Object Detection and Tracking

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***Abstract*— The project deals with an autonomous robot that locates and follows an object. It is mounted with a single camera above and is being controlled by a pc. The robot specified uses an 8051 family Atmel microcontroller AT89S52 with a camera mounted on it which is having video stream in a running mode where it captures the front view of the robot, processes the acquired frame for detecting the object and follows it without human interface [1]. For processing the acquired frames using camera we need to include a software, which is MATLAB. The object detection or recognition is based on the concept of color segmentation using the thresholding concept. The color segmentation approach used is a high level segmentation technique whereby a color model using curve fitting is developed[2]. Matlab is used because it offers integrated image processing toolbox.**

***Keywords:* object, category, detection, tracking, dynamic, path, planning.**

I. INTRODUCTION

The objective of the project is to build an autonomous robot, which searches for a predefined object in its environment and once the object is detected, it follows it. The project consists of two main sections:

- Image Processing section
- Motion Controlling section

Image processing section implements the concept of MACHINE VISION. Machine vision stands for how the machine views the surrounding as compared to a normal Human Eye. For implementing machine vision, our project uses a web camera mounted on board which is interfaced to MATLAB, which is running on a PC. The entire image processing part takes place here. The output of the MATLAB program is passed through a Microcontroller, on-board, via serial communication ports. The microcontroller controls the motion of the robot, by sending appropriate signals to the motor for following the desired object[3].

Firstly, the robot searches for a predefined object and then continues its detection. The motion of robot is governed by two motors: the direction in which the robot is supposed to move is governed by the image processing part. The web camera mounted on the robot captures front view. The camera is interfaced to MATLAB, on which image processing is done. The required object is extracted from the captured frame by segmenting the image using color segmentation technique. The color segmentation is done by color modeling. MATLAB is used because it offers integrated image processing toolbox and curve fitting tool box, required for modeling. The segmentation by color modeling creates a binary image by comparing each pixel value of the captured frame to a threshold value. The white region in the resulting binary image indicates the position of the required object in the view. The coordinates of this portion is calculated and based on this result, the direction in which the robot should move is conveyed to the microcontroller by PC through serial communication [4].

II. BACKGROUND

2.1 Object Category Detection

Detection delivers two important pieces of information, namely where in the image an object of interest is located, and what type of object it is. The former serves to establish the objects' positions in the world, which in a dynamic setting are an important part of the geometric environment model. The latter provides semantic information that supports higher-level reasoning—most importantly for choosing the right motion model for the object, and for taking navigation decisions which depend on the object category. In more detail, the required detector output for further probabilistic treatment is a set of potential object detections, each consisting of an image position, scale, object category label, and a detection probability. The output is then converted to a large set of potential detections by extracting all local maxima of the detection probability which exceed a low threshold[5].

2.2 World Coordinate System

To allow reasoning about object trajectories in 3D coordinates, the camera position in the world coordinate system is estimated at each frame. Compared to standard visual odometry, our system includes scene knowledge obtained from the tracker to mask out image regions which do not show the static background. Furthermore, our system explicitly detects failures by comparing the estimated position to a Kalman filter prediction. In the event of failure, the visual odometry is re-initialised to yield collision-free navigation[5].

