Autonomous Interactive Mobile Multimedia Droid
(GuideBot)

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Abstract

The Autonomous Interactive Mobile Multimedia Droid is capable of interacting with users and showing them to a desired destination. Herein, the methods of how the droid accomplishes this are outlined. The system receives user input via a touchscreen interfaced to a mini PC. Data is also obtained from externally mounted ultrasonic sensors. Using these sensors and movement data from the robotic platform, the droid is able to guide users to a selected destination. This project is a continuation of the 2001 Telerobotics project, which allowed for web control of the robotic platform.

Objectives

The objective of this project is to develop an Autonomous Interactive Mobile Multimedia guide. The robot, designated GuideBot, will be made to interact with people via a touch screen display and audible greetings. Using a touch screen for input, people can use GuideBot to learn more about where they are. In addition, if they desire, they may ask GuideBot for directions and it will take them there using its mapping software. It would be most useful at places like office buildings, malls, or theme parks, with a variety of places to go and lots of information about each of them.

Project Description

GuideBot is comprised of the Pioneer DX2 platform used in the 2001 Telerobotics project and an interactive touch screen interface controlled by an onboard miniature PC as shown in Figure 1. The platform has sonar pingers to detect distances from objects as well as proximity sensors to detect motion and to avoid collision. Thus, the platform is able to move around a room or hallway and alert the PC to call out to passerby. The system uses an oboard 80186 compatible processor to interface to external distance and motion sensors to allow for accurate mapping and navigating. Connected to this platform is an arm attached to the touch screen display and speakers. This multimedia system is driven by a laptop or similar mini PC. Figure 2 shows the high level system block diagram.
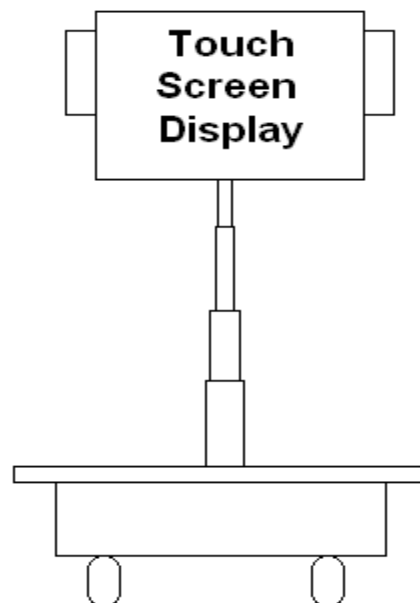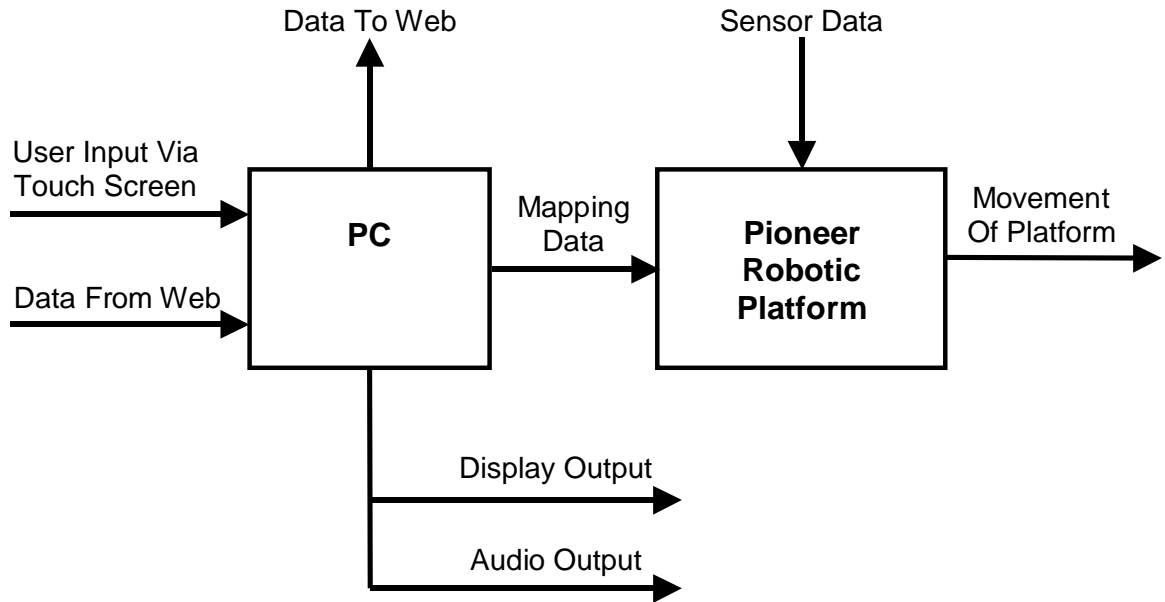

