

A Novel Robotic Aid for Physically Challenged Implemented using Image Processing

M.Mounika¹, M.SatyaVarshini², Dr.B.V.D.S.Sekhar³, Dr.S.Venkataramana⁴,
 Dr. Bh.V.S.R.K Raju⁵

^{1,2} (3rd year B.Tech Information technology, SRKR Engineering College, Bhimavaram, A.P, India,

^{3,4,5} (Department of Information technology, SRKR Engineering College, Bhimavaram, A.P, India,

Corresponding Author : M.Mounika

ABSTRACT

Robots have the potential to become the greatest industrial tool we ever made. Images are playing a crucial role now-a-days. The whole world is fully digitalized. We can see that everything is authorized by CCTV cameras in many places such as Banks, Roads, ATM's etc. Using Arduino board and other electronic components, a robot is developed which can be controlled through digital information. The digital image is processed using image processing techniques which takes the input data from the user who can give commands with gestures [1]. We discuss image processing operations like removing noise and edges, finding contours[8], thresholding[7] etc using OpenCV library. Based on the movement of the colored object in the continuous images (frames), we control a robot. Generally, the robot can be controlled in different ways like by using application, keyboard, voice, hand gestures [4] etc. Here we control the robot with the colored object. Hence, robots with Vision Guided Systems are much more efficient. This can be further extended to help the disabled people who cannot walk but move their hands. They can get the required objects with the help of robot that can be controlled by their hand gestures [2].

Keywords: Arduino, Open CV, Gestures, Physically Challenged, Robot, Thresholding

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I. INTRODUCTION

Robotics is a branch of science and engineering which deals with design, operation, conception and robot[5] manufacturing. This branch involves design planning, construction, control robots utility, feedback from sensors and process of information .This technology follows the human commands. Here the instructions are nothing but the image captured by camera. Image is finite set of pixels in which a pixel is array of intensity values. Every image has some attributes like number of channels which defines dimension of pixel array and depth defines maximum bit size of number stored in array. The 3 types of images Binary , Grayscale, RGB.



Fig1: Different intensity level images

Types	Depth(Bits)	Number Of Channels	Possible Values In Each Channel
Binary Image	1	1	0(Black) or 1(White)
Grayscale Image	8	1	0 to 255
RGB Image	8	3	R – 0 to 255
			G – 0 to 255
			B – 0 to 255

Table 1: Types of Images

II. SYSTEM OVERVIEW:

OpenCV: It is a library which stands for “OPEN SOURCE COMPUTER VISION”. Some enthusiastic coders initiated this to introduce image processing into different coding languages (C, python , C++) on different platforms. Here we focus mainly on python using windows. “CV” contains main OpenCV functions, Image Processing, Vision Algorithms [2].

Image Processing: It is a set of technique and algorithm that applied on digital image to analyze,

optimize and enhance characteristics of image like contrast and sharpness. Most image processing techniques treats image either as a matrix or a signal and applies standard matrix manipulation or signal processing techniques. Here we consider n D-matrix where n represent number of channels of image. Here we use few operations of image processing such as below.

Image Smoothing: Image blurring or smoothing [6, 9,10] is used to remove noise from images. It actually eliminates high frequency contents like edges and noise from images. It is also effective in reducing pixellation of image. There are several methods for image smoothing like Averaging, Median Blurring, Gaussian Blurring, and Bilateral Filtering. Here we focus on Gaussian Blurring.

Gaussian Blurring: Here we use Gaussian kernel. It smoothens [6] an image using Gaussian Filter which is weighted average of intensities in the pixel neighborhood. We use function “cv. Gaussian Blur ()” for this technique.

Contours: A contour [8] is formed by joining the continuous points which have same intensity or color. Contours [8] are used for analysis of shapes, object detection and recognition. Contours are the white objects on black background in Open CV. Every contour is numpy array of boundary points of an object

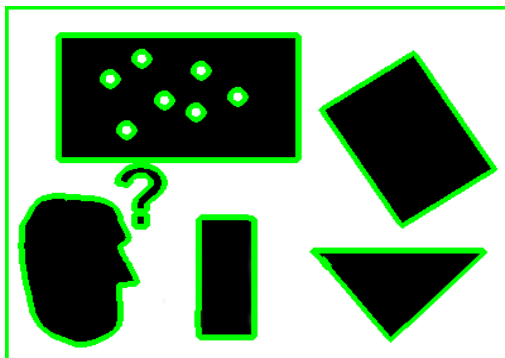


Fig2: Different types of Contours

Arduino: Arduino is a micro-controller. It is collection of software and hardware. It is used in embedded environment. Here we use “Arduino Uno”. Arduino Uno uses ATmega328 which is 8bit microcontroller,16 digital input /output pins and 6 analogpins, VCC, GND(ground),TX(transmitter)and RX(receiver) for serial communication ,on-chip flash memory for storing program, pins with tilt(~) sign used for PWM(3,5,6,10,11 pins) ,16MHz crystal oscillator for clock pulse, USB to interface arduino Uno with computer that is for uploading code and charging in absence of external power supply, reset button for re execution of already uploaded program , 6 pins for ISP programming[5].

