RoboCupRescue 2006 - Robot League Team <RoboRazi (IRAN)>

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Abstract. RoboRazi is a robot specially designed for rescuing mission according to the Real Rescue Competition rules and constraints. This robot consists of three main parts: mechanical (motion mechanisms), hardware and software. The RoboRazi uses a LMS200 laser sensor and a PCM-3370F embedded system for image processing and automatic map planning. RoboRazi sends images received from capture card to operator using the wireless LAN card (802.11a) and receives control command from operator when needed. To determine the victim state, infrared thermometer, CO2 sensor, microphone and a speaker for speaking with victim have been employed. In RoboRazi's mechanic system worm gearbox motors have been used so that the LMS200 can rotate in both horizontal and vertical directions. The RoboRazi has been constructed according to all physical restriction in rescue competition arena.

Introduction

In the earthquake disaster and consequent building destruction, a rescue robot can find victims faster and more accurately than a rescuer human.

The robot based on RoboCup Rescue Competition Design must pass the obstacles of buildings destruction easily reach to the victims and report the victim statue to the operator.

Mechanical and electrical parts of the robot have been specially designed in to search the area for a long time due to its low weight, high speed and low energy consumption. RoboRaziGroup have designed the Roborazi with following functions:

- Searching the area two modes, i.e., manual and automatic.
- Reporting its status data to the operator repeatedly (such as battery charging, robot balance, motors current, …)
- Reporting the arena status repeatedly (such as light, temperature, co2 quantity)
- Reporting the victims state (body temperature, breathing and heart beating)
- Three dimensional analyzing of area, generating the map and defining victims position on map.

1. Team Members and Their Contributions

The team members and their technical contributions are as follows:

- Dr.Amir Rajabzadeh — Advisor
- Ms.Mazdak Radmalekshahi — Advisor and Sponsor
- Mostafa Sattari (Leader) — Electronic and Control
- Saeed Shariati — Software Design and Developing
- Mohammad Rahbar — Mechanical Design and Manufacturing
- Ali Fooladi — Electronic and Control
- Amir Tohidi — Software Design and Developing

2. Operator Station Set-up and Break-Down (10 minutes)

All the constitution parts and its control system containing a laptop and accessories can be placed within a normal size box. It's worth noting that all the tasks are due to the embedded computer. Now, the operator turns it on and while it's uploading, the control system can be assembled. Then, the directing computer will be on.

Initially, the robot observes its accessories and sensors. As soon as communicating with control center it announces its status, then robot can start the competition. All of these will never exceed 10 minutes.

3. Communications

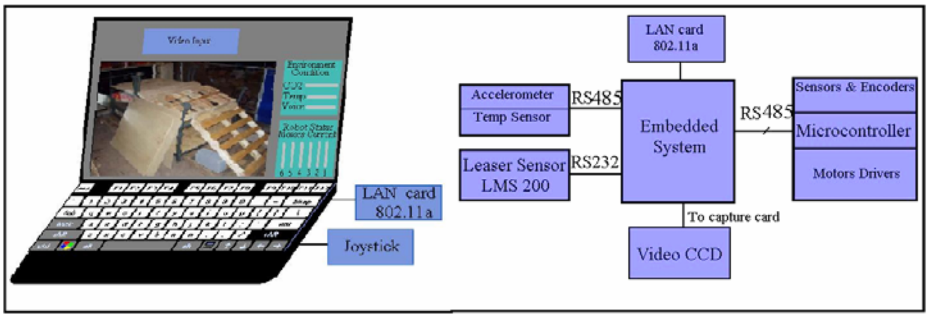
The communication system includes a wireless network through which video stream, orders and data required between the control center and robot are exchanged.

Rescue Robot League		
ROBORAZI (IRAN)		
Frequency	**Channel/Band**	**Power (mW)**
5.0 GHz - 802.11a	5.15-5.25 GHz	STANDARD

4. Control Method and Human-Robot Interface

The user interface is being designed in a manner to be as friendly as possible. Robot can be controlled either by keyboard or joystick.

Its automated base operation is designed by robot itself. Actually, map generation, defining the position, searching the victims, etc; is contributed to the robot. The motion form, balance, speed, passing the way, map, robot and victim position are directed by the operator. Under user monitoring, the wrong decisions or ignoring the victims can be corrected. Note that the operator orders take high priority. Some of abilities of user interface are as follow:



RoboRazi control diagram Figure

- **The camera systems**
  Four cameras with pal outlet system have been fixed on robot (figure 1) and operator receives pictures simultaneously through a card with four inputs who may select each of them. Contributing to the visual angle at 120 ° interface of two angles at 15 ° is formed by two cameras. Aggregation of all pictures in software provides a view of 360°. So user can observe the arena and robot can do vision actions more accurate.

