Abstract

Mobile robot is a device which uses sensor, actuator, and control technologies to navigate intelligently. Mobile robot needs to perceive the working environment, plan a path and navigate using information captured through sensors. The aim of present research is to develop navigational strategies for mobile robot using data from vision sensor to operate in structured and unstructured environments with static/dynamic obstacle(s) and negotiating these to reach the goal location. Many challenging issues are to be addressed for mobile robot navigation which uses vision sensors. The problems vary depending on various domains like motion control, detection, tracking, trajectory/path planning, reasoning, decision making and control etc. Locomotion module is an important element in terms of the design of the mobile robot, which depends on types of locomotion mechanisms used for mobile robot. However, this depends on other factors, such as terrain conditions, stability, and controllability etc. In addition to the above, navigational strategy has important role in the field of mobile robotics. The problem associated with tracking of mobile robot in a known environment is called as localization. Measurements from the vision sensors are noisy and an estimation process is required to determine the positions, orientations and speeds of the mobile robot with the help of local coordinate information. The main objective here is to reach the goal point from the start point using path planning methods while avoiding obstacle(s) using vision sensor. In the beginning, the works is concentrated on 2D path planning and avoid static/dynamic obstacles in the environment. Current work discusses an experimental approach that integrates feature-based object detection, the tracking system based on Kanade-Lucas-Tomasi (KLT) Algorithms and Kalman filter based method to denoise the tracked path. The proposed method is implemented while mobile robot moves on a predetermined (specified) path and tracking of the same as its image size is small compared to the captured image of the environment. Next, a vision-based path planning approach was implemented using A* algorithm in order to avoid the obstacles and reach the goal location using the shortest path and path planning for object cleanup is proposed. In this case objects of handleable type and non handleable type are dealt using priority generation approach. Subsequently, a shape aware path planning algorithm is developed for real time execution as path planning implementations consider mobile robot as a point object. For the implementation and validation, an overhead camera is used to capture the images of obstacles in the task space. The captured images are also processed using OpenCV software for detection, and the mobile robot is tracked using KLT algorithm discussed earlier and Kalman filter is implemented on the tracking results of different test scenarios for denoising. The proposed approach detects and tracks the shape aware mobile robot efficiently with error range 6-10 % in different test cases. For the mobile robot navigation in unknown environment where obstacles are static and dynamic, and the mobile robot uses a stereo vision camera, D*Lite path planning algorithm is implemented for two test scenarios. The navigating mobile robot is tracked using tracking-learning-detection (TLD) algorithm. Thereafter Kalman filter is used to denoise the tracked result so that actual path followed by the robot is known correctly. The error ranges for the test cases are in the range of 7 to 10%. Despite the good performance of path planning and path tracking navigation algorithms, the approach has a few limitations related to motion control (angular speed), obstacle boundary segmentation, from which the minimum distance path is computed. In future these limitations will be addressed by selecting suitable strategies for path planning algorithm, sensing and decision making.

Keywords: Mobile robot, Obstacle detection, Viola-Jones algorithm, Vision based Tracking, Kanade-Lucas-Tomasi (KLT) algorithm, Tracking-Learning-Detection (TLD) algorithm, A* path planning algorithm, D* lite Path planning algorithm, Kalman Filter, Shape aware Algorithm, OpenCV, ROS framework.