AmigoBot
User's Guide

With ActivMedia Robotics Basic Suite Software
Navigator WorldLink Trainer Mapper Simulator WorldPass
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ActivMedia Robotics software uses the Fast Light Tool Kit (FLTK) GUI, used and distributed under the terms of the GNU Library General Public License as published by the Free Software Foundation. Network audio uses the GSM 06.10 speech compression implementation by Jutta Degener and Carsten Bormann of the Technische Universität Berlin (http://kbs.cs.tu-berlin.de/~jutta/toast.html). ActivMedia Robotics software is based in part on the work of the Independent JPEG Group (http://www.iwjg.org)

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Federal Communications Commission (FCC) Statement

This equipment has been tested and found to comply with the limits for a class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial or residential environment. This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. There is no guarantee that harmful interference will not occur, in which case the user will be required to correct the interference at their own expense. Some possible ways to reduce the interference include:

- Reorient or relocate the receiving antenna
- Operate the equipment in a different location
- Connect the equipment to a different power outlet
- Consult with your local dealer or contact support online

Canadian Statement

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numerique de la classe B respecte toutes les exigences du Reglement sur le materiel brouilleur du Canada.

Warning

It is essential that only the supplied power and radio units be used.

Any changes or modifications to the equipment not expressly approved by the parties responsible for compliance could void your authority to operate the equipment.
Important Safety Instructions

- Read the installation and operations instructions before using the equipment.
- Avoid using power extension cords.
- To prevent fire or shock hazard, do not expose the equipment to rain or moisture.
- Refrain from opening the unit or any of its accessories.
- Keep wheels away from long hair or fur.

Inappropriate Operation

Inappropriate operation voids your warranty! Inappropriate operation includes, but is not limited to:

- Dropping the robot, running it off a ledge, or otherwise operating it in an irresponsible manner
- Overloading the robot above its payload capacity
- Getting the robot wet
- Continuing to run the robot after hair, yarn, string, or any other items have become wound around the robot’s axles or wheels
- All other forms of inappropriate operation or care
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Congratulations on your purchase of AmigoBot and welcome to the rapidly growing community of Intelligent Mobile Robot enthusiasts.

This AmigoBot User's Guide provides both the general and technical details you need to operate your AmigoBot Intelligent Mobile Robot. We encourage you also to use these companion resources:

- ActivMedia Robotics software and support services at [http://www.amigobot.com](http://www.amigobot.com)
- AmigoBot-users newsgroup
- 24-hour AmigoBot-support email service
- AmigoBot applications online Help

**What is AmigoBot?**

AmigoBot is an intelligent mobile robot: not a toy, but a powerfully smart moving machine. Intelligent because it has an onboard microcontroller with software (AmigOS) and sensors that enable the robot to sense what’s around it and to safely drive in and around its environment. Combined with state-of-the-art robotics software like Navigator from ActivMedia Robotics Basic Suite running on your PC, AmigoBot can actually determine where it is (localization) and find its way safely from one place to the next, with your help (teleoperation) and without your help (self-guided navigation), all the while going around obstacles, through doors, over bumps, under tables...

AmigoBot is the culmination of many years of mobile-robotics research and development by experts in artificial- and machine-intelligence from around the world. Chief among these contributors is Dr. Kurt Konolige, Consulting Professor with Stanford University and Senior Scientist with the Artificial Intelligence Center at SRI International, Inc. Based on 15 years of experience in robot design, Dr. Konolige developed the Pioneer robot in 1995. Pioneer was the first device to make intelligent mobile robotics affordable for most colleges and universities. It quickly became the leading off-the-shelf mobile robot for research and development.
institutions around the world. ActivMedia Robotics’ commercial Pioneer, PeopleBot, and MonsterBot robots use the same basic sensing, drive system, and robotics software architecture used by AmigoBot, ActivMedia Robotics’ first personal robot.

