OBJECT DETECTION AND TRACKING ROBOT

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Abstract— This paper introduces vision based object detection and tracking robot. The robotic system developed, tracks the object based on color with distinctive feature of real time tracking. The system consists a four wheeled robot with a camera mounted on it acting as an image acquisition device. Algorithm for red object detection is written in MATLAB. The movement of the robot is controlled by signals obtained serially from MATLAB. Universal Synchronous Asynchronous Receiver Transmitter USART module present in the PIC microcontroller is used to receive data serially at a defined baud-rate. Robots with power of image processing find its application in surveillance and monitoring system.

Keywords— *Image acquisition, MATLAB, USART, PIC microcontroller*

I. INTRODUCTION

Object detection is a well studied and researched technology related to the computer vision. Detection of a particular object is a fundamental basis of artificial intelligence and robotic vision based system. Object detection has its application in various fields like science, engineering, surveillance system, autonomous systems. It is the process of finding instances of real-world objects in images and videos. The environment around us displays itself with a variety of forms, shapes, colors and textures. Humans have the capability to acquire, integrate, and interpret all this abundant visual information. Humans perform object recognition easily and instantaneously. It is challenging to in co-operate such capabilities to a robot in order to understand the visual information present in still images and videos. It is important to understand various methods for recognition, data processing and finally interpretation of such visual information.
The system designed aims to detect and track an object of a particular color. This can be considered as an approach in getting acquainted with the basics of image processing along with robotics. The robotic system developed have a vision system onboard which can 'see' the environment, detect the object of a particular color and adapt its movements accordingly, in order to follow the moving red colored object.

II. LITERATURE SURVEY

Every surveillance system uses a unique mechanism to detect objects which serves as a form of focus of attention. Selection of right feature plays a key role in tracking. Tracking algorithms make use of the combination of the following features like texture, optical flow, edges, color [6]. Texture describes the intensity variation in an image and is less sensitive to illumination changes compared to color feature.

The work presented in [7] uses optical flow mechanism. Optical flow basically gives the distribution of apparent velocities of movement of brightness patterns in an image .This mechanism does not produce desired output if the constant brightness and velocity smoothness assumption are violated. In real time, the constant brightness condition is hard to achieve due constant changing environment.

In image processing, the RGB color space is used to represent color. In color images it is easy to identify foreground pixel and background pixel. Common object detection methods include point detectors, background subtraction, segmentation [6].

The work carried out in [8] uses background subtraction technique to detect the moving object in video sequence by subtracting the current frame from reference image. Background subtraction method requires a stable background which is difficult to obtain in real time application. The image frame difference method uses pixel based difference to find moving object. The advantage of this method is that it can resist interference of light to some extent when compared with basic background subtraction method.

III. PROPOSED SYSTEM

The proposed system consists of a robot driven by wheels, intended to detect and track a red colored object.
Figure1 shows the basic interfacing and wired connections of the project.

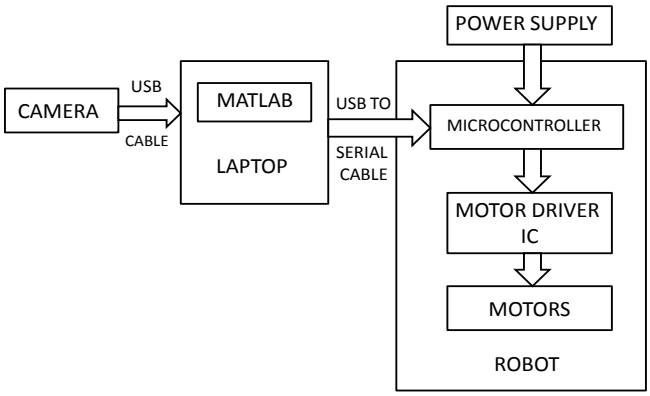

Fig.1 Block diagram of proposed system

The images of the red object are captured by a camera mounted on the robot. Camera is connected to the laptop

through USB cable. Program for acquiring these frames is written by creating video input object in MATLAB.
Suitable algorithm for red object detection and tracking is written in MATLAB. Once the position of the red object is estimated, the controlling signals are sent to microcontroller from MATLAB through an USB to serial convertor cable.
PIC microcontroller consists of an in built USART module for serial communication [2]. The data received at RXD pin of controller is interpreted and corresponding logic are sent to L293D motor driver IC which controls the motors.
The microcontroller gives output according to the received signals through RXD pin. The output is given to motor driver IC which then actually drives the motor with required current. When the red object moves in left, straight or right direction in front of robot, it tracks the object.

