

Abstract

Map generation is a process of learning of a robot about the environment it shall be acting on. Its primary task is to get the information about location and orientation of various objects, present in the environment, in a globally consistent coordinate system, and store these information in a suitable data structure for the navigation of a robot freely in the environment. The primary objective of the work done in this thesis is to develop a monocular vision based map. Two types of approaches have been considered in this regard, namely metric mapping and topological mapping. A metric map preserves the spatial properties of an environment. Whereas, a topological map is a qualitative representation, where each location is usually mapped as a node in a graph.

Targeted for mainly an indoor arena, a novel metric mapping technique has been proposed. The navigable region has been extracted from a frame, and the world coordinates of the navigable region have been computed from these images. A probabilistic occupancy grid has been used to map the world coordinates to form a composite map. Path planning algorithms on an occupancy grid have also been proposed in this work. Two types of algorithms have been proposed, namely path planning using distance minimization, and path planning exploiting the geometry of the obstacles. In the former, the next location is chosen in such a way that the distance from the goal is minimized. This algorithm suffers from the problems of local minima for which an algorithm exploiting the geometry of the obstacles has been proposed. This algorithm provides a near optimal path in a computationally efficient way, as compared to many state of the art algorithms. However, the proposed representation in occupancy grid does not ensure precise obstacle boundaries. Moreover, as the dimension of the mapped arena increases, the path planning becomes computationally expensive.

For building a topological map, a vocabulary based approach has been proposed. But it suffers from huge computation overhead. A global feature based topological map has been proposed, to avoid the task of building vocabularies in a dynamic environment. But these algorithms have certain parameters, which change as the mapping environments change. However, to overcome these limitations, a local feature based map generation technique has been proposed. Experiments have been carried out using several benchmark topological mapping datasets, and it has been observed proposed technique provides superior performance compared to the state of the art techniques.