

### TechX CHALLENGE, SINGAPORE

The development of the fully autonomous mobile urban robot is a special development project in National University of Singapore led by Professor Shuzhi Sam Ge, the director of Edutainment Robotics Laboratory and Social Robotics Laboratory (SRL), to develop a fully autonomous mobile robot X1 (exhibit) to participate in the TechX challenge 2008 in Singapore, which is the equivalent of the DARPA Grand Challenge in USA and involves practical and significant research issues in the areas of sensing, decision making, intelligent control, software engineering and so forth.

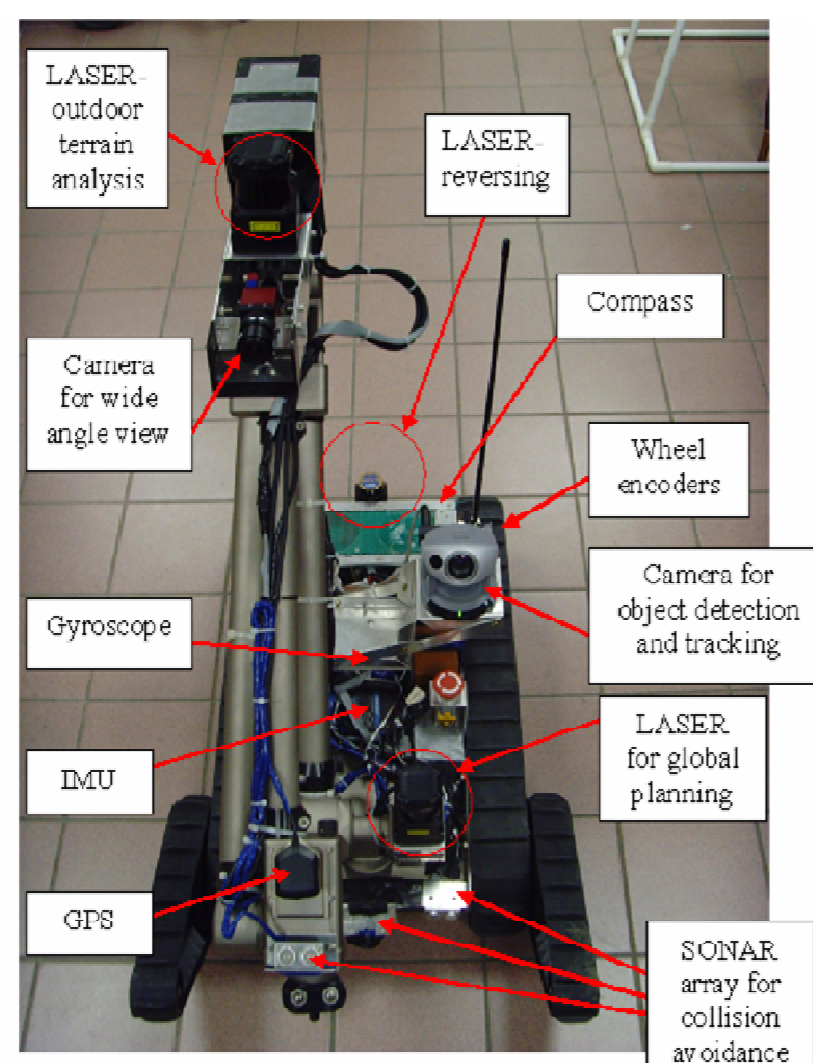


The X1 robot is designed to have the capabilities of overcoming the following challenges involved in the TechX Challenge.

