Our robot consists of an upper body humanoid (HRP2) on a high-power mobile base as shown in Fig.1. The robot is equipped with a stereo camera, a long range laser sensor, a global positioning system (GPS), and a custom made gripper. The gripper consists of a magnet embedded link actuated by a servo motor as shown in Fig.2. The wrist is also equipped with a six axis force torque sensor.

The HRP2 is one of our lab's many robots and has been in use for a very long time. It is relatively mature and we have created a lot of software packages for this robot, like the lisp based program language euslisp. We bought a mobile wheel base robot platform to replace the legs of the humanoid robot and designed both the control hardware circuits and the ROS control interface for the moving base.

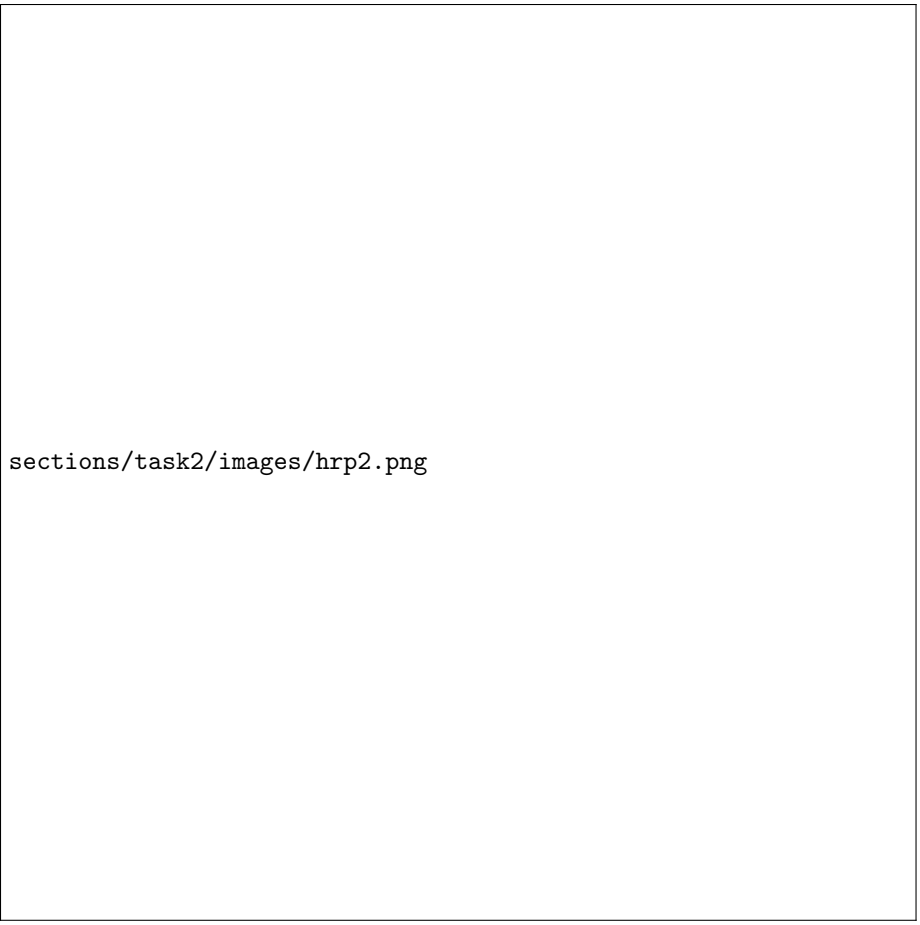

Figure 1: HRP2 robot platform for task2

0.2 Software

For task 2, the software is also implemented on ROS with utilization of multithreading for fast computation. Euslisp, an integrated robotics programming system developed by the JSK lab was used for kinematics simulation and robot control. OpenCV and in-house developed algorithms [1] are used for recognition and perception.

0.3 General Approach

Navigation: Our approach is to use the long range laser sensor and the GPS positioning for searching and navigating to the panel when the robot is at a far distance and the panel is out of range for the stereo sensors. As the panel becomes closer than the minimum range of the laser sensor, the robot will then switch over to use the stereo camera. Our high-powered mobile base can reach up to 4m/s and allows the robot to drive through various outdoor terrains.

Wrench and valve stem detection: We experimented and compared infrared camera with stereo camera, and we have decided to use stereo camera for close range perception, since infrared cameras tend to fail in outdoor environments subjected to lightings variations, and cannot sense objects that are too close to the robot.

We detect the wrench by using Edge detection, Hough transform, and K-

0.1 Hardware