Formal Report

Rescue-R

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Abstract
Mobile rescue platform is introduced, which could not only search the target in emergency, but also could bring the target back to the safe area. The platform is designed in a small scale, the weight for the upper part is light, and the bottom plate is relatively heavy and in a asymmetric form to avoid the vehicle to flip over. We use both CDS light detection (and maybe for the future PIR camera) imaging to search for target (long range), while the IR pair, sonar sensor and bump sensor is applied in obstacle avoidance (short range) and decide when the robot is right in front of the target. The robot could randomly walking seeking for the target before a bright spot shows up, and when the robot is put into a real dark environment, it could turn itself into a state that trying to hide from the bright spot.

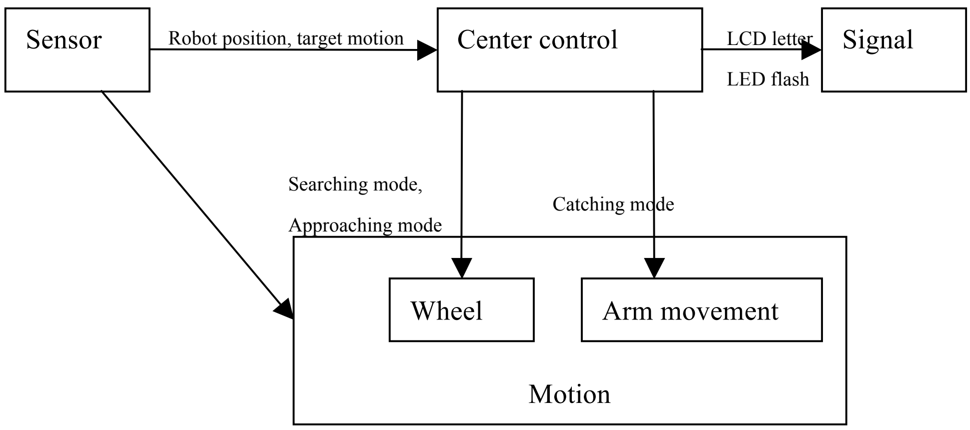
1. Introduction

Imaging that when people was trapped on the cliff wall or in a high building waiting for the rescue, however, the trapped people might be passed out that could not send out voice or movement signal, or some block on the wall prevent rescuer from targeting, we need a robot searching on the wall. The robot is design to do the rescuing job, but here is just for a prove of the schematic, because the power is less far from the reality need.

The robot could search on the 2D vertical surface for the heat target or the flash light, after approaching the target, it will grab the object, and bring it back to the save place(here means the track on top of the surface).

2. Integrated System

The system is composed with sensing, motion, central control and signal part. The motion part including both the 2D surface shift and the robotic arm movement.



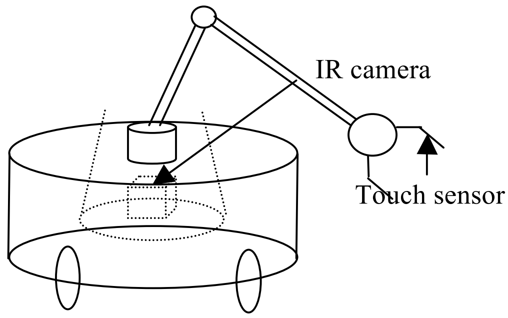
Parts:

- AVR board. Controlling Center. LCD screen and signal LEDs.
- Power board.
- Battery package: 9V.
- 4 Servos and 2 hacked Servos
- Arm with 3 joint and hand with 1 joint

- Bottom platform and wheels
- CDS cells array
- IR distance sensor
- Sonar distance sensor

3. Mobile Platform

The system is quite similar to a reconfiguration of the robotic arm from lynxmotion's robotic arm, adding a target tracking system

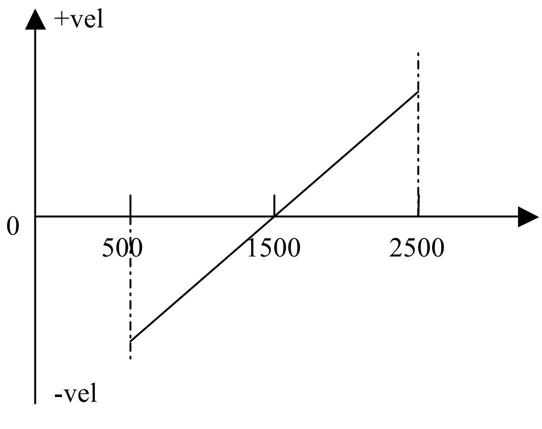


4. Actuation

- For the 2D motion, I need 2 hacked servos.

