ABSTRACT

In the last two decades mobile robots have become a subject of significant interest because they raise a multitude of challenging problems on one hand and also they are open to a broad range of possible applications on the other hand. An important problem being faced by manufacturers in the industry is how automatically backs up a truck like mobile robot to a specified point on a loading dock while loading or unloading. Backing a truck to a loading dock in the loading zone is difficult exercise for all but the most skilled truck drivers. Anyone who has tried to back up a house truck trailer will realize this. A great deal of practice is required to develop the requisite skills. When watching a truck driver backing towards a loading dock, one can observe the driver backing, going forward, backing again, going forward etc., and finally backing up to the desired position in the zone. The forward and backward movements help to position the truck for successful backing up to the dock. A more difficult backing up sequence would only allow backing, with no forward movements permitted.

The task of the truck-backer-upper problem to be outlined is as follows: A truck is positioned at an arbitrary position \((x, y)\) on a yard with an arbitrary angle of the truck with horizontal \((\phi)\). The truck moves at constant speed backwards. The three state variables\(\phi\), \(x\) and \(y\) exactly determine the truck position. ‘\(\phi\)’ specifies the angle of the truck with the horizontal. The
coordinate pair \((x, y)\) specifies position of the rear center of the truck in the loading zone. The goal is to make the truck arrive at the loading dock at a right angle middle position of loading zone and to align the position \((x, y)\) of the truck with the desired loading dock \((0,0)\). At every stage the controller should produce the steering angle ‘\(\theta\)’ that backs up the truck to the loading dock from any initial position and from any angle in the loading zone.

In the recent years fuzzy logic control has emerged as one of the practical solutions when the process is too complex and non-linear for analysis by conventional quantitative techniques. Fuzzy Logic control (FLC) has proven effective for complex, non-linear and imprecisely defined processes for which standard model based control techniques are impractical or impossible. Fuzzy Logic, unlike boolean or crisp logic, deals with problems that have vagueness, uncertainty, etc. However, the development of a fuzzy controller has to rely on the experience of the experts for deriving effective fuzzy control rules. Recently there has been an increasing use of Artificial Neural Networks (ANN) for various applications particularly because of their capability of learning from examples and adaptation. In the proposed system, both the FLC and ANN have been employed together and an Adaptive Neuro Fuzzy Inference System (ANFIS) is developed.

Genetic algorithms are good at taking larger, potentially huge, search spaces and navigating them looking for optimal combinations of things and solutions which we might not find in a life time. Genetic algorithms are very different from most of the traditional optimization methods. Genetic algorithms need design space to be converted into genetic space. So, genetic
algorithms work with a coding of variables. It has been proposed here to use GA to tuning of input output gains so that the convergence will be quicker and better result compared to the plant without GA.

Recently, the Particle Swarm intelligent Algorithm (PSO) has gained momentum in its application to optimization problems. Unlike strict mathematical methods, the PSO does not require the condition that the variables in the optimization problem be continuous and different; it only requires that the problem to be solved can be computed. So, the PSO has an apparent benefit to adapt to irregular search space of an optimization problem. The PSO has been used for optimization of only the scaling coefficient of fuzzy scheme for the truck backer upper problem. The scaling coefficients controller input gains and output gains are taken as individuals in PSO.

In view of the advantages of the intelligent techniques, in this work, the novel approach is implemented; the neuro-fuzzy technique (ANFIS), Genetic Algorithm tuned ANFIS and Particle Swarm Optimization tuned ANFIS is developed to control the backward movement of the truck like robot in the loading zone. Comparative performance measures are done to prove the effectiveness of the proposed controllers.