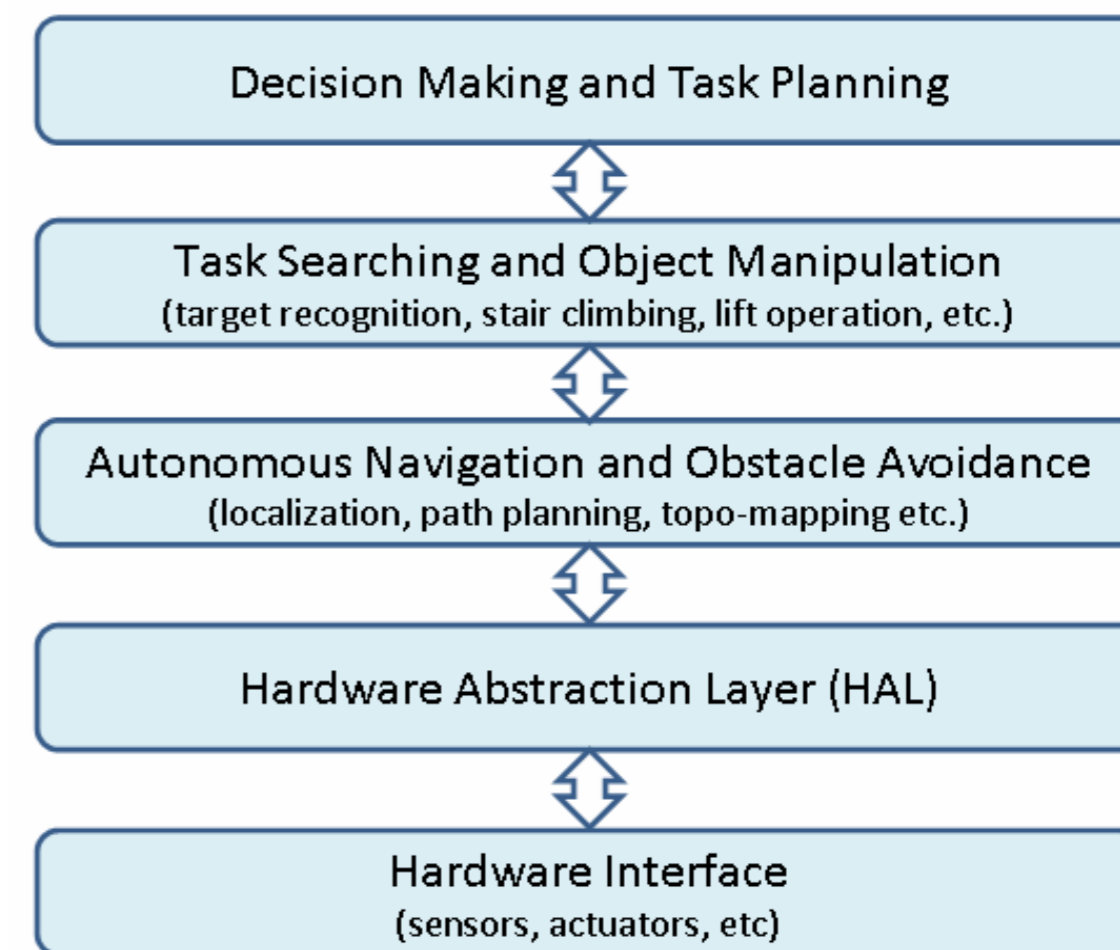
- Autonomously navigation from unknown outdoor environment to indoor environment and navigation to a specified indoor location while avoiding obstacles;
- Searching, identifying and engaging all pre-specified targets before it returns to starting point;
- Negotiate a staircase before the entrance of the building;
- Identifying, locating and then manipulating elevator buttons in order to autonomously operate the elevator.

### X1 ROBOT DEVELOPMENT

The X1 robot consists of three main modules: navigation, vision and control. Autonomous navigation capability is the most critical requirement, enabling it to move from an initial configuration to a final one in a complex outdoor or indoor environment unknown a priori. The functionality of navigation module on X1 robot consists of three main parts: self-localization path planning and map building. Based on its localization system,



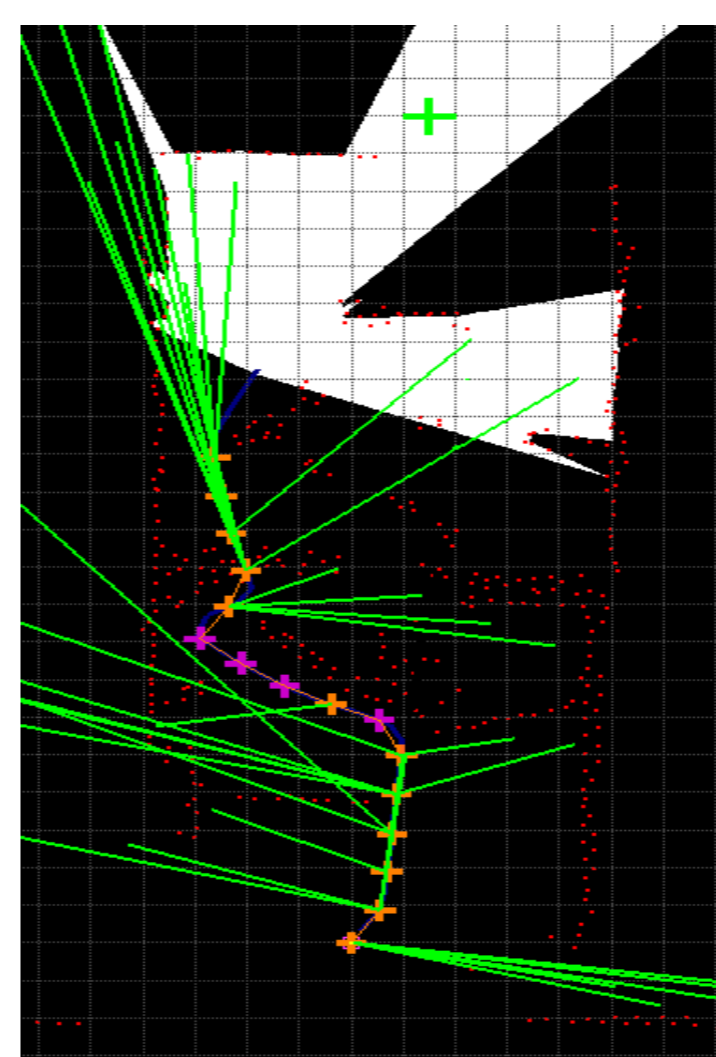
the robot incrementally constructs a topological map online and carries out the path planning simultaneously based on the map built. The vision module is used for visual signal perception. The decision making module of the robot will fuse the information from vision perception and