Torque: 3kg/cm

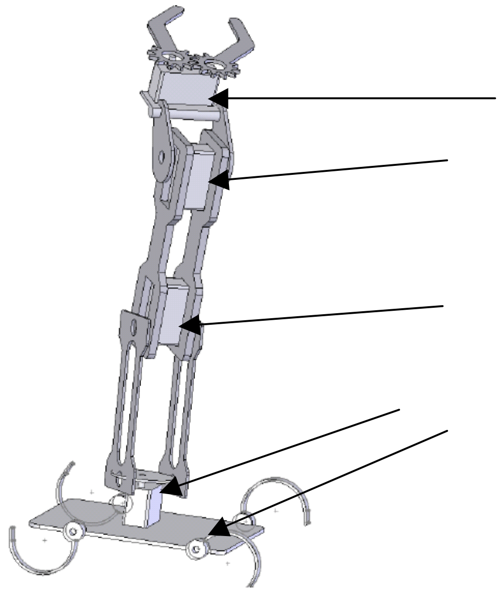
Both servos hacked in a way by cutting the feedback knot and adjusting the rheostat to the place that the hacked sevos stop at 1500 width pulse, in another word, 1.5ms as duty cycle (1.5/20= 7.5%). Then the servos for both side is symmetry, and the pulse width and velocity is in a linear relationship and also symmetry around 1500, as shown in the schematic below.



Actually, from this relationship we could control the coordination between 2 wheels in a dual way. That is when one side value set as "pwm", the other side is "3000-pwm"

- For the arm, 4 joints, each of which needs a servo, the sensor is on the base of the arm, no separate servo needed.

Torque: 4.8kg/cm, 1.5kg/cm



5. Sensors

Position sensor for the servos (not necessary)

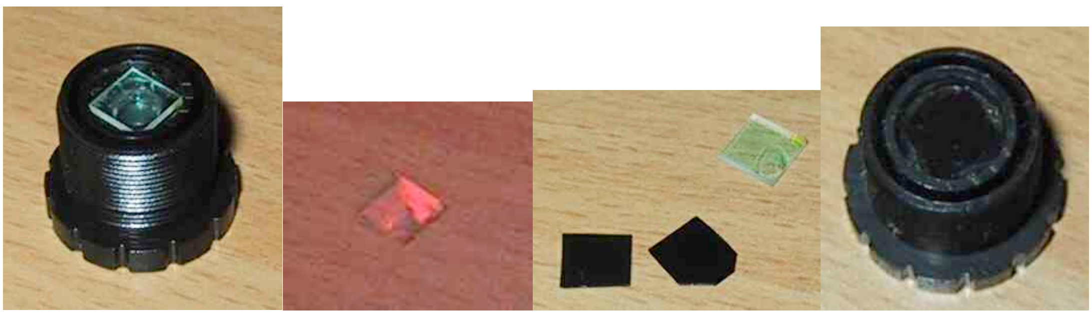
Obstacle avoidance will use IR, sonar sensor and bump sensor. Multiple sensors that is set into different priority level, help to decide the type of the obstacle and will leads to different behavior.

CDS sensor is used to search and discriminate the direction of the target. The sensor keep rotating with a fixed angle, with the decrease of the distance, the differential output will become weaker and weaker.

(a) (An potential sensor, not in use in final product)Hack a webcam into an IR camera.

Step:

1. Hack the camera's lens by taking off the IR filter
2. Put in material (e.g. filmnegative) to filter out the visible light
3. Search for the bright spot in imaging



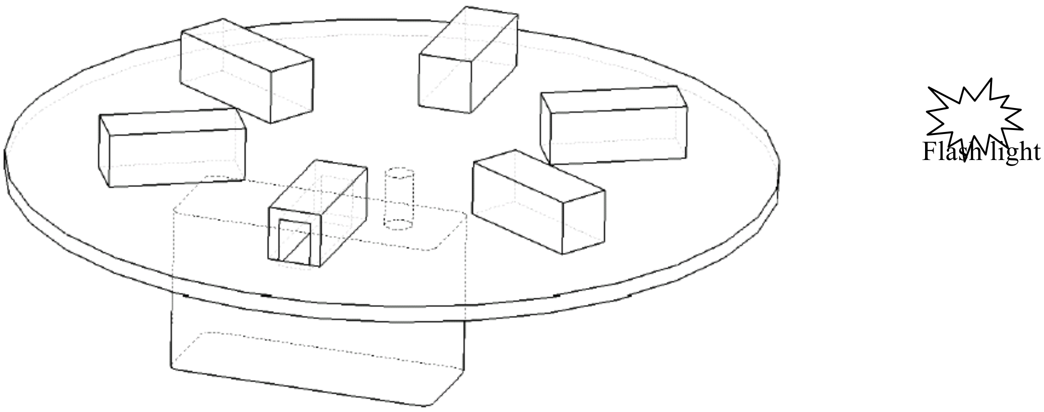
(b)CDS cells array. The problem for the CDS cells is more complicated than it seems to be. Problem is listed as following:

First, each CDS cells has different resistance value and working range, and in each CDS cells, the relationship between the light density and the resistance in nonlinear though monotonic.

Second, the CDS cells response to any environment light, to screen the background light, a tube has to be made.

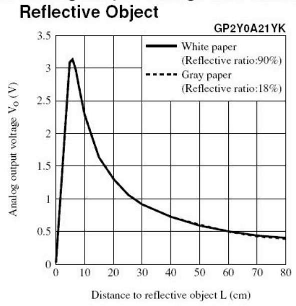
Third, the open direction of the tube confines the detecting direction of the CDS cells, however, it's too narrow for the robot to react to a continuous environment. Therefore, has to make the opening of the tube in a shape as a speaker that gradually increasing the open width.

Fourth, the background light is very complicate, temporally and spatially, the background noise will change, which makes the calibration during initiation part useless, robot will confused when put into different environment.

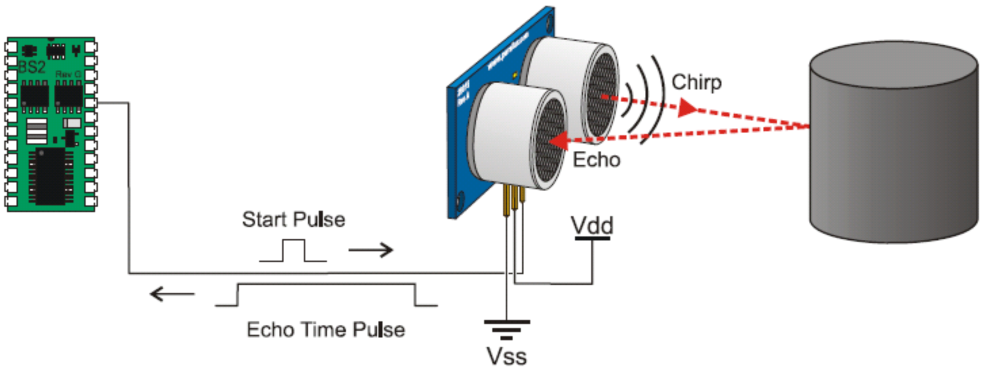


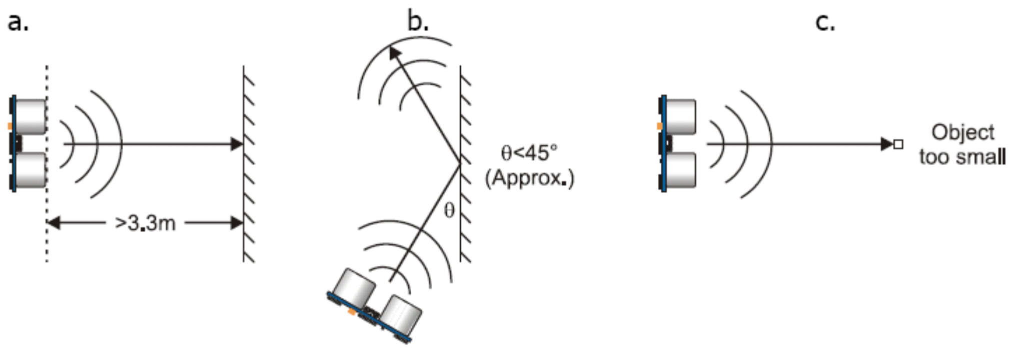
(c) IR range sensor. The IR sensor is easy to applied, because the output of the IR sensor is a voltage that is directly tells the distance. Because in my system, only the threshold for the distance is needed, therefore, a directly Analog-digit result is enough in my code.

Fig.5 Analog Output Voltage vs. Distance to Reflective Object



(d) Sonar range sensor. Unlike the IR range module, the sonar range detector works in a way chirp-echo way. Normal IO pin connects to the sig PIN. First, a 5us start pulse is sent to the sonar module. Then immediately, switch the PIN into an input mode, waiting for the echo. Maybe due to the diffusion or different reflection angle or the target is too small, 2 out of 3 echo pulses will be missed, to avoid this problem, the exit from the waiting loop and rescan is needed.