**AmigoBot Hardware**

AmigoBot is intended for indoor use in wheelchair-accessible places, including homes, schools, nursing homes, hospitals, offices, and research labs. The small, lightweight, and highly maneuverable AmigoBot has two solid 4-inch rubber tires, each driven by a reversible DC motor. Drive power is differentially pulse-width-modulated for fine and independent control of translational (forward and reverse) and rotational (clockwise and counterclockwise) motion. AmigoBot’s drive system includes a passive rear caster for balance, and, unlike many other robots, is “holonomic”—it can turn in place so it doesn’t get stuck in corners.

![AmigoBot's features and dimensions](image)

Each drive motor includes a high-resolution encoder that is used by AmigoBot’s microcontroller to determine the robot’s immediate translational and rotational speeds. Encoder readings also help determine how far the robot is traveling and the direction in which it is heading.
The standard AmigoBot comes with eight sonar—the six perforated gold discs around the front and the two in the rear. AmigoBot’s microcontroller uses sonar like a bat to not only sense objects forward, side, and aft, but also to determine how far away they are (“range finding”).

**AmigoBot Operating System Software**

The high-performance, I/O-rich 20-MHz Hitachi H8 microprocessor is the brain of the AmigoBot microcontroller. It also comes with FLASH read-only memory upon which we have permanently stored the robot’s operating system software. AmigOS, as we call it, manages all the low-level systems and electronics of the mobile robot, including running the sonar and reading the wheel encoders, adjusting the motor speeds for turns and
when going up and down ramps and over bumps, playing pre-recorded sounds, and so on. Like many operating systems, AmigOS is invisible to most users, doing its job behind the scenes. However, it is an “open” technology: its interface is freely available for command and control by your own software.

AmigOS also comes with self-contained programs that operate the robot autonomously, without the need for other computers or intelligent devices. These programs exercise the onboard motors and sonar and have the robot intelligently wander about on its own, navigating around obstacles while performing a simple routine of motions and sounds (see “Self-Test Mode” in Chapter 4). Future versions of AmigOS also may let expert users program their own standalone routines for autonomous performance by AmigoBot.

**AmigoBot Control Mode Software**

![Figure 3. Control AmigoBot from your PC through AmigoLeash or AmigoWirefree radio modems.](image)

We don't recommend that you learn H8 machine language programming just yet. Rather, AmigoBot prefers to operate by a higher intelligence (you, for example) by teleoperating the robot with a joystick from a smart program like Navigator on your PC or with WorldPass connected and in control of the robot across the Internet with ActivMedia’s WorldLink. Our smart software also drives the robot without your help—navigating to a goal that you select with a click of the mouse.

Most people prefer to operate AmigoBot from their PC because it gives them quick, easy access to the robot’s functionalities while working with
high-level software on a familiar host computer. Control Mode employs the power and speed of your PC to perform complex robotics tasks such as processing the raw sensor and position information from the robot, determining where it is in its operating space, and safely guiding the robot from place to place, room to room.

Control-mode software applications like Navigator and WorldLink communicate with AmigoBot through a serial interface, either directly tethered via AmigoLeash or wirelessly with the AmigoWirefree accessory. And with WorldLink, you may connect with AmigoBot or other ActivMedia robot from across the network, including the global Internet.

We make several software-development environments available so that you, too, may create your own programs like Navigator for AmigoBot and other Pioneer-compatible intelligent mobile robots. Colbert, for instance, comes with Trainer in the ActivMedia Robotics Basic Suite. It is a simple, ASCII text-based interpreted language for finite state-based control of the mobile robot. In other words, the Colbert-based Trainer program helps beginners develop simple programs without the complication, delay, and expense of other language compilers, libraries, and so on.

For the advanced software developer, there are C/C++ language-based development environments for AmigoBot, including Saphira from SRI International, our own Ayllu robotics subsumption-like environment that excels for multi-agent cooperative tasks, and ARIA, our new multi-threaded programming system.