Figure 1. System Diagram

Figure 2. System Block Diagram

PC

The PC portion of GuideBot shown in Figure 3 consists of the touch screen user interface associated auditory greetings and instructions. The user is presented with a friendly Java-based menu of options including an option to have GuideBot show the user to a specific location. Once the Guide mode is engaged, the PC will communicate with the platform and determine the best way of navigating to the desired location. In addition, a Java-based web server originating from the 2001 Telerobotics project will be used as a manual control system in case the need arises to take control of GuideBot.
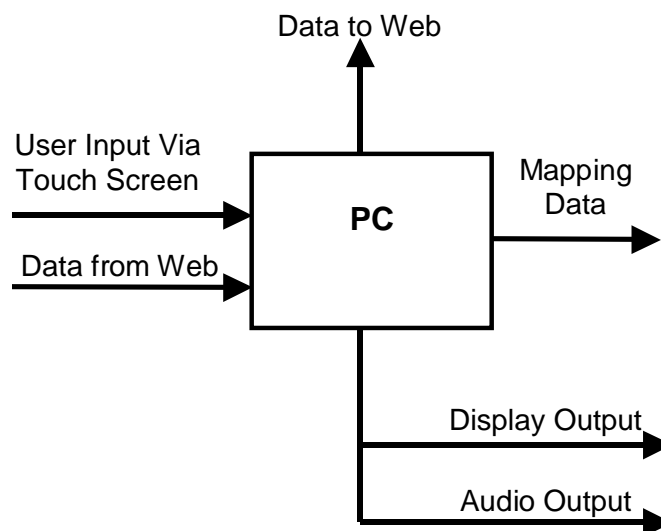

Figure 3. PC Block

Pioneer Robotic Platform

The platform is controlled by an onboard 80186 that interfaces with the multiple ultrasonic sensors and PC as shown in Figure 4. The PC input includes mapping updates and the desired mode. The ultrasonic sensors positioned on the platform are used for mapping decisions and collision avoidance. The outputs include updates to the PC on GuideBot position, battery level, and possible movement hindrances. It also has control of the motors controlling the movement of the platform.
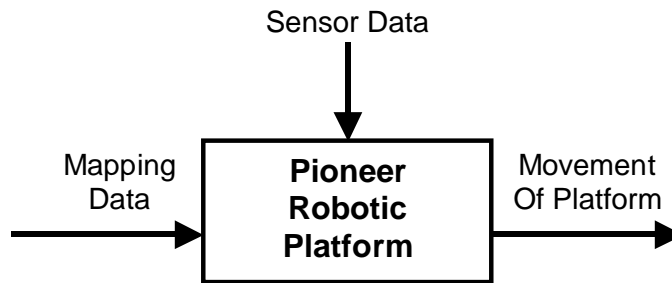
Sensor Data

| Mapping Data | **Pioneer Robotic Platform** | Movement Of Platform |

Figure 4. Pioneer Robotic Platform Block

Modes of Operation

GuideBot has four main modes of operation. Figure 5 shows each of these modes. The initial mode is an idle state in which GuideBot will remain stationary and dormant until a sensor detects movement or a user interacts with the touch screen interface. Once interaction has occurred, GuideBot shifts to its second mode in which it uses both visual and audio outputs to help the user choose their desired information. In this mode, the user may select information from GuideBot but may also request its help in finding a destination. The guide mode involves GuideBot traveling to the desired destination while using its sensors to avoid obstacles. The final mode includes GuideBot moving around its designated area searching for possible users that may need assistance.

