Chapter 46
Localization and Mapping for Indoor Navigation: Survey

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ABSTRACT

Mapping and exploration for the purpose of navigation in unknown or partially unknown environments is a challenging problem, especially in indoor environments where GPS signals can't give the required accuracy. This chapter discusses the main aspects for designing a Simultaneous Localization and Mapping (SLAM) system architecture with the ability to function in situations where map information or current positions are initially unknown or partially unknown and where environment modifications are possible. Achieving this capability makes these systems significantly more autonomous and ideal for a large range of applications, especially indoor navigation for humans and for robotic missions. This chapter surveys the existing algorithms and technologies used for localization and mapping and highlights on using SLAM algorithms for indoor navigation. Also the proposed approach for the current research is presented.

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INTRODUCTION

Navigation includes two main subjects: Outdoor navigation and indoor navigation where data is the main ingredient for navigation and route planning. The outdoor navigation problem can be solved by using systems that have GPS support, where a wide variety of data sources is already available from a mix of local and global data providers. The main spatial data providers are Navteq, TeleAtlas and Google.

Indoor navigation is a broad topic covering a large spectrum of different algorithms, technologies and applications. In order to build a coherent working framework suitable for navigation: Environment Exploration, Modeling, Perception, Localization, Mapping, Path Planning and Path Execution algorithms are all needed. The problem with the current indoor data sources is the huge diversity in data structure, completeness, availability, data coverage, level of detailed linkage to the outdoor networks and geocoding. Most of the existing navigation systems require a priori knowledge of the environment or modification of the environment by adding artificial infrastructure and landmarks (ex: Radio Frequency Identifier (RFID), Bluetooth Beacons, Quick Response (QR) codes). Also building an accurate environment model requires a huge storage on the mobile agent device or high network load for data exchange. Finding solutions for consistent localization and mapping which allowing precise and robust localization in dynamic and real-world environments, is a very challenging research problem. Concise map building and map update that take into account the agent's limited computation capabilities and allow it to plan its navigation path autonomously and smoothly in a dynamic environment is also a big challenge. In this chapter, localization and mapping algorithms and technologies will be studied in terms of accuracy, cost, wide spread adoption capability and dynamicity to environmental changes.

The main challenge discussed is how to build a scalable, dynamic and cheap system for the purpose of indoor navigation. The authors' approach is thus; to leverage the advances in SLAM algorithms in building an optimized environment model that dynamically represents the environment and is easily adaptable to the environment changes without the need of additional environment infrastructures. Moreover, the authors mainly focus on environment representation that minimize both the required storage and the network load and emphasize on building environment models that represent the necessary environment features.

The chapter is organized as follows; in the beginning a basic background to SLAM that is considered a basis for building environment model for indoor navigation is explained. Afterwards different technologies and algorithms for localization is presented. Next, different approaches for environment mapping and representation are explained. Then a focus on existing vision based navigation systems is detailed. After that, location based services based on context awareness is demonstrated. After that insights on the standardization efforts and some industrial projects related to indoor navigation is explained. Afterwards the main aspects for evaluating a successful navigation system is discussed. Then the proposed research approach and the future research direction is shown and finally conclusion of the current research is discussed.

BACKGROUND

SLAM addresses the problem of acquiring a spatial map of the environment while simultaneously localizing the mobile agent relative to this model (Thrun S., 2008). SLAM and navigation techniques have been covered in many citations, most of them have been applied to autonomous wheeled mobile