**System Mode and Sounds**

Besides self-test and control modes, you may also operate AmigoBot in System Mode. This special feature is done through the AmigoBot’s system serial port beneath the robot. System-mode software utilities running on an attached PC (serial ports connected via AmigoLeash) let you modify AmigOS, the robot’s operating parameters, and its onboard sounds. For instance, with AmigoSounds, you download new sound themes that give personality to your robot, as well as provide useful aural cues to its working status, such as when its motors stall or when its battery is low.
Other AmigOS utilities let you modify the operating parameters of your robot, upgrade AmigOS, and many other types of system-related tasks. Some system-mode tools like AmigoSounds come with the basic robot. We provide others, such as an AmigOS download tool, at our AmigoBot support website along with new AmigOS software as it becomes available. We also provide a selection of system tools, such as the AmigoConfigurator, with the AmigoBot Technical Manual.

All generally available tools and updates will be available at AmigoBot’s support website (see “AmigoBot Server” below) as announced over the amigobot-users email news list (see “AmigoBot Newsgroup” below).

AmigoBot Package

Our experienced manufacturing staff put your AmigoBot Intelligent Mobile Robot and its accessories through a “burn in” period and carefully tested them before shipping the package to you. In addition to the companion resources listed above, we warranty the robot and our manufactured accessories against mechanical, electronic, and labor defects for six months. All of these precautions ensure that you have many years to enjoy your new AmigoBot Intelligent Mobile Robot.

Even though we’ve made every effort to make your AmigoBot package complete, please check the components again after you unpack them from the shipping box.

Basic Components (all shipments)

- One fully assembled AmigoBot Intelligent Mobile Robot
- CD-ROM containing licensed ActivMedia software and manuals
- Battery charger (may include socket and 110-220 VAC adapters)
- AmigoBot User’s Guide
- AmigoLeash cable and serial adapter
- $10 Off Coupon for the AmigoBot Store (http://www.amigobot.com)
Optional Components and Attachments

- AmigoWirefree radio modems: One mounted to AmigoBot and another—the “host”—radio modem with power module and serial cable for connection to your PC
- Replacement battery
- High-speed battery charger
- AmigoBot ePresence system with WorldLink network software, color camera and microphone, onboard A/V transmitter with desktop receiver, and video framegrabber for your desktop or portable PC
- AmigoBot-compatible PCMCIA framegrabber for your subnotebook computer (Vision AmigoBot only)
- AmigoDock for unattended, automated recharging
- PC joystick
- AmigoBot Technical Manual and software utilities

User-Supplied Components/System Requirements

- 586-class or later, preferably 300MHz or faster, PC or subnotebook with Microsoft Windows® 95-2000/NT or RedHat Linux® version 6.x or later operating system.
- Color monitor or subnotebook screen capable of 800 x 600 pixel, 16-bit color display
- One available RS232-compatible serial port on PC or subnotebook
- CD-ROM drive
- Vision AmigoBots may be purchased with or without PCMCIA framegrabbers; if you do not have the proper framegrabber for your subnotebook used with Vision AmigoBot, you will not be able to run ActivMedia Color-Tracking Software (ACTS).
- Internet connection for access to AmigoBot through WorldLink. Hardware may include a network interface card, typically Ethernet, and/or a high-speed modem, either DSL or a 56KB standard unit.

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1 This is just a partial list of options and accessories; new ones appear regularly. Sign up for amigobot-users to receive automatic notification or browse the AmigoBot website for details.
Additional Resources

Every AmigoBot customer may take advantage of four additional and valuable resources:

- Access to the AmigoBot Support Web server for downloading software, updates, and manuals
- Access to the amigobot-users newsgroups
- Direct access to the AmigoBot technical support team
- Free subscription to ActivMedia’s Personal Robots Newsletter

AmigoBot Server

We maintain a 24-hour, seven-day per week (24/7) World Wide Web server where customers may obtain AmigoBot software and support materials:

http://www.amigobot.com

Personal Robots Newsletter

You may join ActivMedia’s bi-monthly Personal Robots Newsletter to keep up to date on new accessories, news, and special offers for AmigoBot.

