Vision based Object Tracking by Mobile Robot

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ABSTRACT
Object tracking has become one of the important research areas in robotics. In this paper, we propose a vision based color object tracking by Khepera II mobile robot. The object tracking is realized by color segmentation through image threshold. The wireless camera mounted on the robot will capture the image in front of its viewing range and based on the color property of the target object, the control in tracking is activated automatically by seeking the control align in the direction of the tracked object.

Keywords
Image matching, mobile robot, object tracking, Khepera II, motion planning

1. INTRODUCTION
Visual object tracking is very critical and a key problem in a computer vision having numerous applications including public security system, surveillance system, service robotics, human-machine interfaces and so on. Visual tracking problems mainly focus on tracking mobile object like vehicles or walking peoples. However, in many scenarios where the camera is moving in both foreground and background are dynamically changing due to the motion of camera and changing illumination condition. All these factors could bring more challenges to produce flexible and robust tracking algorithms. the appearance, position and the scale of the object may vary with the background changes. Therefore, tracking algorithms under such situations should be adaptive with complex scenes, robust with noisy images, and capable of real time execution. Visual object tracking has attracted extensive attention in past years. Some of the important tracking methods are Well-known stochastic algorithms, such as Bayesian tracking [1, 2] and Kalman Filtering [3] have successfully been used for multi-agent tracking in mobile robotics. In [4] Extended Kalman Filter is used for vision based target tracking by the mobile robot, The author proposed a scheme for target-tracking realized with two mobile robots, where one robot is configured as tracker and the other as moving target. Fuzzy C-means clustering algorithm has been employed here to segment the target robot in images grabbed by the tracker. A new localization algorithm has also been proposed to determine the location of the target in the segmented images. An extended Kalman filter has been employed here for predicting the direction of motion of the moving target from its current and last few positions**.** In [5] a fuzzy controller is presented for a general target tracking system. Finally, research in [6] uses template matching techniques for visual target tracking. In [7], a fuzzy algorithm is used to detect an object based on a color cue and tracking is based on a maximum radius of displacement in subsequent frames. Concerning vision based techniques, research in [8] uses multivariate decision trees for piecewise linear non-parametric function approximation to learn the color of the target object from training samples. The approach in [9] proposes a color model which includes the intensity information in HSI color space using B-Spline curves for face tracking. Optimum tracking of amaneuvering target in clutter [10], neural net based tracking [11], integer programming based target tracking [12] and tracking and classifying without *a priori* identification [13].Shirai et a*l*. introduced a novel method for visual tracking using the well-known principles of optical flow techniques [14]. This scheme is useful for its inherent robustness, and has many applications in real-time human tracking system in cluttered background. The whole work presented in this paper, however, is novel from the point of view of the technological merits of synergism of Kalman filter and neural networks for tracking applications in mobile robotics. In [15] color segmentation is performed based on contrast information and adaptive thresholds in static images. The authors in [16] use color segmentation to identify obstacles in indoor environments. Using a training set of images and the r-g color space they present a model robust to shadows and illumination changes. Similar to [17]. Another color tracking algorithm is presented in [18] where a neural network is used to robustly identify skin color regardless of lighting conditions. In [19] color histogram information is used to detect and track pedestrian for a stationary visual surveillance system.

2. PROBLEM STATEMENT
In this object tracking problem, we have used one mobile robot Khepera, which is acts as a tracker and one static object as a target. In this problem the static object is placed in the environment and robot is equipped with a wireless camera. The objective of the robot is to capture image in its viewing range of the camera and determine a color based target. In this work the target is chosen as a Red object. From its initial position, if the robot sees any Red object in its front view the robot will move towards the red object. Otherwise the robot will turn small angle in clockwise and again use its vision to detect any red object in the range of its vision, if not, it continue to turn in its Z-axis until a target image is present is found.

3. IMAGE MATCHING AND ODJECT TRACKING
In this section we present the image matching algorithm which is based on pixel value of the object. The image matching performed at the host machine is the most important part of this work. The choice of the threshold value determines the effectiveness of the algorithm. The threshold depends on the color intensity of the target and therefore its value may vary for different targets. Upon receiving the control signal transmitted by the host machine the robot will act accordingly. The tacking solely depends on the accuracy of the image processing performed by the host machine.

The major steps of the image matching and tracking are presented in procedures given below.

Procedure **Image_Matching ( )**

Begin

1. open the image frame send by the robot
2. read the red value of the image and make its average say Avg.
3. **if** Avg >= THESHOLD
   a. Send a control signal ‘F’ to robot.

   else
   b. Send control signal ‘M’ to robot.

End

Procedure **Object Tracking ( )**

Begin

Step-1: Put the robot in the environment, where the red object

will be track.

Step-2: Grab the image through wireless camera mounted on

the robot and send it to desktop machine.

Step-3: Image processing is carried out in the desktop

Machine, **Image_Matching ( )**

(i) if control_ signal= ‘F’ then

robot will move towards the red object

and stop.

