. The images once acquired are subjected to edge detection, histogram normalization for the classification of color coded wastes using support vector machine algorithms.

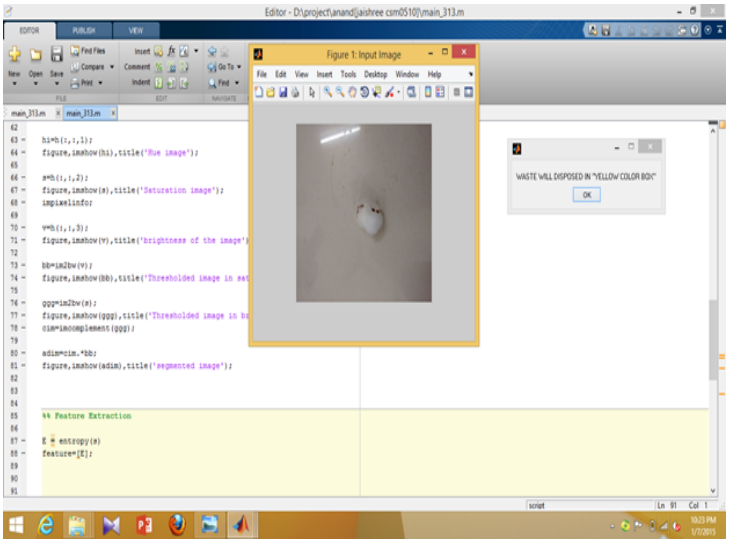

Fig. 15. Result is the Yellow Color Coded Biomedical Waste to be Identified

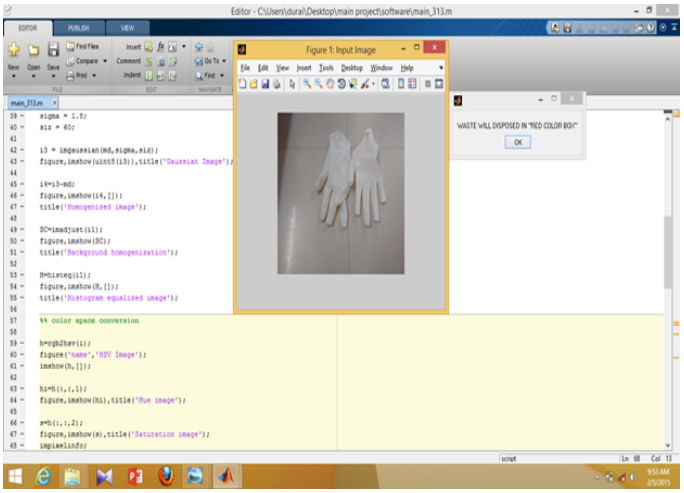

Fig. 16. Result is the Red Color Coded Biomedical Waste to be Identified

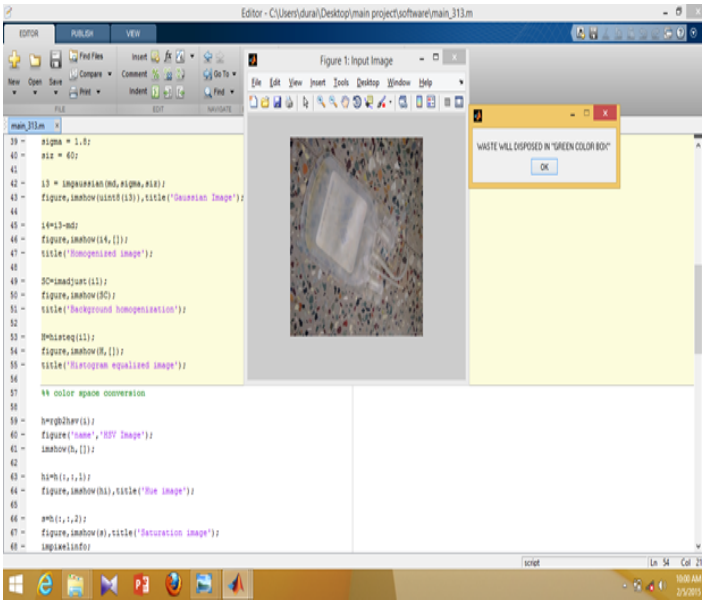

Fig. 17. Result is the Green Color Coded Biomedical Waste to be Identified

Finally, on identifying the color coded wastes, segregation of wastes is done using three trigger guns placed near the conveyor. Result of the proposed technique for test cases shows the successful implementation with an accuracy of 95%. Efficiency of the technique can be improved in future.

RESULTS

An image processing based automated classification system in biomedical waste management for segregation of biomedical wastes based on color codes is implemented using MATLAB.The proposed technique was subjected to test with three different color codes like red, yellow, blue color wastes. By this process many infectious disease can be prevented by spreading in the hospital facility.

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