To: amigonews-request@amigobot.com
From: <your return e-mail address goes here>
Subject: subscribe

AmigoBot Newsgroup

We maintain an email-based newsgroup through which AmigoBot owners share ideas, software, and questions about the robot. To sign up, send an email message to our automated newsgroup server:

To: amigobot-users-request@amigobot.com
From: <your return e-mail address goes here>
Subject: subscribe
Our SmartList-based email list server will respond automatically. After you subscribe, send your email comments, suggestions, and questions intended for the worldwide community of AmigoBot users:

| To: amigobot-users@amigobot.com |
| From: <your return e-mail address goes here> |
| Subject: <something of interest to amigobot-users> |

Access to the amigobot-users newslist is limited to subscribers, so your address is safe from spam. However, the list currently is unmoderated, so please confine your comments and inquiries to issues concerning the operation and programming of AmigoBot.

Support

Having a problem? Can’t find the answer in this guide or any of the other manuals? Do you know a way that we might improve AmigoBot? First consult this guide and check into our online Frequently Asked Questions (FAQ) section on the http://www.amigobot.com server.

If you can’t find the solution, then contact us:

amigobot-support@activmedia.com

Please include your robot’s serial number—look for it on the underside of your robot. We need the serial number to understand your AmigoBot’s configuration so we can best answer your questions.

Your amigobot-support message goes directly to the AmigoBot technical support team. A team member will help you or point you to a place where you can find help.

Because this is a support option, not a general-interest newsgroup like amigobot-users, we reserve the right to reply only to questions about problems with AmigoBot through amigobot-support.

(See Chapter 6, “Maintenance & Repair” for more detail.)
Chapter 2  INSTALLATION & SET-UP

AmigoBot comes pre-assembled for out-of-the-box operation. All you need to do to prepare the robot for operation is twist up and position the camera, if you have the e-Presence surveillance hardware. That’s all there is to it!

Software

Typical operation of your AmigoBot Intelligent Mobile Robot requires that you install software and hardware on your PC. We assume that you know how to operate your PC, attach accessories to it, and install software on its hard drive. Please consult your computer and operating system manuals for details.

ActivMedia Robotics Basic Suite of robot-control software is available for both RedHat Linux®- and Microsoft Windows®-based PCs. Choose the software that matches your PC’s operating system.

Figure 4: AmigoBot needs little setup out of the box.

Figure 5: ActivMedia Robotics’ Basic Suite
Windows9x®

The ActivMedia Robotics Basic Suite software installation program should execute automatically when you insert the disc into your PC’s CD-ROM drive (Windows9x® already running, of course). If not, double-click the ActivMedia Robot’s CD-ROM icon in My Computer. If that still doesn’t work, Explore the CD-ROM and double-click ActivMediaBasic-Suite.exe icon in the Win32 directory manually to start the installation.

Follow the online installation instructions. The default installation places the software in your boot drive’s (typically C:) Program Files directory in a new folder called ActivMedia. Therein is a folder named bin, where you may find the various programs.

The ActivMedia.exe startup program executes immediately after you complete the installation. Thereafter, you should usually start up with that same bin\ActivMedia.exe program. Look for its program icon on your Desktop, too. There also is an ActivMedia item in the Programs directory of the Start menu.

Unlike many other installations, you should not have to restart your PC after installing the ActivMedia Robotics Basic Suite. But from our experience with Windows, re-booting the computer is the first remedy to try if the software doesn’t operate properly.

LINUX

To run, the LINUX-based ActivMedia Robotics Basic Suite software requires that you have X-Windows installed, configured, and running with the desktop environment of your choice.

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2 ActivMedia Robotics Basic Suite software may install and run fine with other Microsoft operating systems, including Windows®2000, but the many differences in accessory drivers limits our support. You’re on your own with the alternative OSes.
Insert the ActivMedia Robot CD-ROM into your PC’s drive and mount it if your system does not automount the disc. The installation software comes as an RPM archive; you will need to have root privileges to install it on your system. We also assume that the CD device is installed and described in /etc/fstab and that the /mnt/cdrom directory exists:

```
# mount /dev/cdrom /mnt/cdrom
# cd /mnt/cdrom/Linux
# rpm -ihv ActivMediaBasicSuite-1.2-1.i386.rpm
```

Most of the ActivMedia Robotics Basic Suite software gets put into /usr/local/ActivMedia. The program executables reside in /usr/local/ActivMedia/bin. Some libraries and tools get put into /usr/local/bin and /usr/local/lib.