Mode 1	Inputs	Outputs
Idle/Wait	Motion Sensors Touchpad	Audio Visual
Mode 2		
Help/Assistance	Touchpad	Audio Visual
Mode 3		
Guide Function	Sensors	Audio Visual Movement
Mode 4		
Search	Sensors Touchpad	Audio Visual Movement

Figure 5. Modes Of Operation

Software Control Flowcharts

An overall software flowchart for GuideBot is shown in Figure 6. Hexagonal blocks represent actions which will update the graphical display on the touch screen and are expounded upon in more detail below. In Help/Assistance mode, the platform is idle and all interaction takes place on the touch screen.
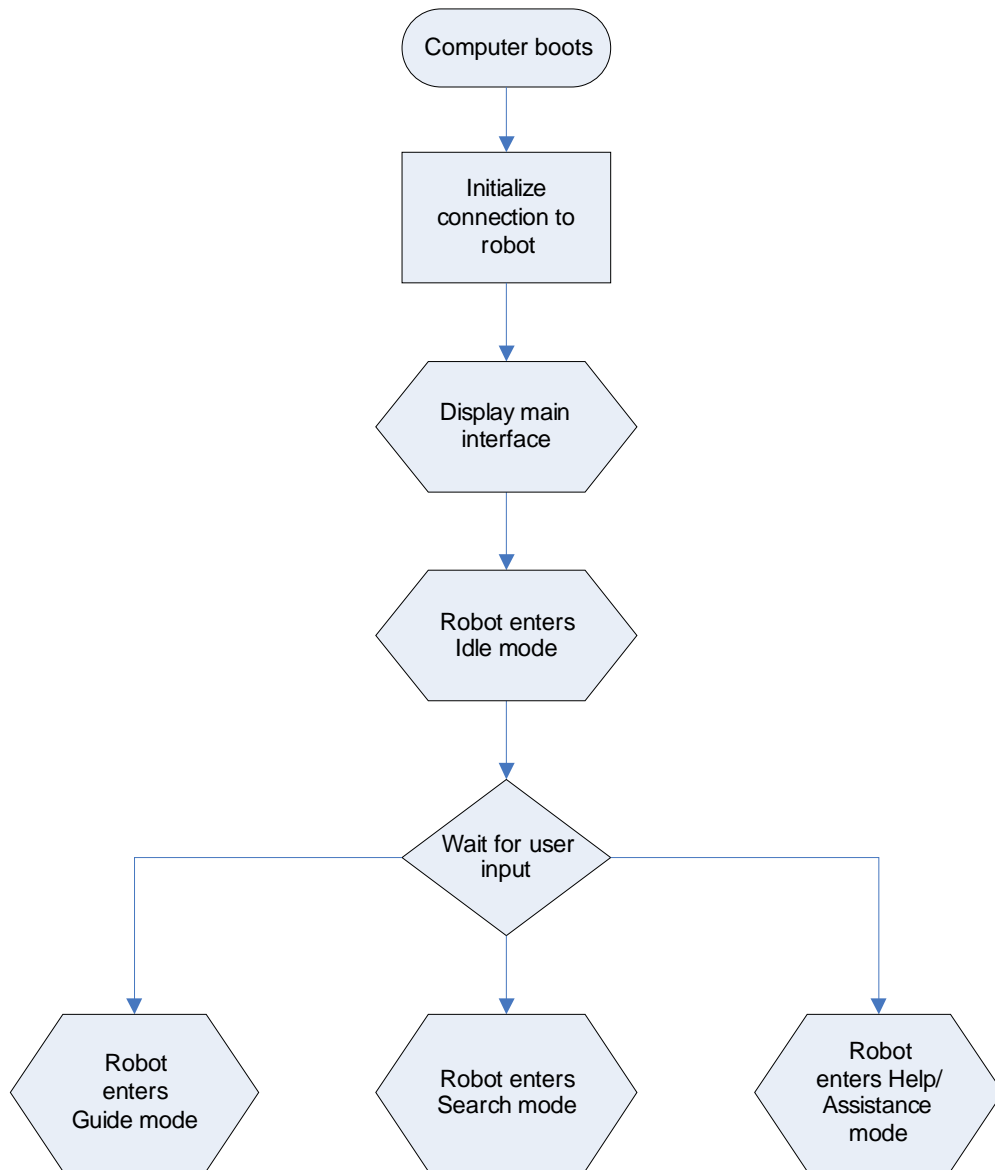
Figure 6. Overall Software Flowchart

Idle Mode

GuideBot enters Idle mode as soon as the PC boots up. Figure 7 is the flowchart for this mode. In this mode, the sonar pingers will be active searching for movement and possible users. If movement is detected, the Greeting software is activated and the system waits for contact. The sonar sensors are turned off when contact with the touch screen occurs. If no contact, the system returns to idle/wait mode until movement is again detected.