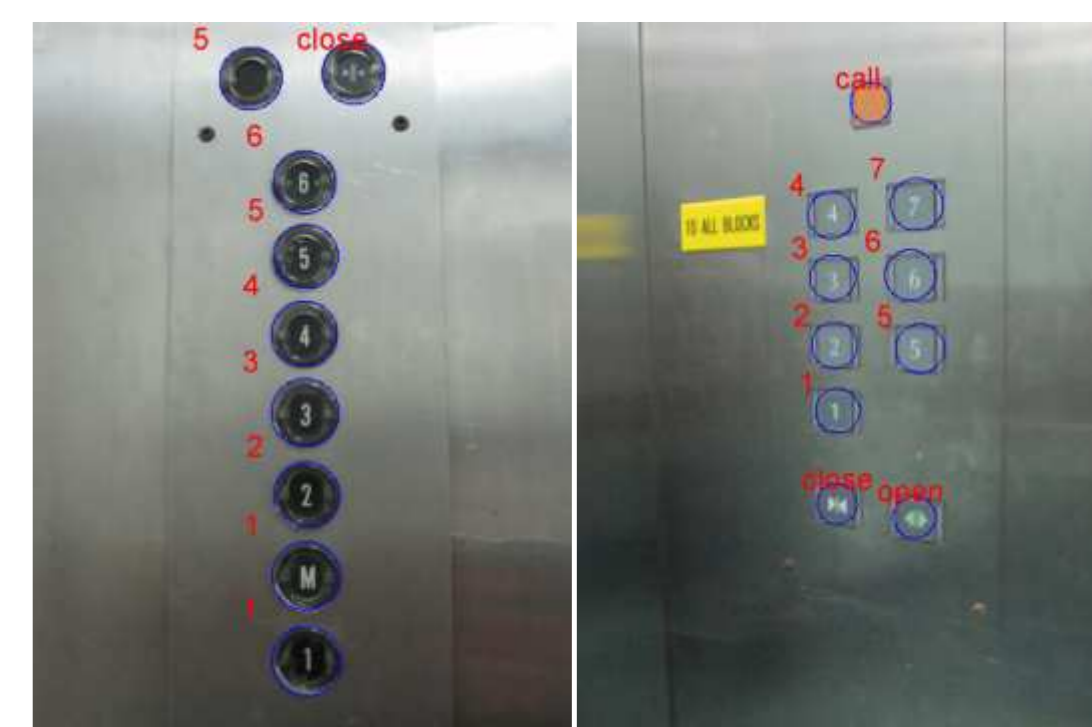
signals from multiple sensors to make final decisions for the mission. Besides, as for the stair climbing and elevator operation, various control algorithms are applied to form an intelligent control system to overcome and adapt to uncertainties in the environment.

During the whole process of development, there come up with a series of new ideas, ranging from fundamental technical problems to practical integration, covering robot multi-sensing, decision making, robot control and many other disciplines and addressing challenges arising from the competition. The X1 robot has taken part in the TechX challenge in 2008 and managed to enter the grand final, which shows the capabilities in robotic research and development as well as a chance to compete against leading robot developers, opening the way for future collaborations.

### TECHNOLOGY HIGHLIGHTS



#### Simultaneous Path Planning and Mapping



#### Elevator Operation



#### Stairs Climbing

#### Object Recognition

