Indoor Navigation Systems for an Autonomous Mobile Robot

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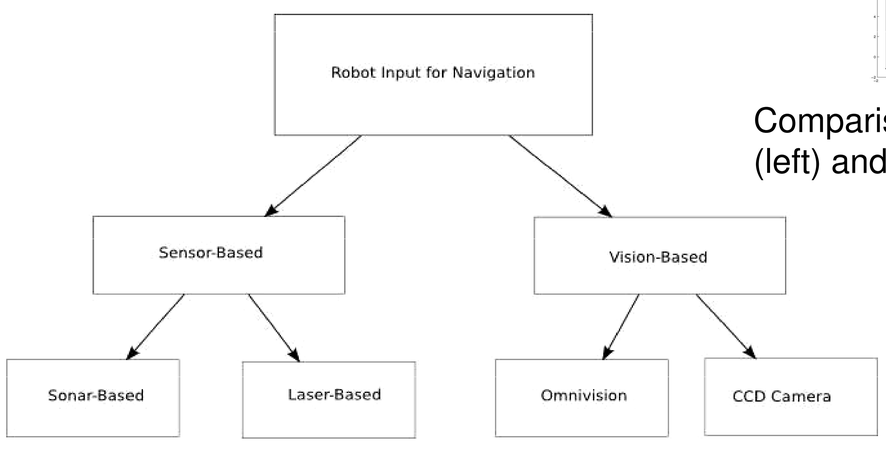
1 Introduction

Robots are becoming more popular every day. For example, in 2005, the robot world market saw an increased of 30% from the 2004 market(1). The picture(2) shows the popular ASIMO robot created by Honda which uses a stereo vision system for its navigation.

2 Problem

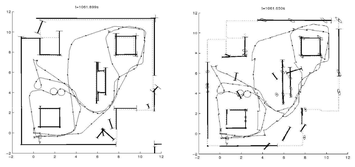
- Various types of input methods available
- Navigation system must work in an unknown environment
- Outdoor navigation systems (such as GPS) do not work effectively indoors
- Map-building and navigation must be implemented as new terrain is discovered

3 Categorization



4 Input Methods

Sensor Type	Advantages	Disadvantages
Sonar	1. Cheap 2. Easy to implement	1. Physical minimum distance 2. Not as precise
Laser	1. Precise measurements 2. Angular precision	1. Angle of incidence limitation 2. Expensive
Omnivision	1. Panoramic view allows for simple map building 2. Geometric rendering of obstacles can be obtained	1. High processing overhead 2. Sensitive to surroundings
Stereo Vision	1. More information from one scan about an obstacle 2. Allows for an easier 3D modeling of the environment	1. High processing overhead 2. Sensitive to surroundings



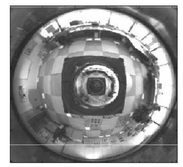
Comparison between a laser-built map (left) and a sonar-built map (right).

5 Navigation

Simultaneous Localization and Map-Building (SLAM)

Different type of map representations

- Feature-based
- Grid-based
- Topological


(3)

Omnivision systems allow for a motion planning system using standard graphic hardware since they obtain a more geometrical view of the obstacles.

6 Examples

Laser System (4)

- 360° scan in 32ms
- Semi feature-based representation
- Next-best-view concept
- Pentium 233 MHz MMX and Pentium II 450MHz
- Separate processing and planning systems
- Failed detection of glass door

Omnivision System (3)

- Images sub-sampled to 128x128 for processing
- Topological representation
- Visual path following for door traversal
- Pentium II 350MHz

7 Proposed Solution

A hybrid system of three types of sensors would be the most optimal solution for a robot navigating in an indoor environment. The three sensors allow for a robust map building solution but would require more processing power than the individual systems, unless parallel subsystems are implemented.

References

1. http://www.ifr.org/press/world_market.htm
2. Courtesy of www.dld-conference.com
3. N. Winters, J. Gaspar, G. Lacey, and J. Santos Victor, “Omni-directional vision for robot navigation,” in *Workshop on Omnidirectional Vision*, 2000, pp. 21–28.
4. H. H. Gonz´alez-Ba¨nos and J.-C. Latombe, “Navigation strategies for exploring indoor environments,” *I. J. Robotic Res*, vol. 21, no. 10-11, pp. 829–848, 2002.
5. J. D. Tard´os, J. Neira, P. M. Newman, and J. J. Leonard, “Robust mapping and localization in indoor environments using sonar data,” *I. J. Robotic Res*, vol. 21, no. 4, pp. 311–330, 2002.