SensorBot 2002

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Abstract. Development has been initiated on a cheap and small robot suitable for search and rescue tasks. It was named "SensorBot" because of the direction of the research towards sensors, sensor platform and sensor data information fusion. This paper introduces the first steps of our research and development for building a SensorBot.

1 Introduction

Development of a cheap Robot, suitable for probing catastrophe areas and to locate victims hidden therein was initiated in the beginning of 2002.

Initial research and development are directed towards sensors and electronics interfacing the sensors with the short-term goal to design and assembly a cheap but flexible sensor-module that can be used for search and rescue robots and as a research platform for sensor data fusion. The focus on sensors made us come up with the name SensorBot for the robot to be developed.

We participate in RoboCup-Rescue 2002 with the intention to demonstrate a prototype of a sensor-module, and hopefully get feedback and new ideas for further development by interacting with the international research community active in the field.

2 Team Members

Team Leader (and currently only team member):
Jimmie Landerman, MS Electrical Engineering

3 SensorBot Development

In the future we imagine human rescue workers to be assisted by teams of different types of robots. One type will most certainly be a cheap, small and autonomous robot that can be deployed in a large number, jointly probing a small-scale (i.e. a building)

debris structure resulting from a catastrophe, locate victims buried therein and direct rescue workers (or other rescue robots) to them.

Key characteristics of such a robot have by us been defined to;

Cheap. It should be economically viable for rescue teams to deploy a large number of SensorBots at a catastrophe area, without having to fear economical consequences if many of them get lost during the search task. This means that the final design must use cheap mass-produced off the shelf components.

High usage of sensors and sensor data fusion. A SensorBot must naturally be equipped with a wide range of sensors suitable for navigation, mapping the traversed environment, locating and actively search for victims and preferably also allowing human tele-operation and supervision. It should be able to generate and execute active probing plans when the sensed information is not sufficient and to fuse data from non-orthogonal sensors as well as from sensor readings at different positions.

Autonomous. The SensorBots must be highly autonomous and put as little load on the human rescue workers and on the limited communication bandwidth as possible.

Small. The size of a SensorBot must be small enough for being able to enter where humans and dogs can not.

Small-scale operation range. Unlike the RoboCup-Rescue Simulation Project which focuses on larger-scale operation [1] SensorBots are assumed to be deployed on the spot for the search and rescue task. Targeted operation range should thus be smaller-scale, such as a collapsed building.

Multi-agent cooperation. One of the probably most complex research areas for building a functional team of SensorBots is the development of robust multi-agent path-planning algorithms for probing the whole accessible structure while dealing with temporary (out of communication range) or final loss of agents.

Operational in difficult terrain. The SensorBots must be able to operate in the tough environments typical for a catastrophe area. That puts very high requirements on the mobile platform. We will use simple mobile platforms for the initial research and design of the sensor module, but for a real SensorBot more advanced locomotion is needed. Caterpillar treads, legged or serpentine-based locomotion could be suitable.

Robust wireless communication. SensorBots need to communicate with each other as well as with some centralized main control computer. Moreover it should be possible to tele-operate individual SensorBots for more precise examination at locations of special interest.

Clearly there are a lot of different research fields that all are of great importance for the development of a team of SensorBots. With limited resources some focus is required and our decision was to start with focusing on sensors and sensor data fusion, and to do so by developing a sensor module. This module is a first step on the way of

building a SensorBot, and is intended to be used for our next step, sensor data fusion research. Hopefully it could also be an interesting component itself for use in robotics.

4 An Overview of the Sensor Module System Design

At the time of writing this, the first prototype of the sensor-module is not yet finished thus making it impossible to give a detailed description of the design; instead an overview will be presented.

It was decided that the main focus for the first prototype of the sensor module should be inertial navigation. Thus gyros and accelerations sensors sensitive for all 3 axis of rotation and motion are used. In addition a magnetic compass and a temperature sensor (for the possibility to compensate for temperature dependent deviations) are also included.

The data obtained from these sensors should be fused with odometer readings from the mobile platform to give a realistic possibility to track the path of a robot with somewhat precision.

A GPS receiver would be an obvious choice for facilitating navigation. Nowadays there are very small and quite cheap GPS modules available targeted for mobile phones and PDAs. For search and rescue tasks among debris GPS is unfortunately believed to be of little use since most operation will be without free sight to the satellites. For that reason, GPS is not highly prioritized at this time but will be considered later.

Also sensors for detection of victims, mapping of the traversed environment and obstacle avoidance are needed. Thus sensors sensitive for IR emissions for sensing body heat, some types of distance range sensors (ultrasound and IR) and tactile sensors have been decided to be used.

The sensor module is controlled by a microprocessor, either from the Hitachi SH-2 or H800 family, and is intended to interface a more powerful main CPU on the robot. It is our intention to later also design such a main CPU module supporting different types of wireless and wired communication standards.

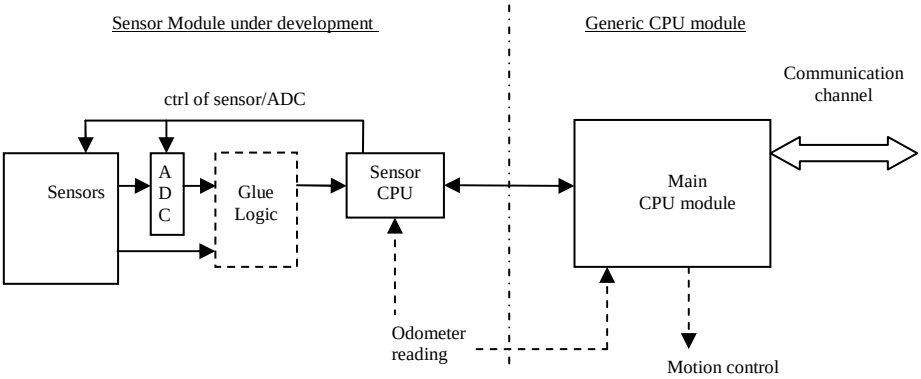

Fig. 1. System design of the sensor module.

Image and sound (video) are of course of great importance, but will not be handled by the sensor module described here. Main reasons are that the high data rates and large processing power needed for video give quite different requirements on such a module compared to the other sensors. Instead we propose a solution for video by using a parallel video module that also interfaces the main CPU.

5 Future Work

The work with developing a team of SensorBots has just been initiated. In the near-term future, development of the sensor-module and research and implementation of information fusion algorithms will be done.

Additionally, we also hope to be able to design a video module as well as a main CPU module for making a complete computer system for a SensorBot.

A software simulation system there algorithms for information fusion, active probe generation and multi-agent collaboration could be evaluated is also considered.

6 Acknowledgements

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References

1. Tadokoro S., Kitano H., Takashi T., Noda I., Matsubara H., Shinjoh A., Koto T., Takeuchi I., Takashi H., Matsuno F., Hatayama M., Nobe J., Shimada S.: The RoboCup-Rescue: An international Cooperative Research Project of Robotics and AI for disaster Mitigation Problem