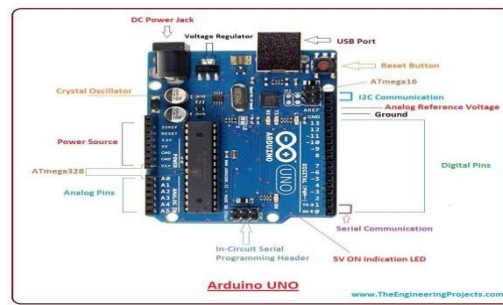


Fig 3: Arduino Uno Pin configuration

Motor Driver: Here we use DC Geared Motor since voltage supplied by arduino (5v) is not sufficient we use Motor Driver containing L293D IC . It is an interface between arduino and motor. This can control maximum of two motors.

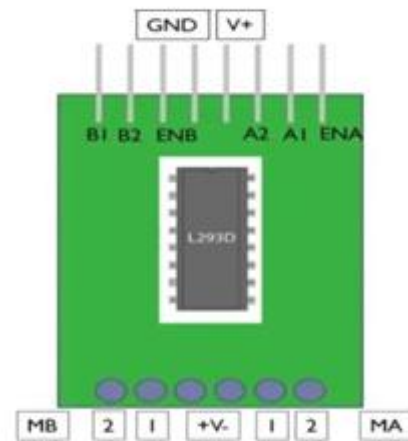


Fig 4: Pin configuration of L293D motor Driver

- V+ and GND are used to power motors via Motor Driver
- Corresponding Motors connected to ENA and ENB can be controlled only when these are HIGH
- INP A1 is input to MA1 and INP A2 is input to MA2
- INP B1 is input to MB1 and INP B2 is input to MB2
- Above 8 pins are inputs of Motor Driver and below 4 pins are output pins.

III. PROPOSED SYSTEM:

Here interaction with physical and digital world is achieved by computer front camera. Camera starts recording live video using method “VideoCapture” of OpenCV[3]. We know video is ordered collection of frames (images) so, processing of sequential images continuously results in processing of video. Now each frame should

undergo certain processing operations for recognition of target color. The output after processing the image is an image in which we can see parts which are in specified color. We can see neither user's hand nor background.(should we mention that background should not contain target color) Operation includes smoothening of image using "Gaussian Blur" (image is at ...), Thresholding[7] using "inRange" function. (Here we should consider a black frame of size equal to size of frame of video and convert a part of size equal to grid(4,4) into white colour(255,255,255).(as shown in the figure...). Now perform "logical AND"(masking) for this whitened frame and smoothened image to obtain grid part of the smoothened image(as shown below). Here we give HSV image for thresholding [7] so, we convert smoothened and masked frame of video to "HSV".

Now we find contours [8] from above threshold image and among the list of contours we consider the one which has maximum area. Now green color pointer is tracked at centroid of the contour using "cv.circle" function. Now based on the position of pointer on the frame of video the robot is moved in forward, backward, left, right and stop.

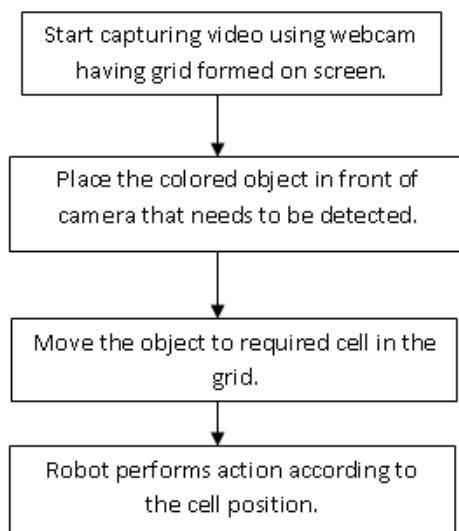


Fig 5: Flow diagram of proposed method

Algorithm:

- Step-1: Process initializes with capturing video (collection of frames or images).
- Step-2: Smoothen every image using Gaussian Blur to remove noise and irregular edges.
- Step-3: Construct a 3*3 red color grid by specifying coordinate values.

