RoboCup2004
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RoboCupRescue, Rescue Robot League
ME1 : Mantes Explorer I, France

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Abstract

Mantes Explorer 1 has been designed for remote exploration of hasardous environments and rescue missions. It has a simple and robust structure which should allow it to achieve its missions with success.
As this report has been written more than four months before the competition some of its information could be changed during the realisation of the project.

Introduction

This robot has been designed in the new mechatronics department of the school of engineering of the University of Versailles (ISTY). The mechatronics department is closely linked to the Robotics Laboratory of Versailles which has some experience about robocup and mobile systems.
This is the first year we participate in this competition and, for this first time, we want to realise a simple robot which could allow us to gather enough information in order to improve our future participation.

1. Team Members and Their Contributions

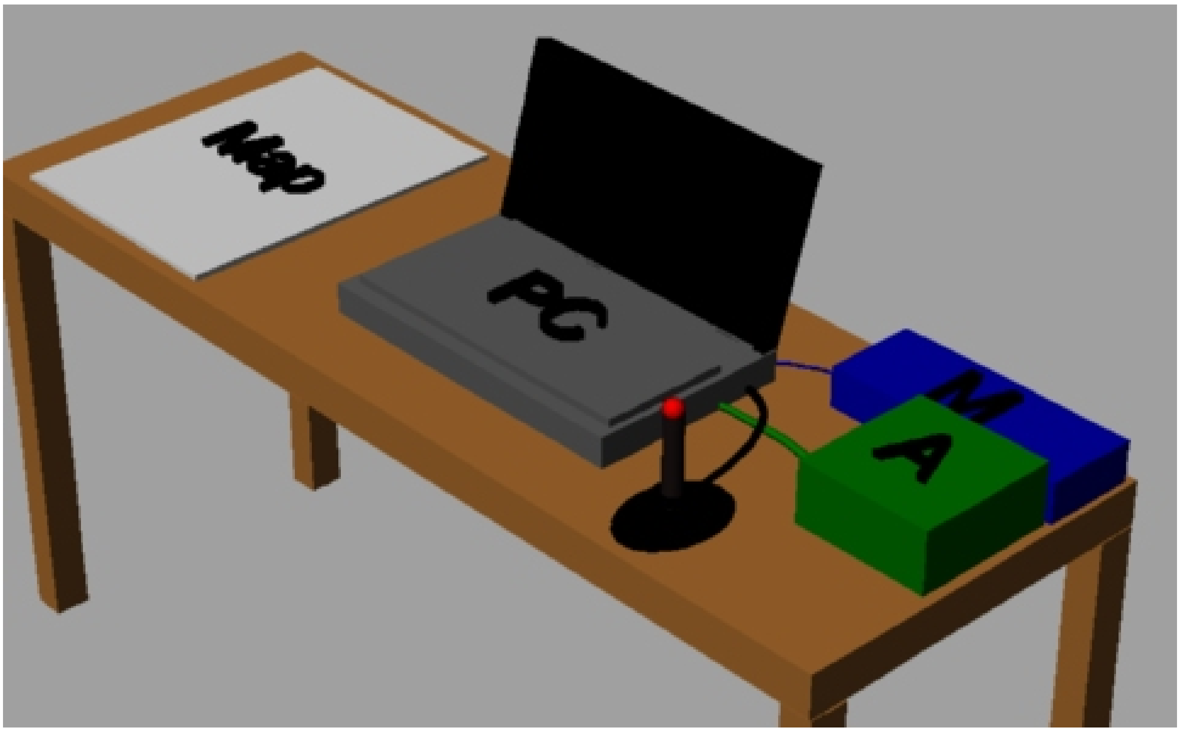
Pierre Blazevic is professor in University of Versailles, deputy director of the LRV and head of the mechatronics department of ISTY.
Jean-Charles Cadiou is leading the mechatronics research group in the LRV.
Their research interest cover mobile robotics and control engineering.
In the project they will have in charge the integration of all technologies involved and they will have to validate all proposed solution by the students.