Guide Mode

Guide mode is initiated when the guide function is selected by the user. Figure 8 is the flowchart for this mode. In this mode, GuideBot leads the user to their desired destination using a series of predetermined waypoints. This mode involves the use of the sonar sensors for both mapping and collision avoidance functions and auditory directions and warnings when necessary.
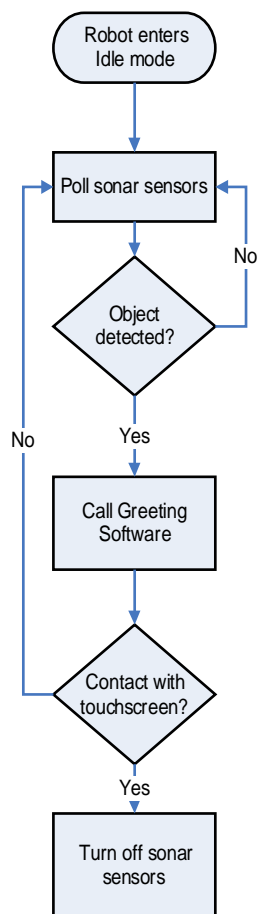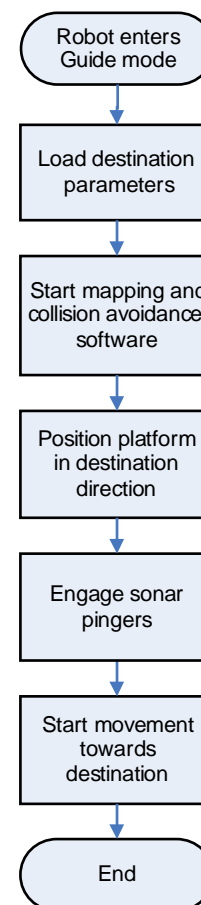
Figure 7. Idle mode flowchart

Figure 8. Guide mode flowchart

Search Mode

In Search mode GuideBot will patrol a predefined path looking for potential users. Figure 9 shows the flowchart for this mode. In this mode, GuideBot relies on the sonar sensors for mapping, collision avoidance, and user detection. If movement is detected, GuideBot stops moving and activates the Greeting software. If no contact is made with the touch screen, GuideBot resumes its Search mode and continues patrolling the area.
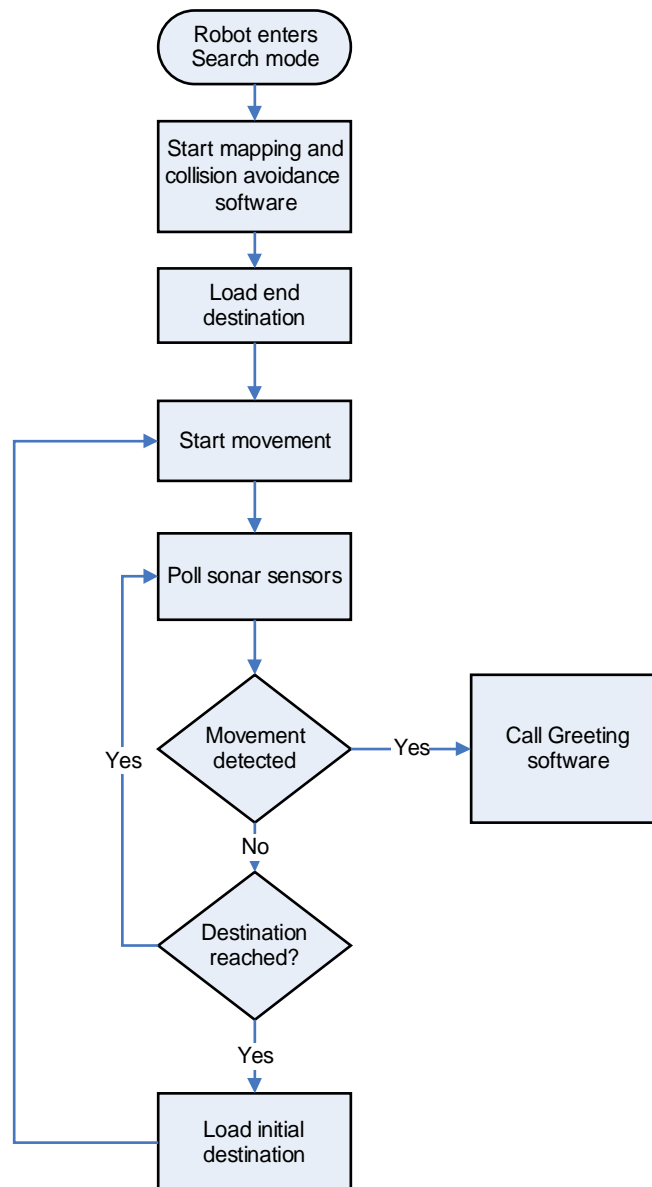
```
        ( Robot enters )
        ( Search mode  )
              |
              v
     +------------------+
     | Start mapping and|
     |collision avoidance|
     |     software     |
     +------------------+
              |
              v
     +------------------+
     |    Load end      |
     |   destination    |
     +------------------+
              |
              v
     +------------------+
 --->|  Start movement  |
 |   +------------------+
 |            |
 |            v
 |   +------------------+
 | ->| Poll sonar sensors|
 | | +------------------+
 | |          |
 | |          v
 | |       < Movement >  --Yes-->  +------------------+
 | | Yes   < detected >            | Call Greeting    |
 | |          |                    |    software      |
 | |          No                   +------------------+
 | |          v
 | |       < Destination >
 | -------   < reached?    >
 |            |
 |           Yes
 |            v
 |   +------------------+
 |   |  Load initial    |
 ----|  destination     |
     +------------------+
```