You need read, write, and execution permissions to operate AmigoBot through your LINUX PC’s serial port and to operate the Simulator through a special robot file that gets put into /tmp:

```
# chgrp users /dev/ttyS0 // Use ttyS0-Sn, depending on actual port
# chmod g+rwx /dev/ttyS0 // ditto
# chgrp users /tmp
# chmod g+rwx /tmp
```

We assume that the serial device and the /tmp directory already exist (they usually do when you install LINUX) and that you and others who wish to operate AmigoBot and the Simulator are members of the users group. Indicate the alternate serial port name if you have AmigoLeash or the AmigoWirefree host modem attached to a different port: /dev/ttyS2, for example.

### GUIs and Displays

ActivMedia Robotics Basic Suite Software make use of the Fast Light Tool Kit (FLTK) for the Graphical User Interface with both the RedHat Linux® and Windows9x® versions. We include the latest FLTK libraries, so you need to install only the ActivMedia software.

However, for those interested, source code and complete distributions of FLTK may be obtained from:
Please be careful. Versions of FLTK other than that which accompanies your ActivMedia Robotics Basic Suite may not work.

ActivMedia software graphics look best in 24-bit color video-display mode; 8-bit and 16-bit modes work fine, but they won't look quite as nice. ActivMedia software also requires a minimum 800 x 600 pixel screen area.

**Serial Ports and Connections**

Software that runs AmigoBot from your PC communicates with and controls the robot through a serial connection. Use the AmigoLeash that came with your robot to tether the robot to one of your computer's serial ports. Use the AmigoWirefree radio modem accessory to operate AmigoBot without a tether.

**AmigoLeash**

AmigoLeash comes in two parts: an adapter containing both a 9-pin DSub and an RJ-11/12 socket, and a long cable terminated on each end with an RJ-11/12 plug (a common telephone cable). Plug one end of the AmigoLeash cable into the adaptor, and then plug the adaptor into one of the serial ports on the back of your PC.

Adaptors (9-pin to 25-pin) are available for the less common 25-pin serial port connectors that are on some of the older PCs. However, don’t confuse that uncommon serial port connector with the common 25-pin socket to which you typically attach a printer. One quick way to tell the difference is that serial ports are plugs (male) and the parallel port usually is a socket (female).
If you plan to operate your robot tethered to your PC and do not have AmigoWirefree installed, plug the other end of the AmigoLeash into the RJ-11/12 receptacle (Control Port) that comes out of the top of the robot. The similar RJ-11/12 receptacle on the bottom of AmigoBot next to the charger port and power switch also is a serial port connection, but to a different part of the robot’s controller. You’ll eventually use AmigoLeash in that port, too, but not to operate AmigoBot. Rather, the alternate “System” serial port is for special tools like AmigoSounds. More about this in the separate ActivMedia Robotics Basic Suite Software Guide.

**AmigoWirefree**

AmigoWirefree is a popular AmigoBot accessory that allows tetherless remote control of your robot with ActivMedia software and other applications. AmigoWirefree transmits and receives serial communications by radio (900 MHz in the US), thereby eliminating the wire tangles and limited range of travel when the robot is connected to your PC with a serial tether like AmigoLeash.

One AmigoWirefree modem is mounted to the underside of the robot. With your computer turned off, attach the “host” modem to a serial port on your PC using the serial cable that came with the accessory, possibly replacing the AmigoLeash that you may have installed earlier.

**BE VERY CAREFUL!**

USE ONLY the AmigoWirefree power adaptor to operate the host AmigoWirefree. Otherwise, you may cause irreparable harm to the modem and void the warranty.
Also plug the host modem’s power adapter into a 120 volt (or 240 volt where appropriate in some countries) AC socket and its low-voltage (5 volts DC) power cable into the host modem. The AC plug may need a receptacle adaptor.

