ABSTRACT

Robotics in automation environment is being implemented more frequently in industries to increase labour and machine productivity. Generally, the robotic system is classified into two major categories namely, Industrial Robots and Mobile robots. In order to perform a specified task by mobile robots like box pushing, pick-and-place, path planning with obstacle avoidance etc. the navigation strategy plays a vital role. The complex algorithmic procedure of mobile robot navigation requires much computation time and effort. Hence, the navigation procedure must be simple enough to implement and effective in terms of computational effort for real time applications. With reference to the previous literatures, different kinds of algorithms and complex computational methods are being used to achieve reasonable navigation results. The researchers have tried to adopt simple and effective navigation methodologies in order to achieve simplicity through heuristic algorithms.

In the present work, simple and effective methodologies of three different types of newly developed mobile robot navigation for box pushing with touch sensors, path planning with obstacle avoidance with IR and RF sensors and path planning with obstacle avoidance with computer vision are experimentally analysed by implementing simplified reinforcement learning, potential field and wave front algorithm respectively. The three categories of mobile robots are fabricated in-house with microcontroller, touch sensors,
infra red, radio frequency, computer vision and DC motors along with driving and steering circuits for performing three different tasks proposed.

The objectives of this dissertation work are formulated based on the research gap identified in the field of mobile robot path planning through literature survey and as follows:

- To develop a pair of homogeneous mobile robot with touch sensors for box pushing task.
- To develop a mobile robot with IR and RF sensors for path planning with obstacle avoidance task.
- To develop another mobile robot for path planning with obstacle avoidance task with computer vision.
- To implement the simplified reinforcement learning, potential field and wave front heuristic algorithms respectively for the three different types of mobile robots for navigation.
- To develop a computer vision based positional error compensation procedure for an existing IR52C industrial robot using linear regression analysis for experience and learning purposes, which will be forerunner for the mobile robots used in box pushing and path planning tasks.
- To apply linear regression analysis to obtain the generalized equation to check or compensate the positional deviation in path planning.
To apply the analysis of variance (ANOVA) statistical test to ensure the reliability and stability of the experimental procedures proposed in order to realize simple and effective navigation methodology for real time applications.

Firstly, the box pushing task is performed using a pair of homogeneous mobile robot developed in-house provided with touch sensors by implementing simplified reinforcement learning algorithm. Secondly, the path planning with obstacle avoidance task is carried out using a single mobile robot developed in-house provided with IR and RF sensors by implementing potential field algorithm. Thirdly, the path planning with obstacle avoidance task is performed using a single mobile robot developed in-house provided with computer vision by implementing wave front algorithm. In all the experiments, the orientation of the mobile robot is calculated by comparing the coordinate values of successive locations of the robot’s resultant path generated from staring position to target position. An exclusive linear regression analysis is performed for pick-and-place operation with the help of an existing EUROBTEC 5 DOF IR52C industrial robot for experience and learning purposes and subsequently, it has been used for the development of mobile robots for path planning applications. In all these developments, there is no need of complex fabrication methods and algorithmic implementations to perform the real time tasks. The mean, standard deviation and standard error of the resultant paths produced by the mobile robots are also calculated.

The MATLAB 7.0 software user-written-code is used for implementing the heuristic algorithms and the software codes are written
using C-programming language for interfacing the mobile robot with computer and the functions required for AT89C2051 microcontroller to provide robot’s basic movements like move_forward, move_reverse etc. The linear regression analysis by least square method is performed using SPSS 10.0.1 for obtaining equation for compensating the positional deviation in the robot’s resultant paths. The analysis of variance (ANOVA) statistical test is performed in order to ensure the reliability of the proposed experimental procedure for all the tasks conducted. In each case, the experiments are repeated many times and ANOVA test is performed based on the results obtained from the experiments.

In summary, the required hardware for fabricating the three different categories of mobile robots are designed and developed using AT89C2051 microcontroller with all other necessary elements. The mobile robots are interfaced with computer through RS232 serial communication. The simplified reinforcement learning, potential field and wave front algorithm are implemented and the same are verified experimentally by performing box pushing with touch sensors, path planning with obstacle avoidance with IR and RF sensors and path planning with obstacle avoidance with computer vision tasks respectively. The linear regression analysis by least square method is performed for obtaining equations for checking or compensating the positional deviation in the robot’s resultant paths and the ANOVA statistical test is also performed to ensure the reliability and stability of the proposed methodologies. The experimental results reveal the viability and applicability of the proposed methodologies for real time applications.