Step-4:Mask (logical AND) every image with n-D array in which grid part is white (255,255,255) and remaining part is black (0, 0, 0).

Step-5: The above steps result in the captures image within range of grid coordinates.

Step-6: Thresholding [7] is done on images to convert RGB to HSV.

Step-7: Find the range of object color that we use for controlling robot.

Step-8: Perform thresholding[7] to identify parts in image which are in range of object color.

Step-9: Find contours[8] list in the thresholded image.

Step-10: Consider the contour which is of maximum area as resultant contour.

Step-11:Consider the centroid of resultant contour as position of object.

Step-12: Based on the centroid position on grid, the robot moves in specified direction as shown in below table.

IV. RESULTS:

Pertaining to the proposed work carried out results are given below

Table 2 : Coordinates Range of boxes in Grid

X-Coordinate	Y-Coordinate	Action Performed
150-250	50-150	FORWARD
150-250	250-350	BACKWARD
50-150	150-250	RIGHT
250-350	150-250	LEFT
150-250	150-250	STOP

Different image outputs obtained in this work are shown below from Fig 6 to Fig 11

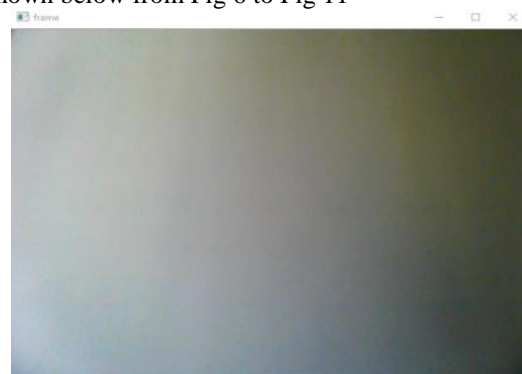


Fig6: Frame in video



Fig 7: Red Grid



Fig 8: Finding contour

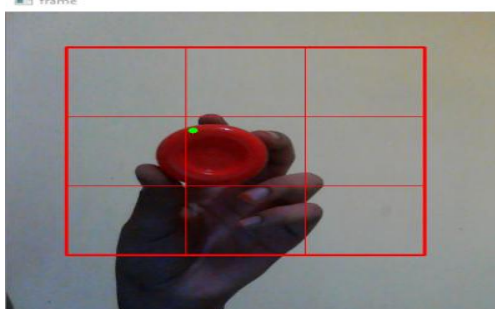


Fig 9: Detecting object

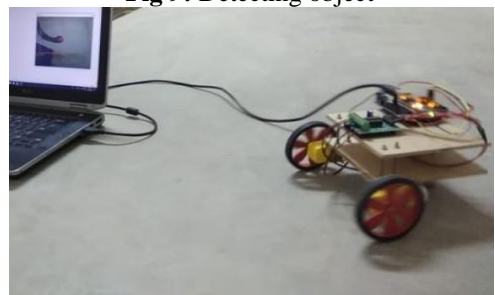


Fig 10: Robot moving right side

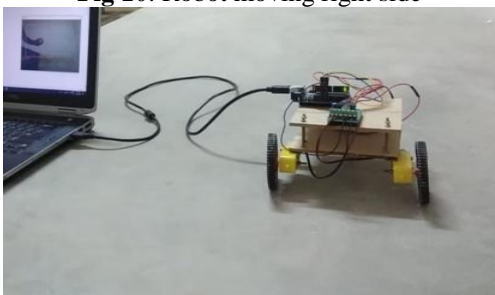


Fig 11: Robot is stopped

As we discuss before that video is collection of continuous frames, Fig 6 is one frame. After selecting the area of interest in the Fig 6 and forming that into a 3*3 grid results in Fig 7.

Fig 8 is the result of contours based on the selected range of color.

Fig 9 is detecting the object position based on specified color.

Fig 10 is the resultant action (i.e moving right side) when object is placed in range (50 – 150, 150 -250) as shown in above table (2).

Fig 11 is the resultant action i.e being stopped when object is placed in range(150-250 ,150-250) as shown in above table(2).

Similarly for the directions forward, backward, left.

V. CONCLUSION AND FUTURE EXTENSION:

Robot control can be done using hand gestures [4] without any hardware components connection. It can be extended by providing the facility to pick and placing back the required item by a robot for disable people (unable to move from bed but can see and move hands) in their vicinity. This can be done by dividing the whole vicinity into grids and items are placed in cells of grids. A chart is available for the disable person which contains a list of items and their positions (coordinate values) in the vicinity. As disable person places the detectable colored object at required grid in front of camera by using information in the chart. Robot take that information and move to corresponding position, pick the object and place it back in the same position. This helps the disable to feel like others and can get required items.

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