(ii) **Else**

robot will turn small angel θ in clockwise

and repeat step-2

End

4. IMPLEMENTATION DETAILS

The road map based motion planning is implemented on the Khepera robot. Khepera II is a miniature mobile robot and circular in shape and equipped with a Motorola 68331 microcontroller. The robot possesses on-board power supply and two motors, which can be independently controlled by a PID controller. It is also equipped with eight infrared proximity sensors which are distributed around the robot in a circular pattern to cover the circumference of the robot uniformly, and a wireless camera vision turret module which is plugged in on top of the Khepera robot, enabling it to capture video. It is a passive device without onboard processing and frame is grabbed through TV tuner. The wireless camera vision turret is designed to transmit sound and video from the Khepera robot to a base receiver. Images and sound can then be processed on a remote computer. The resolution of image is 380×450 and maximum range of image grab is 50-100m. Image transfer from the robot to the desktop computer is accomplished by a 2.4GHz wireless image transmission system. Figure 1 shows the connection set up of wireless camera on the Khepera and also the network of image grab through the TV tuner. The work is implemented in C- language platform. The software comprises one source code for image matching and one code for motion control of the robot based on the matching result of the image.

The snapshots taken during a sample run of tracking a Red object is shown in figure 2 and figure 3.It shows that from a starting initial position the robot finally moves towards the target. In this sample run obstacle were not used. However the avoidance of obstacles if present can be implemented using any robust obstacle avoidance algorithm.

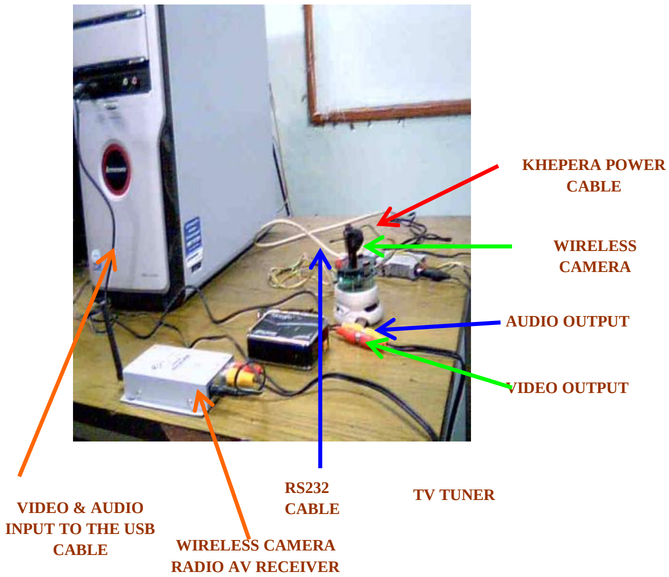

Figure 1: Experimental setup

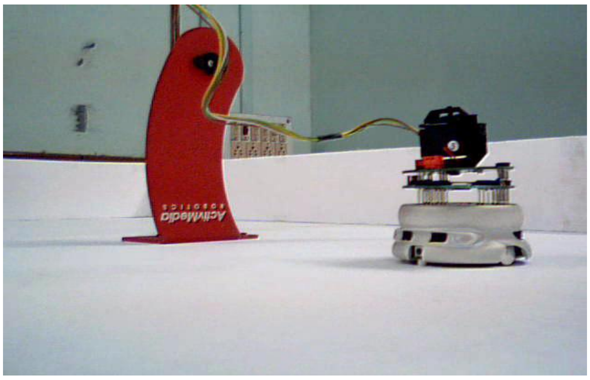

Figure 2: Environment setup for tracking a Red object

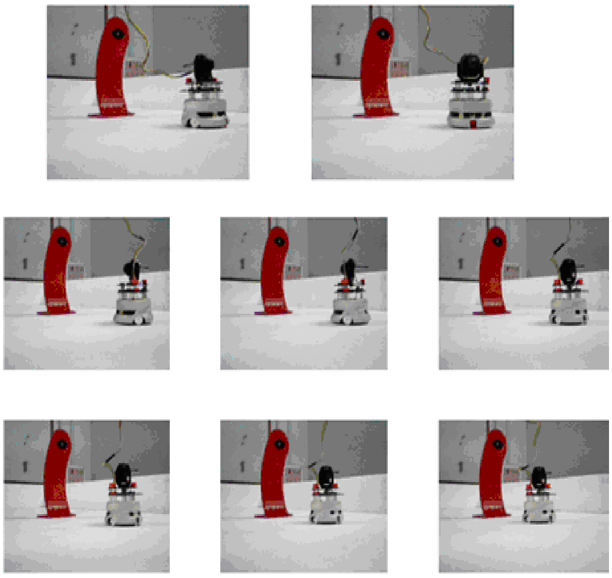

Figure 3: Snapshots taken during tracking

5. CONCLUSION

This paper has presented a vision based object tracking method for mobile robots using a stereoscopic vision system and introduced the new approach of the vision based object tracking of the mobile robot. The main focus of this paper is on color based object tracking techniques which was successfully implemented using Khepera II mobile robot. Future work is undertaken for tracking human using facial recognition system.

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