CHAPTER 1

INTRODUCTION

Robotic applications are gradually becoming a part of our everyday lives. The major bottlenecks to a widespread use of these robotic systems are the complex implementation procedure, lack of ability to perceive and adapt to unpredictable environment. Generally the robotic system takes much computational time due to complex implementation procedure for doing some specific task like box pushing, path planning with obstacle avoidance etc. Now-a-days, the robotic system is used in different areas right from engineering to agriculture field. In case of path planning task, the problem of generating collision free path for mobile robot navigation is a challenging one and has drawn the attention of researchers in the last decade. Several procedures for the control of autonomous vehicles are being developed. The touch sensors and infra red (IR) sensors can be used for identifying obstacles within the working area. The radio frequency (RF) sensor can be used to define target position within the working environment. The machine vision is one of the important tools used as sensor for the mobile robot navigation purpose and widely employed in engineering field. The machine vision system can also be adopted for manipulation works like finding the exact location of a component in pick-and-place type operation of industrial robot.

For autonomous robot applications, different types of heuristic methodologies are proposed like reinforcement learning algorithm with contact sensors for box pushing task, potential field algorithm with infra red and radio frequency sensors for path planning with obstacle avoidance task.
and wave front algorithms along with computer vision as sensor for path planning with obstacle avoidance task. In the present days, the challenge is how to minimize the fabrication procedure and simplify the navigation technique, since the industry requires an effective navigation method for real time applications. Robotics in automation is being implemented more frequently in industrial environment.

One of the important goals of robotics research is to develop cooperativeness among the robots, which can perform a specialised task. Cooperative robot system can enhance and expand the capabilities of single robot through various functions performed collectively. Achieving cooperativeness is desirable task for number of reasons. Firstly, the robotic applications are inherently distributed in space, time and their specified functions, thus requiring a distributed solution. Secondly, it is quite possible that many applications could be solved much more quickly if the mission could be divided across a number of robots operating in parallel. Thirdly, by duplicating capabilities across the team of robots members, one can increase the robustness and reliability of the solution. Finally, it is much cheaper and more practical in many applications to build a number of less capable robots that can work together, rather than building complex robot that can perform different kinds of operations with adequate reliability (Ronald Kube and Eric Bonabeau 2000). Robot cooperation can be done implicitly or explicitly. Implicit communication makes decentralized control on robots, so that there is no need of any transmitter and receiver system. A cooperative robot system without explicit communication is more robust and inexpensive (Seiji Yamada and Junya Saito 1999). Box pushing is one of the classical problems for studying the cooperation among more than one mobile robot pushing a regular three dimensional object such as a box to the predefined goal position. The reinforcement learning describes the mapping of the different robot situations to actions by trial-and-error interactions with the environment
(Sutton and Barto 1998). The performance of pushing a box towards the goal position is difficult by a single robot and the performance can be improved significantly when the same task is performed cooperatively by more than one robot, but requires careful coordination among the robots. Robotics is still an open and challenging field having many applications such as shop floor, educational and research applications. The Robot Institute of America (RIA) has defined an industrial robot as “a reprogrammable, multifunctional manipulator designed to move materials, parts, tools or specialized devices through variable programmed motions for the performance of variety of tasks” (Havas 1995).

A widely accepted definition for mobile robot is “a mobile machine situated in the real world interaction with the environment through sensors and actuators in order to perform various intelligent tasks without constant attention”. The most common problem with the mobile robot is that the technique of avoiding the obstacles and accordingly plans the path for performing certain industrial applications like pick-and-place type material distribution. The design of mobile robot should have the capability to move intelligently without colliding the obstacles. In this context, the navigation methodology plays a vital role. At the same time, it should have simple architecture and implementation procedure. No generalized mobile robot design is available to address all sorts of industrial needs. It needs to be developed independently for each application along with suitable heuristic algorithm to address a specific task, since each task has its own specific characteristics. The approaches for obstacle avoidance using heuristic algorithms like potential field algorithm, wave front algorithm etc. can be implemented.

The important metrics of the robot path planning is the total distance from starting to target position and the time taken to reach the target.
The different types of sensors like touch sensors, IR and RF sensors used for acquiring the information from the robot’s environments. Apart from the regular contact and non-contact sensors, other miscellaneous sensors like computer vision is also used in robot environments. Computer vision is a process of automatic acquisition of images by camera and their automatic image analysis to extract the needed data for controlling a task. Machine vision brings the advantages of repeatability and consistent high accuracy at relatively lower cost. The computer vision is useful tool for mobile robot navigation for path planning applications such as discrete material distribution in automated industries, row-following in which, the robot will recognize the plant in the agricultural field etc.

In order to reduce the development effort required for the development of robot navigation, the statistical tools are adopted. The statistical tools have wide scope for implementing it in the field of robotics. In certain cases like path planning, it may have some positional deviation. The linear regression analysis by least square method may be performed for obtaining equations for checking the positional deviation in the robot’s resultant paths. The analysis of variance (ANOVA) statistical test can be adopted to check the reliability and stability of the methodologies proposed. As a whole, the adaptation and usage of robots in industrial environment is inevitable. So, any development in the field of robotics such as path planning with obstacle avoidance is useful to the society of robotics.