Figure 9. Search mode flowchart

Software GUI Flowcharts

The following flowcharts describe how the GUI (Graphical User Interface) changes as different modes are entered.

Main Menu

Figure 10 describes the behavior of the GUI when the system is first turned on. After the introduction video plays, the main menu is displayed for the user allowing them to choose between Guide mode or getting other information about the area (Help/Assistance mode).

Idle Mode

Idle mode is entered after no interaction occurs within a given amount of time. Figure 11 outlines the flow of the GUI in Idle mode. The screen is turned off and every so often GuideBot will call out to someone to touch the screen to get information.
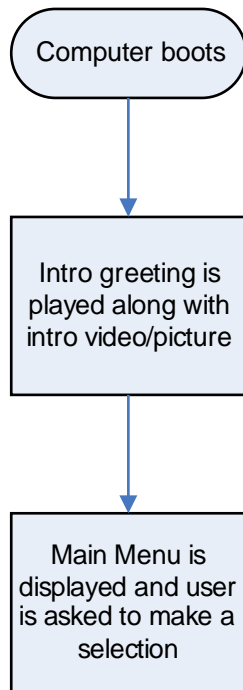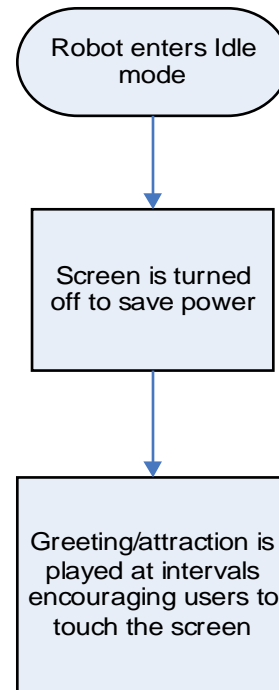

Figure 10. Main Menu GUI flowchart

Figure 11. Idle mode GUI flowchart

Guide Mode

When GuideBot enters guide mode, the display shows a map of the area surrounding GuideBot indicating his position. It is then updated as it moves towards the specified destination as it passes pre-programmed waypoints.

Search Mode

In Search mode, a message is displayed stating that GuideBot is searching for users. Upon detecting motion, a greeting is played and the Main Menu is displayed.
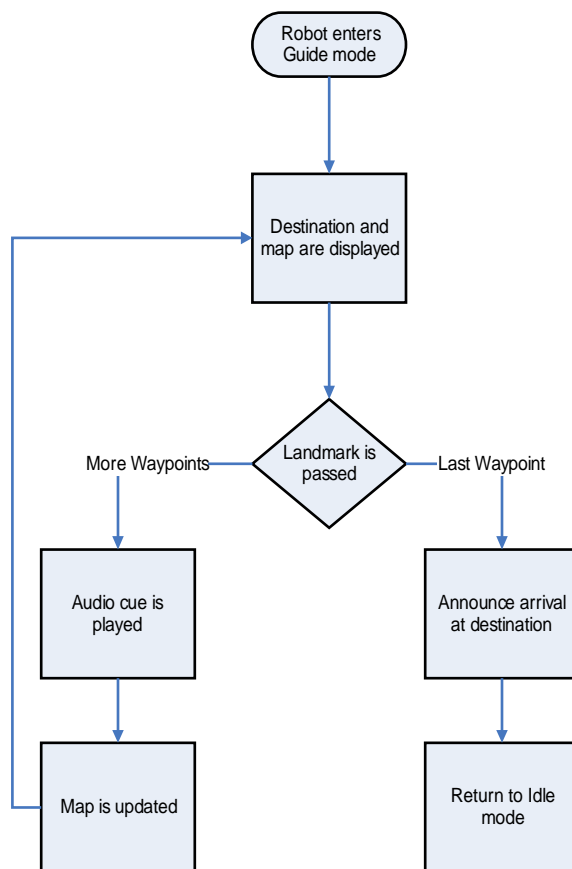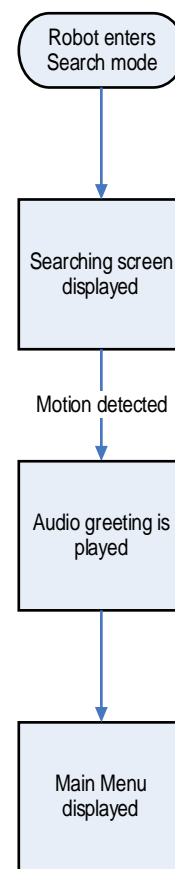
Figure 12. Guide mode GUI flowchart