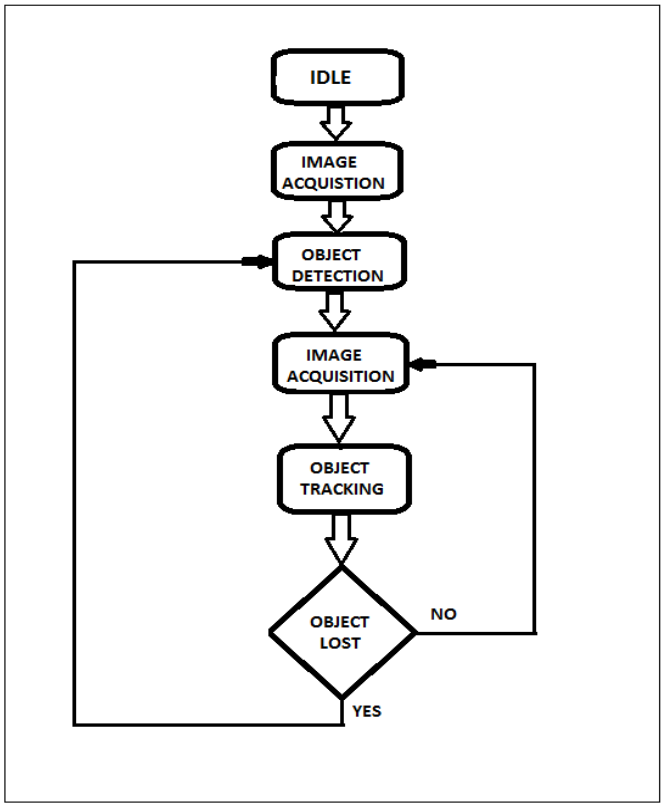
***2.3** Ground Plane Estimation*

Instead of directly using the output of a pedestrian detector for the tracking stage, we introduce a simple scene model: all objects of interest are assumed to reside on a common ground plane. The ground plane and the set of detected pedestrians are jointly estimated in a Bayesian network, using as input

detection probabilities from the object detection stage and stereo depth, as well as priors on object size and a temporal smoothness prior on the ground plane. Joint estimation has the advantage that evidence is propagated in both directions: for largely empty scenes the ground plane can be reliably estimated from depth measurements and significantly constrains object detection; in crowded scenes less ground is visible, but a large number of detected objects may in turn constrain the ground plane[6].

III. METHODOLOGY

Our project aims at RECOGNITION of a predefined object, based on its physical characteristics and TARGETING the object. Recognition of the object will be based on DIGITAL IMAGE PROCESSING using MATLAB. The project comprise of two subsystems, the Object Detecting subsystem and the Targeting subsystem[6]. The Bot accepts the front view from a camera mounted onboard as the input. It then processes the image using the concept of Digital Image Processing and extracts the object based on its physical characteristics. It determines the coordinates of the object, which are then passed as input to the targeting subsystem, to target the object. Digital Image Processing, which is a part object recognition subsystem, processes the input image based on prior knowledge about the image content/problem domain. It then segments the required object from the image using colour segmentation, and morphing techniques. We are using MATLAB platform for processing the image since it has highly concrete image processing TOOLBOX.



IV. CONCLUSION

The proposed system is used to detect the suspicious object and motion of the person holding it using various algorithms. This system is invariant to lighting condition, background scenario and view point. Once the object is detected using this system, and if the person holding it goes out of range of the still camera then a hardware system is designed to follow the respective person and thus tracking of the suspected person is achieved[3]. The algorithms used in the designed SODT system are DWT (Discrete Wavelet Transform) for motion detection and Template Matching using Cross Correlation method for object detection. However the main disadvantage of using Template Matching Algorithm is that a large database is required where the templates of the gun to be detected need to be stored else the object will not be detected. Hence if you want to detect all the guns, then the templates of each type of gun should be present. Also, more the number of templates, more is the time required in matching and thus giving the final results[7]. In case of Kalman filtering, as the background is varied, we get undesired results. This problem is avoided by using DWT. Also, the Robot used for tracking of the suspect is just a prototype and can be actually made into a smaller one so that it cannot be recognized by the suspect. The entire system comprising of software as well as hardware can easily be turned into a completely wireless one.

V. FUTURE SCOPE

We had implemented our project using microcontroller 8535 but DSP processor could have been used for fast action and better processing. The robot wheels have been designed to travel on plain surface only; but it can be modified to travel in presence of obstacles and even climb stair[4].We have used intex night vision webcam having 2.0 megapixel resolutions hence we could use high definition cameras for better results.Tracking of person have been implemented using Kalman filter. We have used MATLAB software for detection and tracking but we could use C or C++ or visual C for fast processing operation. Bluetooth device have been used for interfacing SODT system with microcontroller using ESD100 whose range is limited to approx 10m but an extension option could be provided to increase the range upto 300m.The code could have been further modified or improved to provide better results even for low contrast images taken in low lighting conditions[7].

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