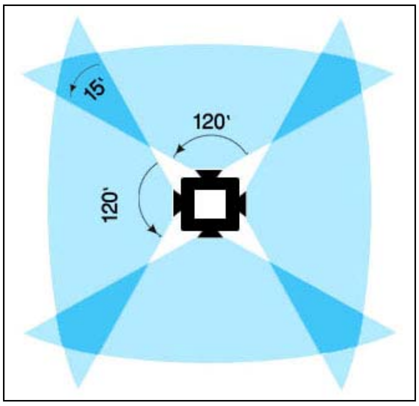


Figure 1

- **Balance system**
  One accelerometer has been fixed on it. When the robot is not moving, its steep from the horizon can be determined in two dimensions. We can observe such a balance status with arms position (three dimensions) on graphic device.

- **Ambient obstacles determination**
  Using ultrasonic sensors around the robot, the user can determine the big obstacles and display data on monitor. The sensors, mentioned above have been utilized in automated control of motion when it is passing a narrow corridor with it's maximum speed.
- **map observation**

The user can always observe the map (drawn by robot) on user interface. It is also possible for user to determine portions of arena which are sent by camera and have not been processed yet.

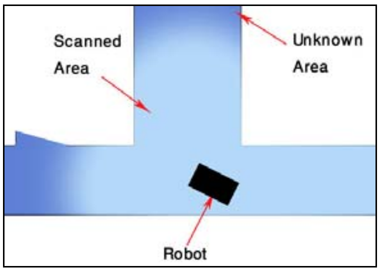


Figure 2: the map which user observe

5. Map generation/printing

Initial effort was to apply stereo vision for three dimensional map generation. However, it was extremely time consuming in practice and is not reliable in far distances. So the most suitable choice was Laser Measurement Sensor (LMS200) by which it generates two dimensional scan in an angle at 180° in 20 milliseconds. Figure 3 illustrates that its rotation around the defined axes can generate accurate estimation. By the use of three dimensional pictures extra objects can be determined and provide the final map. Laser Measurement sensors encounter an error with mirror and glass which can be corrected by using an ultrasonic sensor. Map generation is an automated base process and can be printed at the end of competition.

6. Sensors for Navigation and Localization

First, a three dimensional picture is taken from surroundings. Then, LMS will be fixed in a specific direction, thus by moving the robot and measuring the distance relative to some reference points robot's new position will be determined. If it fails to obtain the reference points, a three dimensional scan should be taken, and by last robot's position and information sent by accelerometer new position will be determined. If it is not possible to do so, operator will be called for help.

By comparing parts of arena which have been controlled and map, robot decides where to go, thus by three dimensional map and ultrasonic sensors find it's way.

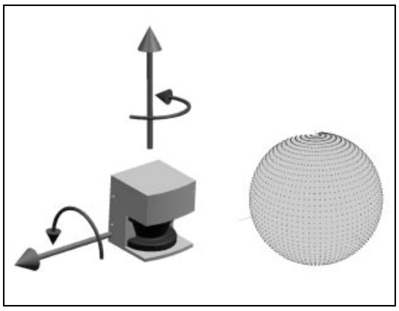


Figure 3

7. Sensors for Victim Identification

- **motion detection**
  It uses vision at an angle of 360° from cameras.
  It uses IR Motion detecting sensor.
  It uses ultrasonic detecting sensor.

- **Color Detection**
  It uses vision at an angle of 360 ° to search victim's clothes color.

- **Sound detection**
  It finds victims by sensing their groaning voice.

- **Chemical sensor**
  It uses aggregation of co2 in the closed area and reports victim next to it. Note that the position of victims can not be found with this sensor. By using three dimensional pictures and temperature sensor it can validate the victim's presence.

8. Robot Locomotion

The main goal in its mechanics is based on robot flexibility in various and difficult situations. Regarding this, the overall scheme is as follows: there at the main stem of robot two caterpillar tracks have been situated on its sides. Four motive arms have been situated on their front and back wheels; So it can rotate at an angle of 360°. Using motive levers, the robot can pass the highest obstacles, stairs and steeps with utmost efficiency. The optimum overall size of robot enables it to pass over the mentioned obstacles. Using the simplest approach, enables the overall scheme to reach maximum efficiency, desired goals and avoids making the system too complex.