Figure 13. Search mode GUI flowchart

Help/Assistance Mode

In Help/Assistance mode, the user is presented with a menu listing the names of professors and other information as shown in Figure 14. If the user touches the image of a professor, that professor's schedule is displayed as well as information about him. In addition, the user is presented with the option of being guided to the professor's office, thus engaging Guide mode.

```
┌─────────────────────┐
│ Robot enters Help/  │
│ Assistance mode     │
└─────────────────────┘
          │
          ▼
┌─────────────────────┐
│  Information menu    │
│  is displayed and    │
│  user is presented   │
│  with options        │
└─────────────────────┘
```
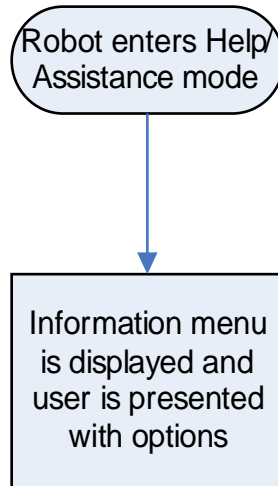
Figure 14. Help/Assistance mode GUI flowchart

Week	Tasks		
12/02/04-1/20/05	Research and design mapping and navigation software	Design Flash GUI	Research sensors and other parts
1/21/05-1/28/05			
1/29/05-2/3/05		Write software for interfacing Flash code with robot platform	Design and test sensor circuitry and design touch screen mounting hardware
2/4/05-2/11/05	Implementation and testing of mapping and navigation software	Link Flash code with robot interface code	
2/12/05-2/19/05		Build and mount onboard PC	
2/20/05-2/27/05			Finish sensors and begin mounting necessary hardware
2/28/05-3/06/05	Prepare mapping and navigation software for integration with entire system		
3/07/05-3/14/05			
3/15/05-3/22/05	Integrate and test GUI interface and mapping and navigation software	Polish up Flash GUI	
3/23/05-3/30/05	Prepare for EXPO		
3/15/05-3/22/05	Prepare Final Presentation		
3/23/05-3/30/05	Sleep		

Parts List

Item	Manufacturer	Cost	Model Number	Vendor Web Site	Misc.
15" Touch Screen W/Speakers	3M	$791.00	11-81374-505	www.wiredzone.com	USB, Capacitive Interface
Mini-ITX Motherboard/CPU	VIA	$195	MII1200	www.shentech.com	
256 MB RAM	Kingston	$28		www.newegg.com	
Sonar Pingers					
Motion Sensors					

Applicable Patents

The site http://www.uspto.gov was used in searching for patents relating to a variety of ideas used within GuideBot. These include the touch screen interface, sonar sensors, mapping software, and obstacle detection.

- 6,760,687, 6,539,284
  An autonomous robot to interact socially with people.

- 6,108,597
  An autonomous robot used in navigating pipes using sensor and map based navigation.

- 5,911,767, 5758,298, 4,638,445
  Autonomous robots used in workplaces and methods of navigation.

- 6,446,130
  A computerized multimedia delivery system designed to simultaneously display multiple streams of multimedia content.

- 5,702,166
  An information kiosk serving as an interactive information source for multiple users including users in wheelchairs.

Standards

The PC portion of GuideBot complies with all PC standards as of December, 2004 including communication over RS232 and USB 1.1.

Future Plans

There is the possibility of adding wireless Internet capability in order to get updated information about a place and provide users with a familiar web interface that they could use to give feedback about the system.