IV. SOFTWARE ALGORITHM

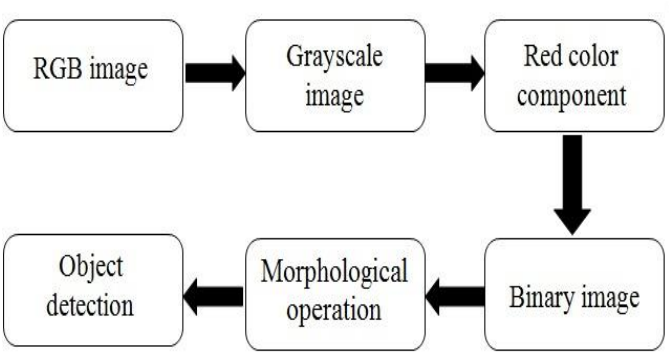

Fig.2: Figure shows stepwise operations done for red colored object detection by camera using image processing in MATLAB

These operations are performed continuously on each frame of the video input to obtain the position of the red object.

- Image Acquisition

The first step in this process is to take live video of surrounding through image acquisition device. The 'getsnapshot' function of MATLAB is used to convert video into an image array and then returns one frame from the video input.

- Converting RGB image to grayscale image

The images are converted to grayscale images [5]. In order to process the image using image frame subtraction, it is converted into grayscale format.

- Extracting red component in image

The red colored object is in image is detected using image frame subtraction. It removes all components from the RGB image except red by subtracting it from grayscale image.

- Binary image

The image is then converted to binary image in which red colored object appears as white and the background is black using a threshold.

- Morphological operation

Morphological operation [3] is performed on the binary images using structuring element. The distortion and irregular boundaries are removed by performing morphological opening and closing on the binary image using same structuring element.

- Centroid estimation

For each connected component in binary image, the 'regionprops' function measures a set of properties. This measured property is Centroid of the red object.

- Tracking and serial communication

From the (x,y) coordinate of centroid, the position of object in image is estimated. Accordingly, conditions for left, straight, right are applied and data is sent from the COM port. For serial communication in MATLAB, a serial object is created by specifying port. The connection is then opened and data is written to the port by specifying the required baud rate and the format of string.

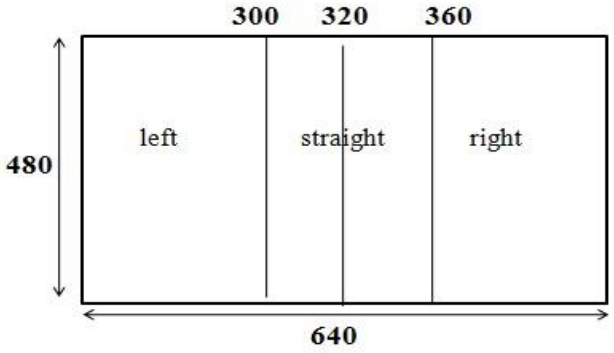

Fig.3 Figure shows position estimation of red object in the frame

The X coordinate of the Centroid is monitored continuously to identify the location of the red object in every frame. Table 1 shows the data sent from MATLAB to microcontroller according to the Centroid estimated.

No	X coordinate	Command
1	<300	Left (L)
2	300<X>360	Straight(S)
3	>360	Right(R)
4	None	Wait

Table 1 Movement of the robot

V. SERIAL COMMUNICATION

Data transfer from laptops can be achieved in two ways: parallel and serial. In parallel data transfer, several data bits are transferred simultaneously to a device at a shorter distance. A large set of data can be transferred which in turn requires many wire strips in parallel.

In serial data transfer a single bit is transferred at a time. The device in communication may be at a longer distance. With serial data transfer synchronization is easy; requirement of input output pin reduces which in turn reduces the cost.
The PIC microcontroller contains the Universal Synchronous Asynchronous Receiver Transmitter (USART) module**.** The registers that are responsible for serial communication and handling USART are:

