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Introduction to Image Based Robot Navigation

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A B S T R A C T

We describe a framework for robot navigation that exploits the continuity of image sequences. Tracked visual features both guide the robot and provide predictive information about subsequent features to track. Our hypothesis is that image-based techniques will allow accurate motion without a precise geometric model of the world, while using predictive information will add speed and robustness. A basic component of our framework is called a scene, which is the set of image features stable over some segment of motion. When the scene changes, it is appended to a stored sequence. As the robot moves, correspondences and dissimilarities between current, remembered, and expected scenes provide cues to join and split scene sequences, forming a map-like directed graph. Visual servicing on features in successive scenes is used to traverse a path between robot and goal map locations. In our framework, a human guide serves as a scene recognition oracle during a map-learning phase; thereafter, assuming a known starting position, the robot can independently determine its location without general scene recognition ability. A prototype implementation of this framework uses as features color patches, sum-of-squared differences (SSD) sub-images, or image projections of rectangles.

1. INTRODUCTION TO IMAGE BASED ROBOT NAVIGATION

1.1 Introduction

This thesis details a project whose objective was to create an entire interior navigation system that relied solely on visual data. The systems that allow robots or vehicles to travel independently in enclosed spaces, such as homes or factories, without the use of the Global Positioning System (GPS), are referred to as indoor navigation systems. It is crucial to split navigation into two categories despite the fact that this approach is not as accurate as others since moving from one place to another depends entirely on the system's ability to understand its location. Because of this, the methods, tools, and localization algorithms utilized in interior navigation are primarily different from those used in outside navigation. Since they are not constrained by outside factors like sunshine, range of range finders, or noise, these approaches are really best used indoors.

1.2 Motivation

You may employ image-based robot navigation. The basic purpose of mobile robot navigation is to get them from their starting point to their destination position safely and smoothly while creating the shortest possible path. They aid in time and financial savings.

1.3 Aim and Objective of the work

- To demonstrate a cutting-edge framework for image-based scene identification that will enable navigation in such vegetated areas.
- To demonstrate a novel aspect of AI-based mechanisms that aid in image-based robot navigation.
- A real-world experiment verified that the robot using the suggested identification approach could successfully navigate in areas with a lot of plants.

In order to find the best route from the start point to the destination position, this project seeks to navigate through a congested environment

Fundamentals of Image-Based Robot Navigation

Image sequences

This phrase refers to a collection of photos that were consecutively captured by particular sensors at distinct time intervals. All image-based navigation algorithms are built on the analysis of visual sequences. It is possible to infer three-dimensional movements inside the scene. Tight and loose sequences are characterized in the literature based on the amount of time between projections. In general, free sequences will have more geometric deviations than tight sequences.

Path Planning

According to the control engineer, one of the most important research issues in robotics is path planning. Path planning is an idea that offers solutions to several issues across many sectors. It has been used to direct the robot toward a specific goal at all stages of trajectory planning, from the simplest to the most complex.

1.4 Specifications

Semantic Modeling Framework

Robots must be able to grasp the core of each mission and their working environment in order to carry out complex tasks. However, complicated missions cannot be carried out using recognition algorithms based on conventional modelling approaches that make use of low-level geometric and semantic data. In other words, in order for robots to perceive their surroundings, they require a unique, high-level environmental model that incorporates superior knowledge information. In this part, we suggest the SMF based on the TOSM that mimics the capacity of people to communicate with and comprehend their surroundings.

TOSM-Based Environment Modeling

We first categorize the components of the environment into an item, a location, and a robot. According to Figure 2, each environmental component is represented by explicit, implicit, and symbolic models built on the TOSM in order to accommodate high-level environmental data. Information that may be immediately retrieved by processing sensor modalities is referred to as explicit information. It includes data that may be sensed by logical sensors based on sensor models for metrics (position, velocity, size), geometrical characteristics (shape, boundary), and picture data (features, colors). The implicit model, in contrast, uses databases and knowledge models to infer information. The connections between facts (like an automobile) and ambient variables (like The blue chair is within the conference room.

1.5 Illustration

Figure 1 Autonomous Navigation Framework

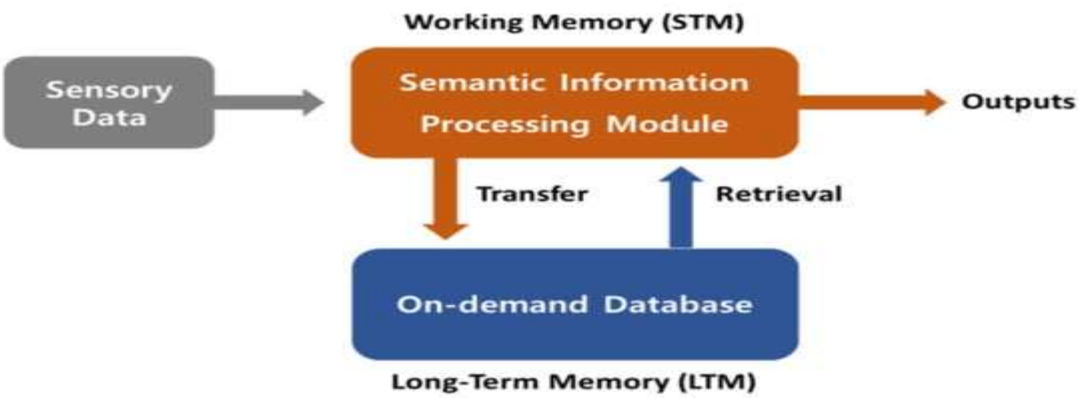

Figure 2 Processing cycle of STM

1.6 Methodology

Semantic Segmentation Module (SSM) for pixel-by-pixel generic object categorization ("Semantic segmentation is the process of identifying each pixel relating to a certain label").

The pseudo-label learning approach is used to train SSM.

For pixel-by-pixel Traversability estimate, there is a tool called the Traversability Estimation Module (TEM), which classifies Traversability images according to labels.

The Traversability masks produced based on the robot's experience are used to train TEM.

The conditions are:

Path planning, human-machine interaction optimization, medical applications, the food sector, and agricultural applications

1.7 Enhancement

i. This architecture is efficient and effective but slow.

ii. As this technology has less accuracy, by Using Trajectory Planning it can be improved.

iii. Hence it should be made easy to operate and understand.

2. Conclusion

In this study, a novel control law for robot navigation is provided. First, an image route is taken out of a visual memory that describes the surroundings. The visual elements that the camera should see while following the motion are specified by this image route. The proposed control law does not call for a 3D recreation of the surroundings. Additionally, the pictures that make up the path are not seen as successively desirable locations for the robot to get at. Robot movements are specified in terms of the spots that match in successive views of the path. These matches are taken into account as descriptions of the region that the robot must eventually reach. The system comes closer to the intended location by compelling the robot to view these sets in favorable conditions. Utilizing suitable objective functions, a qualitative visual servicing has been provided. This control law is unique in that confidence intervals, rather than specific ideal locations or intended visual metrics, are enforced. The viability of the suggested technique has been shown by experiments carried out in simulations and with a real robotic system.

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