INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

This dissertation addresses safety and performance optimization issues related to guidance and control of pursuit vehicles. Applications including but not limited to surveillance, inspection, monitoring, man-machine interaction and assistance, industrial and service robotics, exploration and rehabilitation robotics, automated cars and the likes benefit from pursuit vehicles.

The dissertation illustrates optimal path planning with second order gradient descent directions which exhibit faster convergence and reduced oscillations than linear methods in both sparse and narrow populated environments. Multi-objective optimal moving-target tracking controllers have been developed for free and fixed planning horizons. Strategic design of an optimal backup trajectory for navigating narrow spaces like corridors, hallways etc. have been developed, with special emphasis to computation of optimal switching conditions between the tracking and collision avoidance modes of navigation. A technique for smooth transition between tracking and collision-avoidance control variables has been proposed. A shrinking horizon based sub-optimal control strategy has been developed that integrates the merits of both short and long-term navigation guidance. Intent-awareness pertaining to the motion of the target and the obstacles has been incorporated into the optimal plan and logarithmic penalties have been imposed on path and control violations to achieve optimal constraint management and safe navigation under speed and lane restrictions.

To implement the designed optimal plans a Lyapunov-stable local tracking controller has been developed based on actual state feedback. In cases where state feedback may become unreliable due to disturbances like wheel-slippage, an observer based state and slip estimation technique has been proposed, which can generate accurate state feedback using optical flow and avoid the need to replace the existing optimal tracking control by more complicated and computationally intensive adaptive or disturbance rejection methods.