The Keystone Fire Brigade

Jacky Baltes

Centre for Image Technology and Robotics
University of Auckland,Auckland
New Zealand
j.baltes@auckland.ac.nz
http://www.citr.auckland.ac.nz/~jacky

Abstract. This paper describes the design and implementation of the Keystone Fire Brigade, a team participating in the RoboCup Rescue competition.
The goal of this research project is to provide a vehicle for research into vision based fully-autonomous operation in complex unstructured environments.
The Keystone Fire Brigade hopes to achieve the following four goals in their first appearance at the RoboCup Rescue competition: (a) show rudimentary localization capabilities, (b) detect victims solely based on vision information, (c) test the motion capability of the robots in the orange and red zones, and (d) perform a systematic search of the yellow zone.

1 Introduction

This paper describes the design and implementation of the Keystone Fire Brigade, a RoboCup Rescue team from the University of Auckland.

The paper will briefly introduce the hardware (Section 2). Section 3 describes proposed solutions to the problems of localization Subsection 3.1) and detection of victims (Subsection 3.2). Section 4 summarizes the goals of this research and summarizes the achievements so far.

2 Description of the Robot Hardware

The Keystone Fire Brigade robots are based on the 4 Stooges ([1]), a small sized RoboCup team from the University of Auckland. The small sized (also called F180) league uses robots with a maximum diameter of 18cm. These robots play a game of five versus five soccer on a 2.80m by 2.30m large playing field. The F180 league allows global vision systems, so most teams use a camera which is directly mounted overhead.

Partially due to the availability of small, cheap, and low power CMOS cameras and fast processors, a number of teams have developed local vision approaches, and two teams (Viperoos and 4 Stooges) have even developed fully

autonomous solutions in the F180 league. These teams compete each year in the local vision derby.

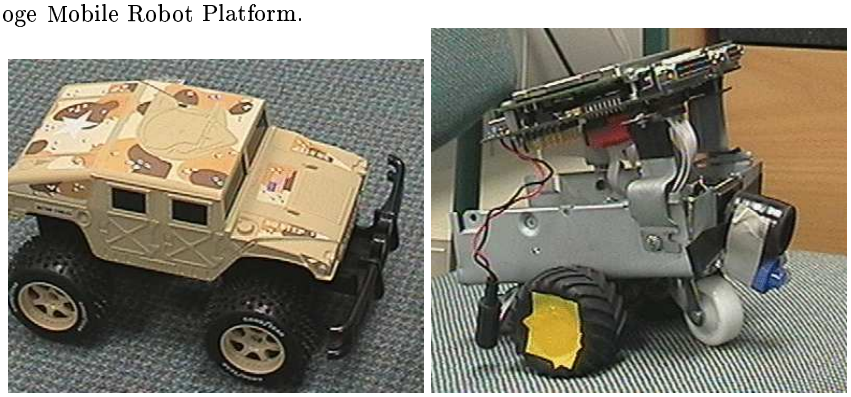
The robots of the 4 Stooges were designed to be robust and versatile enough to be used in a variety of different ways. This has paid off since the robots of the Keystone Fire Brigade are identical to those of the 4 Stooges.

The Keystone Fire Brigade use a small CMOS camera and Thomas Braunl's Eyebot controller [2]. The Eyebot controller consists of a 35 MHz 68332 processor with 2 MB of static RAM. The design is clearly dated nowadays, but has the advantage that they are comparatively cheap and provide the possibility of directly connecting a CMOS camera to the processor. Furthermore, they provide the necessary interface to connect motors, servos, gyroscopes, and many other sensors directly to the controller.

The 4 Stooges use a commonly available Tamiya twin gearbox and off road tires for locomotion. This makes the mechanical platform very inexpensive.

The base platform for the Keystone Fire Brigade uses the same setup as the 4 Stooges for some of the robots, but also uses a similar setup using an RC-car model from Nikko, the Hummer. Figure 1 shows the base systems used by the Keystone Fire Brigade.

