CMSC 828D Report 2 - Preeti Bhargava (prbharga@cs.umd.edu)

Maryland Robotics Day @UMD

Maryland Robotics Day (http://robotics.umd.edu/Md_robo_day/index.php) was a free event, organized by the Maryland Robotics Center (http://robotics.umd.edu/) on September 21 2012, intended to acquaint visitors and students alike with the University of Maryland's robotics research projects, faculty, students and facilities. Visitors had the opportunity to tour labs, talk to faculty and students, and see videos and demonstrations of robots in action. The Maryland Robotics Center spans eight departments in UMD and houses around 20 laboratories that work on all aspects of robotics including development of component technologies (e.g., sensors, actuators, structures, and communication), novel robotic platforms, and intelligence and autonomy for robotic systems.

Here I describe the activities of six of the labs that I visited:

1. Autonomous Systems Laboratory (http://robotics.umd.edu/research/labs/Blankenship_ASL.php)

This lab is headed by Prof. Gil Blankenship and is affiliated with the ECE Department of Electrical and Computer Engineering (ECE), the Institute for Systems Research (ISR) and the Maryland Robotics Center (MRC). Its research is centered on Cooperative Simultaneous Localization and Mapping (SLAM) using a “network” of robots. The primarily use robots for indoor mapping, navigation and localization. The laboratory has several off the shelf truck sized robots, which can carry 15-20 lbs of weight, and are fitted with Windows box, wireless routers and cameras that help in localization and navigation.

For Robotics Day, they demonstrated a four-wheeled robot that could be controlled using the accelerometer of a smart phone running android. Tilting the phone up or down and sideways made the robot move. The robot’s camera communicated wirelessly with the smart phone and a person using the phone could see the camera feed. Another robot could autonomously navigate the corridors of the building and thus, help map the walkable or navigable portions of any building. Some of the robots have a wireless router mounted on top that helps communicate and stream audio and video data from the cameras of other robots at broadband speeds. The work here seems to be a neat combination of robotics with wireless communication technologies. An application of this work, as they mentioned, would be for defense purposes to enable soldiers to map unfamiliar terrains like caves and tunnels.

2. Cooperative Autonomy Laboratory (http://robotics.umd.edu/research/labs/Martins_CPS.php)

This laboratory is headed by Dr. Nuno Martins and is affiliated with the ECE department, ISR and MRC. Their work involves coordinated control and tracking of small robots, and quad-rotor and ground robot coordination. They are mainly interested in applying swarm intelligence to robotics systems such as coordinating a group or a swarm of tiny robots and helping them navigate unfamiliar territory like hills and tunnels. This swarm would be guided by a tiny quad-copter flying above them.

Their demonstration on Robotics Day consisted of flying a quad-copter in a 5 sq.m grid with a aid of a visual system using twelve mounted high-resolution cameras and Bluetooth. The copter guided a group of four e-puck robots that were on the floor underneath it. The copter could be controlled using the +/-/up/down/left and right arrow keys on a keyboard.

3. Simulation based Systems Design Laboratory (http://www.simulation.umd.edu/)

This laboratory is headed by Prof. S.K. Gupta and is affiliated with the Department of Mechanical Engineering (ME), ISR and MRC. It has both real robots as well as simulation systems. Their work focuses on "efficient simulation techniques for modeling, evaluating, and optimizing systems in order to improve decision-making throughout the system development life cycle."

For demonstration purposes, the laboratory had an alligator robot, a stair-climbing robot and a flying bird like robot. The alligator robot moved like an alligator and could detect obstacles in its path. As soon as it detected obstacles, it altered its course. The stair-climbing robot could climb a flight of steps of varying width – 3 inches/4inches. According to students working on it, it used its vision system to learn its gait and position itself automatically irrespective of the size of the steps. The flapping wing micro-air vehicle i.e. the bird like robot was the most fascinating one. It flew autonomously like a bird avoiding obstacles in its path while changing its course and altitude occasionally. They also had path planning and unmanned vehicles simulators.

4. Robot Realization Laboratory (http://robotics.umd.edu/research/labs/Gupta_RRL.php)

This laboratory is head by Prof. S.K. Gupta and Dr. Sarah Bergbreiter and is affiliated with the ME dept., ISR and MRC. It works on miniature robotics particularly those inspired by biology and nature.

Their demonstration consisted of a small off-the-shelf caterpillar sized robot that had to walk and stabilize its movement. For this, the students had developed a tail for the robot that had a small propeller attached to it. As soon as the robot started turning, the propeller would start rotating and assist the robot in turning smoothly. Another robot was inspired by the hummingbird and had a long tail to stabilize its flight.

5. Perceptual Robotics Laboratory

Figure 1. The robot at Perceptual Robotics laboratory

This laboratory is headed by Prof. Yiannis Aloimonos and is affiliated with the Dept. of Computer Science and University of Maryland Institute for Advanced Computer Studies. Its main research involves mobile robots that interact with people and thus operate in everyday environments. Their focus is on robots that need to be able to acquire knowledge through perception and to take sensor measurements from which they extract meaningful information. Thus, their main research is in recognizing human actions, everyday objects and speech recognition and generation.

The students of this laboratory demonstrated a mobile robot which had a camera and a Microsoft Kinect mounted on the top. The robot was facing a table on which a few objects were kept such as a knife and a tomato. The robot initially used the Kinect to recognize the objects. It then translated this into speech and declared that it could see a knife and a tomato on the table. A person visiting the laboratory was then asked to walk over to the table and raise his hands so that the robot could position itself at an optimum distance from the person. The person then cut the tomato as if he was preparing a salad. The robot then recognized the visitor as a man and stated his performed action as 'Cutting the tomato'. Another visitor then went up to the table and used a ladle to mix the salad. The robot recognized the visitor as female and stated her action as 'Mashing up and down'.

6. Autonomous Vehicle Laboratory (http://www.avl.umd.edu/)

This laboratory is headed by Prof. J. Sean Humbert and is affiliated with the Dept. of Aerospace Engineering and MRC. It is similar to the Autonomous Systems Laboratory and works on autonomous guidance and navigation, path planning, obstacle avoidance for robots. They did not have any specific demonstrations but had laboratory tours where people could see the laboratory facilities and several robots being used here. Most of the robots are inspired by nature and biology– such as robots inspired by insects like bees and birds. They also work on biologically inspired autonomous vehicles for civilian and military applications.

A common thread running among many of these laboratories is the focus on tiny and miniature robots inspired by biology and nature. Roboticists are looking towards nature to develop algorithms for movement, coordination, and stabilization as evident by several robots mimicking insects, reptiles and birds being used for demonstration purposes. This is mainly because compared to current robots, the behavior of animals is extremely flexible and robust in the face of environmental changes and they hope that using the same design principles will make the robots more flexible and robust too. In addition, tiny robots are easy to manage and control. They can squeeze into small spaces and are not bulky.

Another significant advance is the use of common devices like a smartphone and a keyboard to control the movement of the robot as opposed to using a specialized remote control or a joystick. If such robots are commercialized, it will enable people unfamiliar with robots to control them easily without the hassle of learning how to operate a remote control.