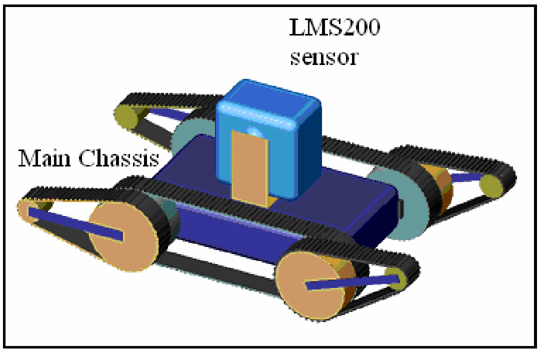


Figure 4

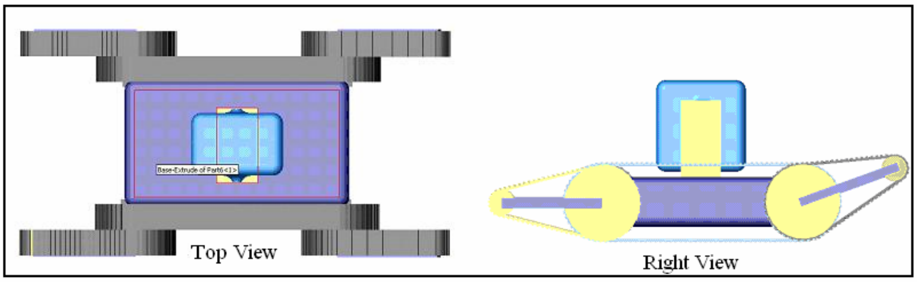


Figure 5

Power transmission by a DC motor

Two simple gears transmit 1.3power to the main motive wheels at the back of robot. Also a single motor controls each of motive arms. These arms are flexible enough to enable robot passing the most difficult obstacles.

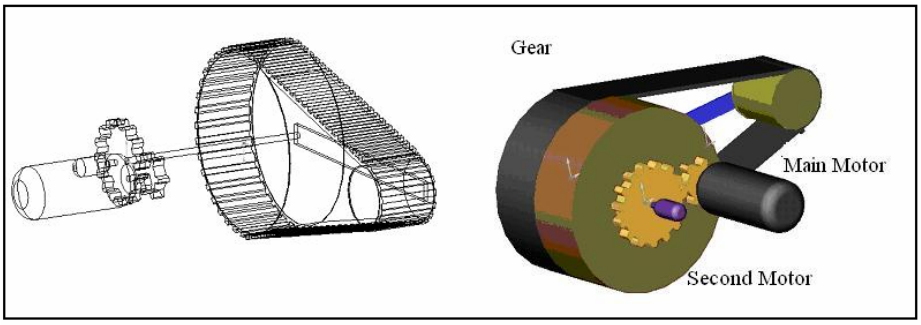


Figure 6

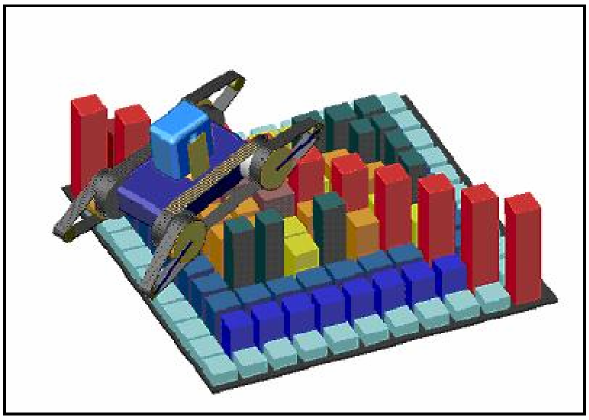


Figure 7

The related Figure illustrates how the system rotates the main packed sensors located on chassis: a central motor is defined for rotating all the packed sensors at an angel of 360°, Located under the sensors layer. It is used for rotation and oscillation as well. Rotation is at an angle of 25° vertically.

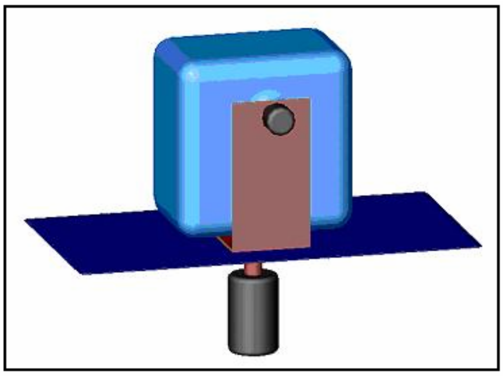


Figure 8

9. Other Mechanisms

- It uses the light at dark areas.
- It uses the microphone and speaker to speak with victim.

10. Team Training for Operation (Human Factors)

Uploading the functioning system of Roborazi, it checks out the sensors, motors and accessories. Then it reports that is ready to function without operator.

For preparing the control system to work, first turn on the laptop. After operating system is uploaded, software starts to work. Then the operator can control the robot with game pad connected to laptop in order to observe the online data on the monitor from robot. The operator can control the robot like playing a simple game. Manual form enables the operator to direct the robot toward victim and robot saves the victim's position.

11. Possibility for Practical Application to Real Disaster Site

- The mechanics of the robot is industrial based. It can be hopeful to apply it in real situation regarding its industrial sensors and computers.
- The robot motors are powerful enough to overcome the encountered obstacles.
- The ultrasonic sensors are water proof. It can be mentioned that the predicted problem of robot in real situations is contributed to limited transmission range of wireless LAN which can be improved by replacing it.

12. System Cost

	Part Name	Model	Qty.	Total Cost (USD)
Mechanical Part	Motor Gearbox	Baskurt 12v dc	2	300
	Motor Gearbox	Buhler 20 Ncm	5	100
	Other Cost	------	--	200
Electronic Part	Electronic Board	------	2	200
Computer Part	Leaser Sensor	LMS 200	1	5400
	Embedded System	PCM-3370F	1	1200
	CCD Camera	Proline 4.6m	4	280
Sum				7680