The team is also composed by five students, each student has a responsability of one subject but students have to work in small group.

- Romain Boudet frame and propulsion
- Teddy Gommard HMI
- Bastien Hudelot HF link
- Yann Verdier Video turret
- Franck Vic Sensors

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

Operating environnement will consist on a notbook, a wireless connection and input/output device.



MAP: Place where the operator draws his chart
PC: PC notebook
A: Optional analog video receiver
J: Force Feedback device
M: Wireless access point

Only one operator could be enough to control the robot and to chart the rooms, but we are going to have two oerators one to control the robot and one to draw the chart and to organize the strategy of displacement. Moreover, it will be easier and faster to set-up and check all the configuration with two persons.

During the 10 minutes of preparation, we plan to:

- To install the notebook,
- To connect the various peripherals,
- To check PC (network, joystick, program)
- To install the batteries in the robot
- To check the RF communication,
- To check the calibration of the sensors
- To check the motors

3. Communications

Connection PC – Robot:

Data have to be exchanged in both direction as the robot has to be controlled and to send back video and sensors data. 802.11a protocol link will be used. 802.11a uses a different frequency than the most commonly used 802.11b/g and will procure a more robust connection.

At a higher level, UDP sockets will be used instead of TCP sockets which are less efficient in bad network conditions. Thus the application sofware will have to take care of all the streaming yn-chronization.

Data to be transmitted to the robot :

- ➢ Motor control
- ➢ Turret control
- ➢ Camera parameter (luminosity, resolution)
- ➢ Video rate

Data to be received:

- ➢ Sensors data
- ➢ Images

4. Control Method and Human-Robot Interface

Remote operation will use a PC notebook running under Microsoft Windows 2000 using a force feedback device. Programming language is C++ in Builder 5 environment, graphical and user interface are through Microsoft DirectX libraries.
Embedded PC is a PC104 board with a frame grabber. The embedded sofware will run under the realtime operating system QNX. In our configuration we have install QNX on a 64MB static disk.

5. Map generation/printing

No automatic map building is scheduled for this participation. Map building will rely on vision feedback and human interpretation. At this time an incremental behaviour is planned. The robot will move few seconds and we will position it on the map, using odometry, vision, magnetic sensor we hope to obtain, at least not a precise map but a useful one. Victims when identified will be drawn on the map.

6. Sensors for Navigation and Localization

The robot is equipped with several kind of sensors that are going to be used for navigation or detection purpose.

Navigation sensors

Two types of proximity sensors are set-up around the robot, ultrasonic and infrared PSD detector. These sensors will be used to avoid obstacles and to progress in narrow space.
In order to improve localisation and ease map building a magnetic compass is alsa included in the robot, but reliability of information will depend on the magnetic caracteristic of the environnement.

One difficult problem when teleoperating a mobile robot is the perception of local attitude, to solve this problem a 2 D accelerometer used as an inclinometer will allow the operator to be informed of the direction of the vertical.

Also a laser line is considered to help the 3D reconstruction of the environnement using the camera during the forward progression. At this time laser line is only a project,and final decision will be made soon.
All sensors exept the vision are connected to the embedded PC using microcntrollers and several RS232 links.

Victim detection

The robot will have a microphone to help discover victims obtaining more element to determine the life state of the buried people.