1. SPBRG Register
2. TXREG Register
3. RCREG Register
4. TXSTA Register
5. RCSTA Register
6. PIR register

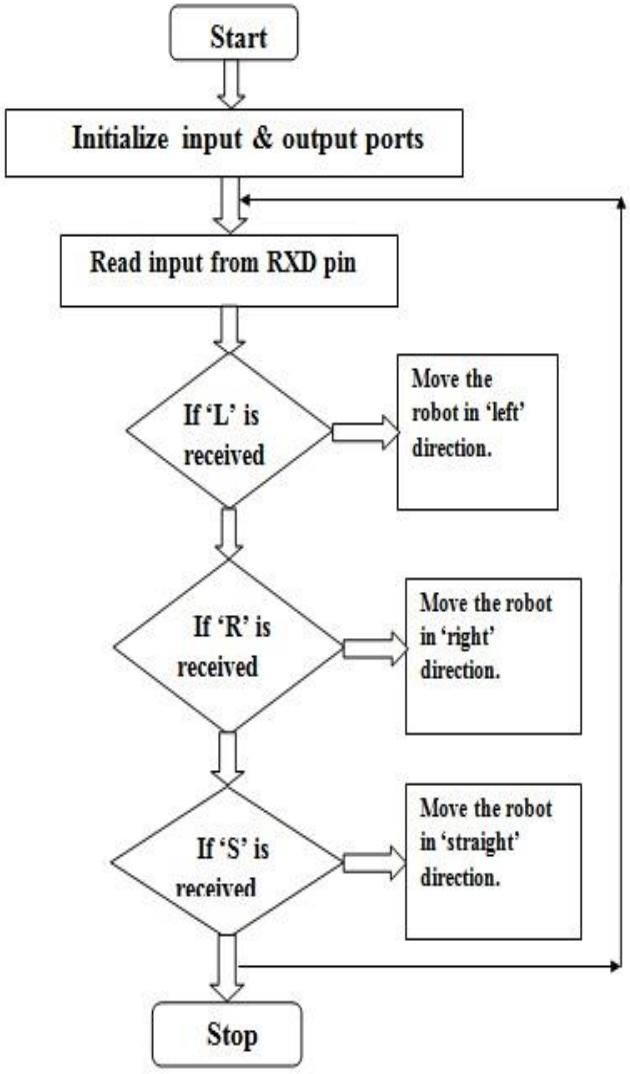

Fig.4: Flowchart of microcontroller code

Port D and Port C are first initialized as input and output port. All the registers mentioned above are also initialized. Microcontroller receives the controlling data on RXD pin (RC6) from MATLAB. This received data is stored in the receive register of the microcontroller.

Received data and a pre-defined data are compared and the generated signal is fed to the motor driver IC. The motor driver IC provide sufficient amount of current and voltage to drive the dc motors in the direction of the red object.

Table 2 shows logic levels applied to the driver IC in order to rotate the motor in direction of the red colored object.

No	Pin2 and pin 4	Pin 7 and pin3	Direction
1	Logic 1	Logic 0	Clockwise
2	Logic 0	Logic 1	anticlockwise
3	Logic 0	Logic 0	Idle

Table 2 L293D Logic Table

VI. IMPLEMENTATION RESULTS

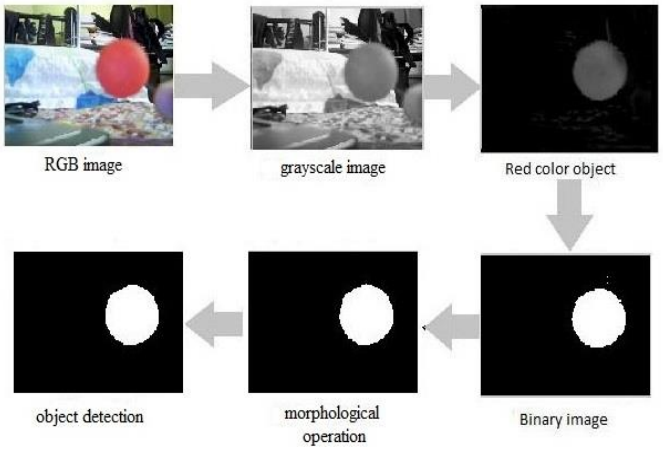

Fig.5 Step wise results of detection of red colored object

No	X coordinate	Motion
1	170.173	Left
2	319.522	Straight
3	438.109	Right

Table 3 Results show motion of the robot based on x coordinate values

After implementation of the project, following results were obtained as seen in Figure 5 and Table 3. The red object to be tracked is detected in right plane of the frame. Microcontroller responds and drives the motor with a right motion towards the moving object. Similar to first result, the microcontroller interprets the 'left' and 'straight' conditions. When the value of x coordinate of the Centroid does not fall in anyone of the condition, the microcontroller respond with stop or wait

condition. The intended object is detected and tracked down successfully.

VII. CONCLUSION AND FUTURE SCOPE

The robot implemented makes use of the camera for acquiring images and follows the red object according to the instruction from microcontroller. The processing of the image in MATLAB was performed in stepwise manner to get the required results. The robot implemented is cost effective, light weight and simple that gives optimal output. Further improvements can be made by processing the image using on-board processor like the beagle board instead of the laptop. Zigbee Module can be used for wireless transmission of serial data from MATLAB to the microcontroller.

VIII. REFERENCES

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