LOBOtomous: An Autonomous Platform for Indoor Environments

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Abstract

The University of New Mexico's entry in this year's AAAI Mobile Robot competition is LOBOtomous. LOBOtomous was constructed from scratch by UNM students in a senior level design class. Hardware for the project was loaned by Sandia National Labs. LOBOtomous will be entered into the home vacuuming and the hors d'oeuvres event.

Introduction

LOBOtomous is a mobile platform constructed from scratch by several senior level students at the University of New Mexico. LOBOtomous is shown in Figure 1. Most of the parts were loaned to the University by Sandia National Labs. It was designed specifically for entry into AAAI's mobile robot competitions. It competed in last year's AAAI robot exhibition. This year LOBOtomous will compete in the vacuuming and the serving hors d'oeuvres events. This paper describes LOBOtomous' current hardware and software organization.

Hardware

The hardware of LOBOTomous consists of a drive base, control system, sensor systems, and a communication system. Figure 2 shows the various systems and how they are connected together to form LOBOtomous.

LOBOtomous employs a differential drive with two casters. DC gear motors with incremental encoders provide torque for the two drive wheels. The base contains two sealed lead acid batteries, DC-DC converters for the onboard electronics, and pulse-width modulated (PWM) servo amplifiers. The lead acid batteries provide 10 amp-hours of capacity at 24 volts.

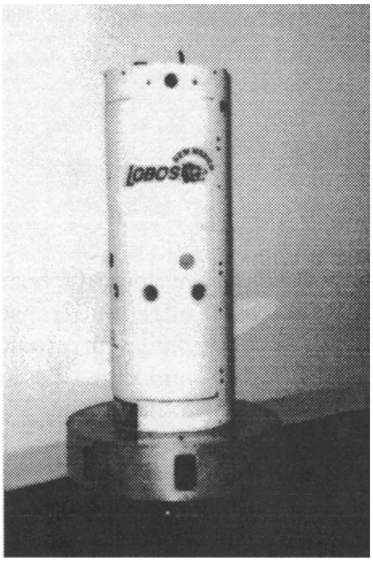

Figure 1: Photo of LOBOtomous

The control system consists of an embedded Intel based 486 processor. This embedded PC is in a PC104 form factor. The PC104 form factor was chosen because of its compact size and low power usage. This processor is responsible for high level motion control, sonar control, and communications with the basestation. Along with this processor there is a motor control board (MEI 104/DSP) which has its own processor to do the low level control of the motors. There is one more auxiliary processor, a PC104 Intel based 286. This 286 does the voice synthesis using a PC104 voice board and also controls the vision system. The 286 is connected to the 486 master processor through a serial link. Overall this arrangement provides sufficient processing power for rudimentary tasks.

LOBOtomous has two primary sensor systems. The first, a sonar system, is used for distance measurement and general obstacle detection. The sonar system con-

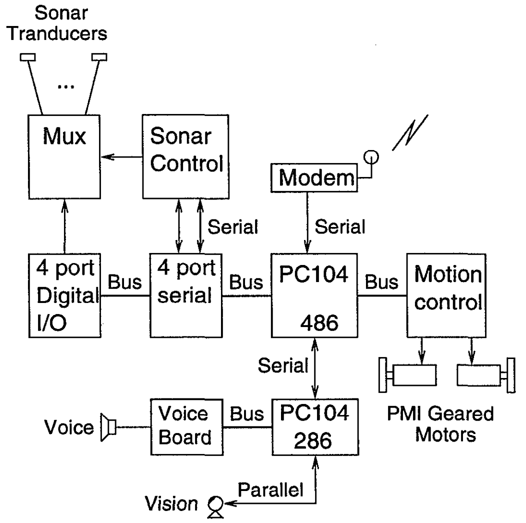

Figure 2: Hardware Organization

sists of a single Polaroid development board, a multiplexing board, and twenty ultrasonic transducers. The Polaroid board fires an individual ultrasonic tranducer, waits for the return pulse, and then calculates the distance. The ultrasonic tranducer that is to be fired next is selected by a multiplexing board. The twenty ultrasonic transducers are arranged around the robot to provide sufficient detection of objects and obstacles.

The second sensor system is the vision system. The vision system consists of a Connectix QuickCam which is connected to the 286 through a parallel port. This particular camera was chosen because of its affordability. As mentioned previously the 286 is connected to the 486 master processor through a serial link. This link does not provide much bandwidth, so all image processing is done on the 286 with results of the processing being sent back the master processor. These two systems together gather sufficient information to allow LOBOtomous to navigate through an indoor environment.

Finally, for communication with a basestation, LOBOtomous is equipped with a 9600 baud frequency hoping radio modem. This modem is used to send status and navigation data to a basestation. The basestation is responsible for monitoring the robot and ensuring that all systems are functioning properly. A secondary responsibility of the basestation is to gather data on the operation of the robot for further study. The basestation is a Intel based PC running Linux. Linux, the freely available UNIX operating system, was chosen because of its rich development environment.

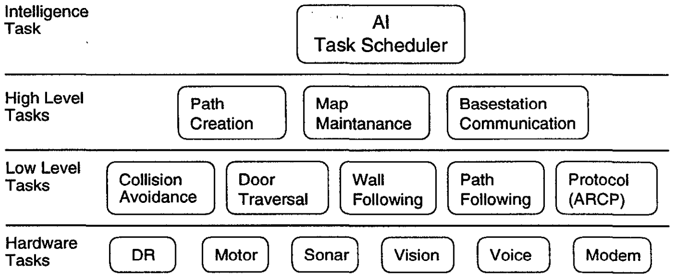

Figure 3: Software Organization

Software

There are currently two different implementations of the software which runs on LOBOtomous. Both share a common architecture which is shown in Figure 3. This architecture breaks the work down into distinct tasks which are organized in a hierarchical manner. At the highest level is the intelligence or scheduler task which is the brain of LOBOtomous. This task is responsible for all decisions relating to the current work the robot is trying to accomplish. The next level contains the high level behavior tasks. This level consists of path creation, map maintenance, and communication with the basestation. Next, the low level behavior layer, consists of tasks such as wall following, path following, collision avoidance, door traversal, and creating the protocol packets for communicating with the basestation. The final layer, the low level hardware layer consists of tasks which interact directly with the hardware. The motion control, dead reckoning, sonar control, voice synthesis, modem communications, and the vision tasks reside in this layer. This organization provides a clear and simple view of how the software is organized on LOBOtomous.

The first implementation of LOBOtomous' software was done using the AMX real-time operating system library. AMX provided all of the necessary support code for real-time tasks. This implementation was was used in last years AAAI robot exhibition.

The second implementation of LOBOtomous' software was done using custom routines which implement a rudimentary real-time operating system. This implementation is far simpler than the AMX version, and is much easier to understand and maintain. This implementation is being actively developed on LOBOtomous.