Mobile Robot Designed with Autonomous Navigation System

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Abstract. With the rapid development of robot technology, robots appear more and more in all aspects of life and social production, people also ask more requirements for the robot, one is that robot capable of autonomous navigation, can recognize the road. Take the common household sweeping robot as an example, which could avoid obstacles, clean the ground and automatically find the charging place; Another example is AGV tracking car, which can following the route and reach the destination successfully. This paper introduces a new type of robot navigation scheme: SLAM, which can build the environment map in a totally strange environment, and at the same time, locate its own position, so as to achieve autonomous navigation function.

1. Introduction
The story “old horse is a good guider” is about a king with his army, lost in mountains, but with the help of several old horses they finally found the way out. In the story, the old horse could know the way out because they had been passed through this mountain before. But, for robots, it seems that it’s much more complicated than ever. First of all, most robots moving in an unknown environment, such as exploring the kind of car, sweeping robot, this is not experienced "old horse" to rely on; secondly, GPS communication mode is used in the traditional navigation robot is no longer applicable, because most of the work on the interior, even underground river environment; finally, the robot is designed for specific purposes, so they are unable to withstand the pressure of navigation algorithm. Based on the above reasons, we introduce the new mobile robot navigation and positioning scheme - SLAM.

2. Design Objectives
When the robot is in an unknown environment, it needs to know the following three things: where am I? What is this place? How to get out of this place?

In SLAM theory, the first problem is called Localization, the second is called Mapping, and the third is the subsequent Path Planning. To achieve the three goals we need to give the robot "armed", which includes the installation of the eyes, the robot legs, and most important: the brain.

3. Robot's "eyes"
The "eye" of a robot is a camera or a laser sensor. Through these sensors, the robot can get the understanding of the surrounding environment, so as to lay the foundation for building. In recent years, more and more engineers use the following two sensors as the robot's eyes.

Kinect is released in June 2010 by Microsoft, which was initially widely used in the field of games! It has three lenses; the middle of the lens is a RGB color camera, used to capture color images. The left and right sides of the lens is infrared transmitter and infrared CMOS camera composed of 3D structure light depth sensor, used to collect the depth of data (objects in the scene to the camera distance).

Kinect and laser sensor are shown in figure I.
The collected and processed images are shown in figure II. When the robot is equipped with a Kinect or a laser sensor, in her eyes, a strange external environment is recorded, especially with the distance between obstacles. When the robot moves, the eyes of the external environment is certainly changing, the robot will collect all of these image information, by the brain for analysis and processing. Smart brain according to this image can draw a picture of the external environment of the real map, and in the process of continuous incremental, find out their location (positioning). If there is a set of goals, the robot will further path planning, in order to achieve the fastest and safest way to reach the destination.

4. Robot's "brain"
The brain of the robot, which is the control center of the whole system, is usually held by a PC (or embedded control board). PC runs on the software, to control the robot to walk, collect information, avoid obstacles, to build plans and positioning, etc. This is a complex and difficult work, because all of these work are interrelated, interaction, fortunately, the emergence of ROS.
when receiving sensors to collect environmental information, the SLAM package will analyse and process the complete and build the environment map and its positioning etc. The specific composition of the SLAM package as shown in figure III:

Of course, the development of the present, SLAM is no longer a simple algorithm or software, but includes hardware and software platform, a number of processes, a variety of solutions and mapping system. Generally speaking, the robot to complete the SLAM process generally is: the robot continuously through the depth of the camera or the laser sensor, the odometer information collection robot path of their own, and then analyze the information, draw their own position and the environment map. The robot is to infer the location information (EKF) by the way of probability, because the acquisition environment, the path information will have errors, noise. Thus, in all of these steps, the EKF is the core, which keeps the (probabilistic) update of the robot's position.

When the odometer changes because the robot moves the uncertainty pertaining to the robots new position is updated in the EKF using Odometer update. Landmarks are then extracted from the environment from the robots new position. The robot then attempts to associate these landmarks to observations of landmarks it previously has seen. Re-observed landmarks are then used to update the robots position in the EKF. Landmarks which have not previously been seen are added to the EKF as new observations so they can be re-observed later. All these steps will be explained in the next chapters in a very practical fashion relative to how our ER1 robot was implemented. It should be noted that at any point in these steps the EKF will have an estimate of the robots current position.

The general framework for SLAM is shown in figure IV.

![SLAM components](image)

**Figure 4 SLAM components**

5. Acknowledgment
The mechanism of SLAM is discussed in this article, which can make the robot recognize the road, autonomous navigation even in an absolutely new environment, just like the "old horse". Especially with the increasing demand of service robots, SLAM will have more and more applications. However, due to the complexity of the actual environment, such as indoor light will change, the obstacles move, let a robot at a slower speed (2cm/s), this paper looks easy to realize the function, in the actual environment are often stretched, run everywhere. The good news is that companies such as Google have released a SLAM development kit, marking the industry's research and development in this field into a new stage. Challenges to the actual environment, is the main direction of development of SLAM technology, which includes the dynamic scene, semantic maps, multi robot cooperation, etc. It's believed that with the continuous progress of SLAM technology, it will soon come into our life.
6. References

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