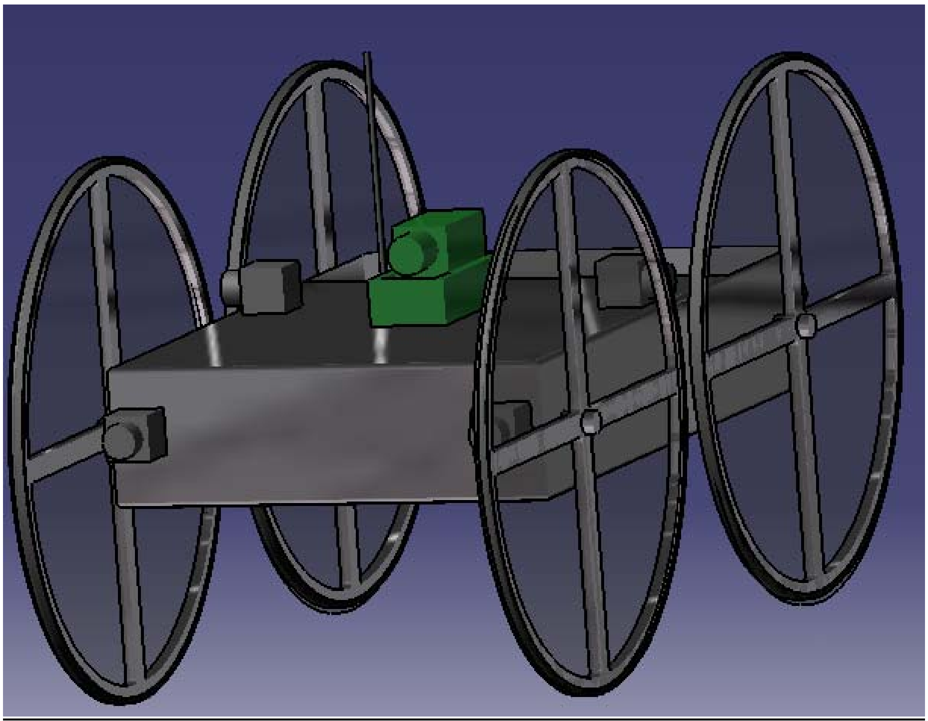
We will use a passive infra-red sensor for detect the movements of the victims.
They have the advantage of not to be sensitive to insects and to domestics animals.

Via the camera, laser aiming, microphone and sensor of movement, we can realize an effective location of victim presenting signs apparent and/or detectable of life.

7. Robot Locomotion

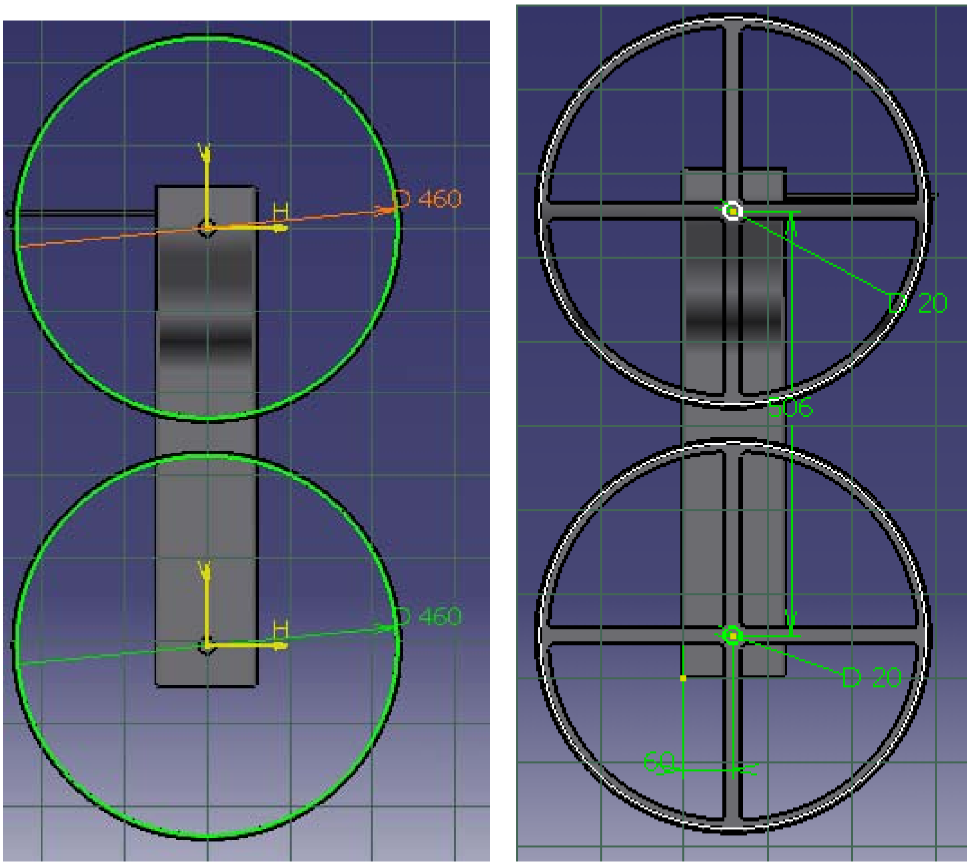
Numbers of wheels: 4 non direct driving wheels
Transmission between the wheels: timing belts
Dimensions of the wheels: Ø =460mm
Coefficient of friction enters the wheels and the ground: > 0.6
Number of motors: 2
Supply voltage of the motors: 24V
Power : 20W/engine
Speed of the robot: 0.2m/s
Other characteristics of the engine:

- incremental encoder
- engine 1 : control of the 2 wheels of left-hand side
- engine 2 : control of the 2 wheels of right-hand side
- Rotations of the robot will be carried out by a speed variation of the 2 motors.



View of the robot

- The wheels will be covered with Plexiglas plate to prevent objects to interfer with the wheels.
- 6 sensors with ultrasounds and IR PSD are disposed on the side of the robot for the detection of objects around.
- the turret with the camera is located at the middle of the frame
- The frame will be covered to protect the elements inside the robot. There will remain an opening for the antenna, to have a good quality of connection.



Dimensions

8. Other Mechanisms

Camera on turret:

In order to increase the field of vision of the robot, we decided to develop a mechanical system of rise.

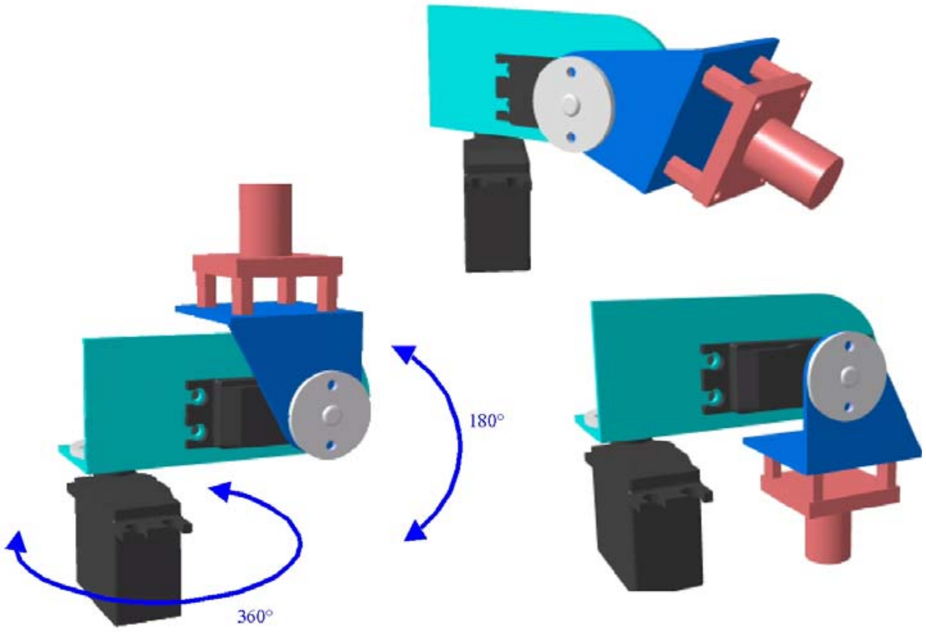
This system will enable us to bring the camera, the microphone and lighting to one height of 1500mm compared to the ground, thus limiting the exploration of places not accessible.