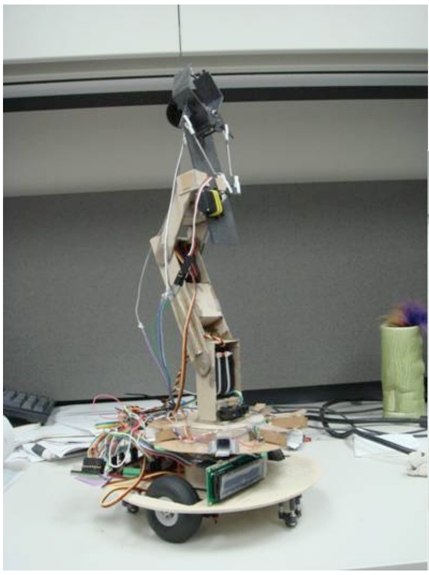
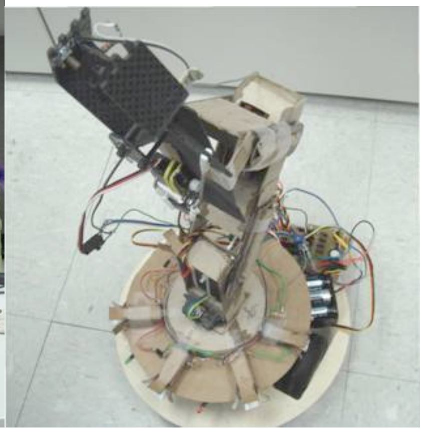




(e)Touch sensor detect whether the target has been catch. Attach a bump sensor in hand, when the hand crapping something, the bump sensor will trigger the interruption and stop switching the servo further more.

Finally, I'm pretty close to my original design. Both the mechanism part and the behavior almost finish.

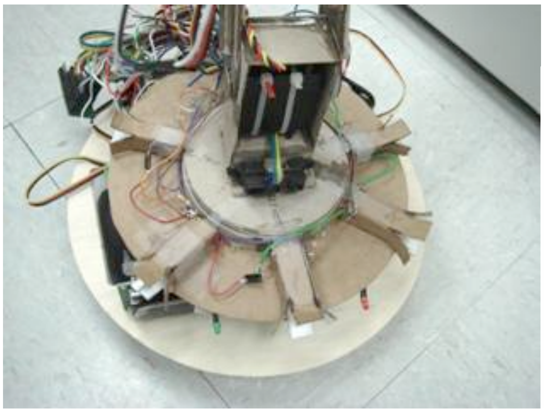
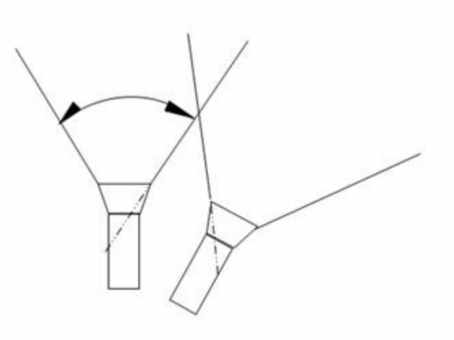
The robot could traveled around the room and then following the light attracting signal to reach the target, after pick up the subject, it will try to search the other positon to place the target? which is also identified with a flash light (Sounds strange~~=.=b)