Fig. 1. Mobile Robot Platforms of the Keystone Fire Brigade: Hummer RC and 4 Stooge Mobile Robot Platform.



3 Vision Information in the RoboCup Rescue Domain

Clearly, the design of the Keystone Fire Brigade with two simple toy motors for propulsion limits their usefulness in the more difficult sections of the RoboCup Rescue domain. We hope to overcome these limitations by collaborating with Dr. Nadir Ould Kheddal's team from Temasek Politechnic, Singapore.

Therefore, the focus of this research is the development of autonomous vision algorithms which are suitable for embedded devices.

3.1 Localization

One of the biggest challenges for a local vision team in the small sized league is the localization problem. The playing field does not provide enough visual information to allow a robot to localize itself on the playing field with a single image.

Most other team therefore use odometry readings to help in localizing robots. This solution works well in simple domains that use a hardwood floor or a suitable carpet. However, the usefulness of odometry is limited in the USAR domain. The 4 Stooges do not use any odometry but rather use optical flow algorithms to substitute for the odometry and to provide relative motion information. In addition the optical flow information is used to update an internal robot model which is used as a last resort in case neither absolute localization, nor relative motion via optical flow can be detected.

In RoboCup Rescue, the problem is markedly different. The real world provides many different features and distinguishing views. In fact, the problem is that the robot assumes that it is in a different location although it is in fact at the same place. This mis-classifications can happen through changes in lighting or motion in some part of the image.

3.2 Detection of Victims

The NIST and RoboCup Rescue domain include a number of simulated victims. These victims provide a number of features which allow their detection, including their shape and colo, motion, sound, and heat.

In the 2001, it was evident that the vision information alone was sufficient to detect most victims since the tele-operated robots (where a human operator interprets the visual information remotely) had no problem picking out the victims. One goal of this research is to develop methods that can perform similar in this environment.

This problem (scene interpretation) is a very hard one. Many researchers have tried to develop vision systems but have failed so far.

Our victim detection uses both color as well as shape information. Flesh colored spots are marked as possible victim location. We have developed a 12 parameter color model which uses Red, Green, Blue as well as the three difference channels Red - Green, Red - Blue, and Green - Blue. This color has proven itself in years of robotic soccer competition and we will use the same in the RoboCup Rescue competition.

Secondly, a number of "typical" poses of human appendages hands, head, and feet will be used to support pattern matching.

4 Goals

Since this is our first year in the competition, we have selected the following goals for the Keystone Fire Brigade:

1. Show that the robots are able to determine correctly if they have visited a specific location previously or not. The main focus of our research has been this problem. The robots should avoid previously seen places and seek novel or unknown places in the environment.
2. Detect victims through interpretation of the vision information alone. This detection uses color hues as well as edge information to determine if the robot is sufficiently close to a victim or not. This part of the system will be evaluated by putting the robot close to a victim and measuring the recognition rate of the system.
3. Show that the mechanical design of the robots is capable of navigating the yellow and orange zones of the NIST playing field. This will be investigated by field trials. Some field trials will also be held in the red zone, but the terrain in the red zone may well require tracked or legged robots.
4. Move at systematically/randomly through the NIST playing field and cover an appropriate part of the playing field. The robots have not been programmed with a map of the playing field as this would be impossible to do in a real USAR scenario. Therefore, the robots will have to map the environment themselves and incrementally develop a map.

The first competition will provide anecdotal evidence for how well the Keystone Fire Brigade is able to achieve these goals. It is non-trivial to develop quantitative measure for how well a robot is able to perform the tasks mentioned above. One of the measurements of course will be the score that the Keystone Fire Brigade will accumulate during the competition.

References

1. Jacky Baltes. The 4 stooges homepage. WWW, November 1999. http://www.citr.auckland.ac.nz/~jacky.
2. Thomas Bräunl. Thomas bräunl's homepage. WWW, November 2002. http://robotics.ele.uwa.edu.