On this system, we will install a camera equipped with a mechanical system for a rotation on 360° and a vertical angle of 180 °.

the system of camera mobility:

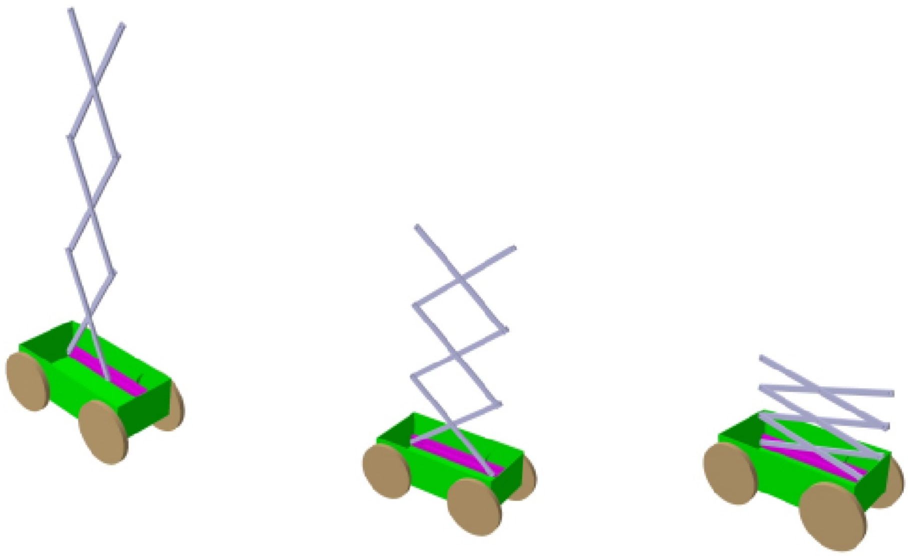
This system consists of two model making servomotors which will be ordered by a microcontroller of type 8051.

Thanks to the combination of the 2 freedom degrees of the servos, an angle of sight is obtained in all the directions of space.

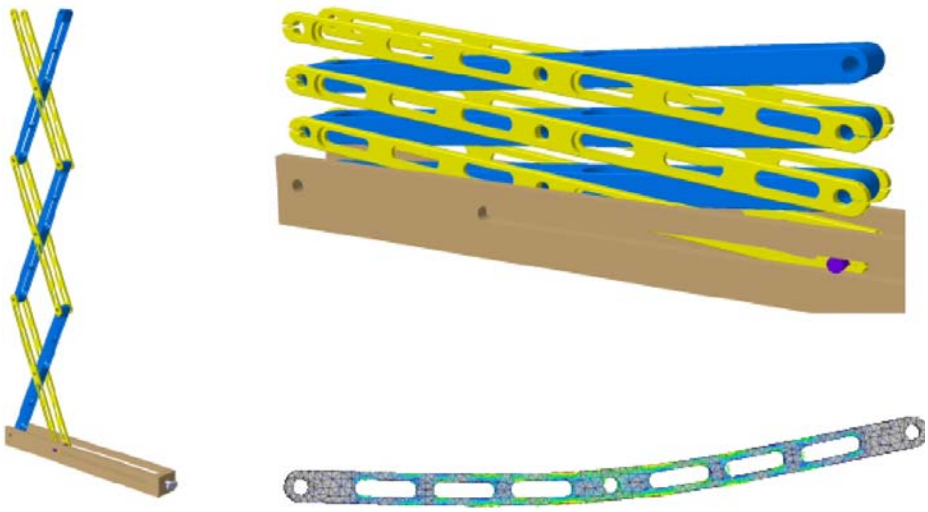


Elevation

The system use a common structure in mechanical design.



The shape of the rods was studied in order to minimize the mass total of the system.



This system will be animated by an engine of 20W which will rotate a screw nuts thus getting displacement necessary to the system.

9. Team Training for Operation (Human Factors)

Team training is not yet solved as we cannot access to any rescue type environnement. If no better solution is found training will be organised as follow:

Material and software training
Use of the sofware, test link, set-uprobot

Building map
This training will be indoor in structured environnement so we can check different map building techniques and find best operator in our team

Robot control
This training will outdor in a non structured environnement to verify our remote operation station, the embedded sensors and the vision

10. System Cost

Mechanical structure	1000€
Motors+transmission	700€
Sensors	300€
PC Notebook	1200€
Wireless	800€
Embedded PC+framegrabber	2000€
Total	6000€