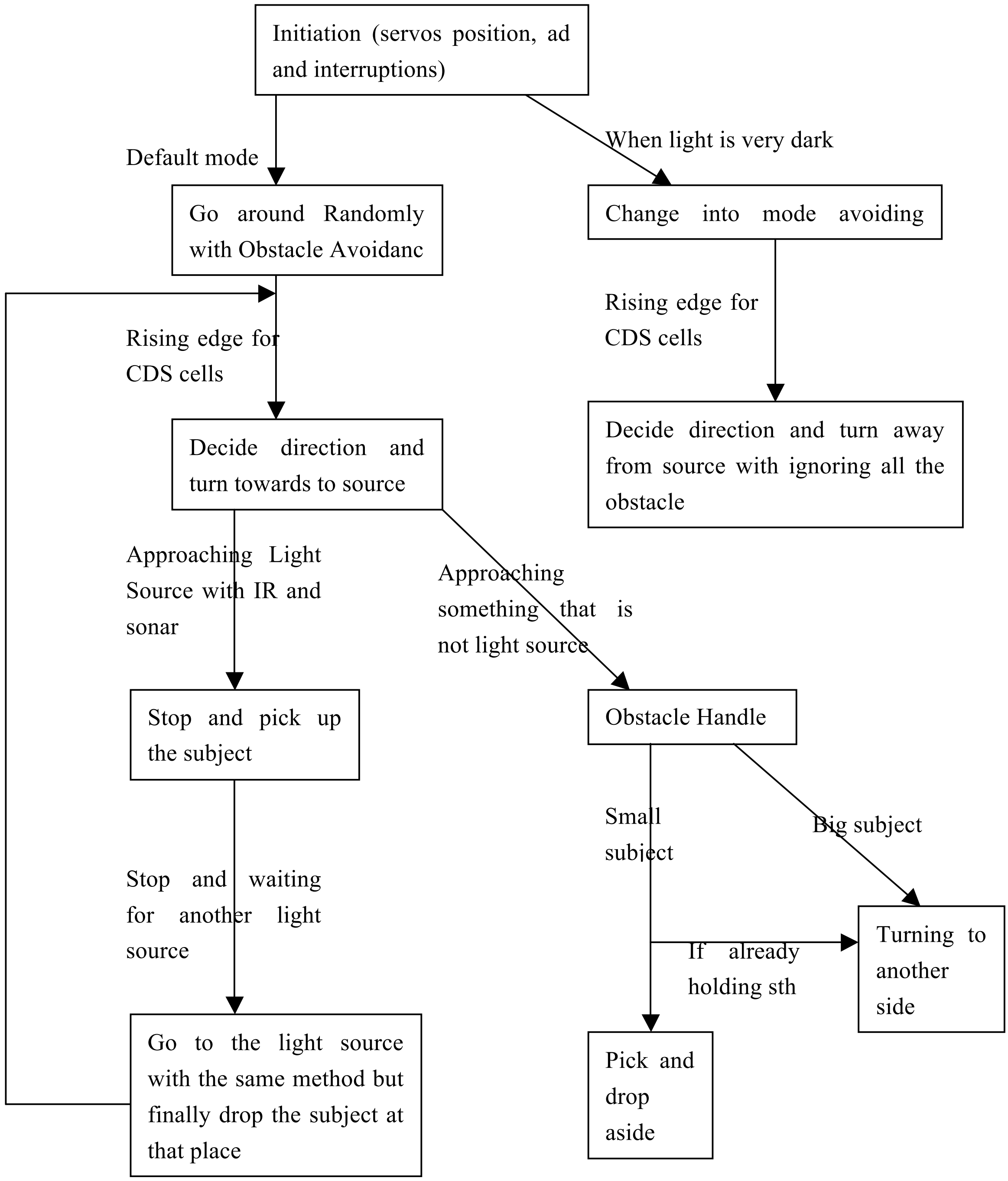
Find out that the most important and most difficult part is the sensor design. The problem is, you might not have too much money to buy a more accurate and more sensitive sensor. Or else, normal light, force and position sensors don't fit into the special requirement.

In the following picture, my CDS cells array is put on a relatively high platform rather than the bottom platform. The opening of the tube that cover each CDS cell is designed in a shape as a HORN, then the detecting scope will overlap with each other and the working space is now continuous.

I think to re-consider the original demand of my robot is very important, I find out that the obtained IR picture could be also very dependent on the exposure time, as well as ordinary visible light picture, and some of the picture they showed on Web is under the illumination from the IR emitter that has been set on the camera, and another thing I'm not sure, the visible light could not be completely filtered with a sheet of film-negative in my camera. I will do an experiment on a camera (not Webcam) with good CMOS sensor to obtain passive IR picture.

6. Behavior Schematic



Appendix:

1. How to decide whether it's a obstacle or a target. Set a threshold for the CDS sensor, (for the CDS cells, this could always be a problem, that: the background light + flash light = output density) when that's something in front of the robot that is not bright enough, the robot will take it as an obstacle.

2. How to decide the type of the obstacle. When the obstacle appear in the guarding scope of sonar sensor, but not in the scope of IR sensor, which means that the obstacle is a swallow one—small one. If both sonar and IR detect the obstacle, the robot will assume that the obstacle is huge, e.g. the human's leg, then it will try another strategy as turn to the side that has more space.

3. Decide the response to light. If the environment is suddenly set as very dark, after that, the robot will consider the light is bad and try to run away from the light, the robot will turn towards to light and retrieve.

4. After getting close the light source, make the tiny adjustment to make the robot centered face to the brightest light spot.