Power indicator LED’s on each of the radio modems light up when they are switched ON and connected to power. The modems have their own pushbutton power switch, located on the side of the unit. Also, AmigoBot’s main power switch also must be ON, too, to provide power to the robot’s AmigoWirefree modem.

**Internet and LAN Connections**

With AmigoBot’s ePresence system, including Navigator surveillance hardware and WorldLink software, you can see and hear what your robot sees and hears through its onboard camera and microphone. So what, you ask? With ePresence, you can see and hear, as well as take control and drive the robot, from the other side of the world or anywhere else across the network. You even can share the experience with several friends, family, and colleagues at the same time, each connected from their own remote location.

People and robots interact in many different ways with AmigoBot ePresence because you can develop many simultaneous links over the Internet as well as in your own Local Area Network (LAN). You and your family, friends, and colleagues see, hear, and control the robot through:

- Your own AmigoBot ePresence WorldLink software
- Remotely through the WorldPass and Navigator software connected over the network to an WorldLink host
- To someone else’s AmigoBot ePresence system with WorldPass, Navigator, or WorldLink to control their robot
- With someone driving your AmigoBot ePresence system with WorldLink while you control their AmigoBot ePresence system with WorldPass

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3 Includes video camera, microphone, an A/V transmitter on the robot, and an A/V receiver and video framegrabber for attachment to your PC.
With up to four robots communicating with a host PC running WorldLink, with people from different parts of the world controlling each robot.

The ePresence software also contains a chat facility, so that you may exchange messages with other WorldLink-connected users instantly, exchange audio messages, and even take digital snapshots.

**ePresence**

The AmigoBot ePresence system contains all the features of a basic AmigoBot, as well as AmigoWirefree and Navigator surveillance hardware, plus two network software applications, WorldLink and WorldPass.

Figure 9: ePresence lets you share AmigoBot with friends, family, and colleagues around the world.

Connect your AmigoBot to a nearby PC running the ePresence WorldLink software, then enable the program’s WorldLink connection with your network. Thereafter, you and your friends, family, and colleagues can
connect with the WorldLink host over the network from another WorldLink program, or from Navigator or the free WorldPass program in any combination of users.

Once connected, your AmigoBot program becomes a network console in which you follow the WorldLink-connected robot’s activities and movements in its own world. Although far away, the WorldLink-connected AmigoBot appears as if it is right next-door.

As a bonus, and without any extra equipment, you and your friends can see and hear what the WorldLink-connected AmigoBot sees and hears through its live video and audio. And you can “chat” with other connected users over the network.

We talk a lot more about WorldLink and WorldPass in the separate ActivMedia Software Guide.

Networking Hardware and Software Basics

Successful operation of AmigoBot and other ActivMedia robots through WorldLink requires that you not only have the ePresence hardware and software, but also have a network connection, either through a modem connected with a network provider over telephone lines, through a special DSL or cable connection, or through a network interface card attached directly to a local- and/or wide-area network.

You also need a PC network connection that uses “TCP/IP” protocols for communication between networked computers. TCP/IP is the most common type of network today, including the global Internet and the World Wide Web. If you are connected to the Internet, you most likely may connect and use ePresence. Consult with your local network administrator or Internet provider to obtain the software and hardware you need to configure your PC for access and use of a “TCP/IP-based inter- or intra-network.”

WorldLink Network Address and Access

To access a WorldLink connected AmigoBot over the network, you, your colleagues, family, and friends must be connected to the same TCP/IP
network and use either another WorldLink program, or Navigator or WorldPass software. You also need to know the “hostname” or “IP address” of the WorldLink PC. In some cases, you will need to know its “port number,” too. And you will need an access-security username and password.

A hostname is a unique name given to some, not all, computers on the network. It consists of the computer’s name and the name and type of network to which it is connected. For instance, “www.amigobot.com” is a hostname; “www” is the name of the computer, “amigobot” is the name of the network, and “.com” is the network type—a commercial one, in this case; “.edu” is for an educational institution.

While hostnames are convenient for us to remember, TCP/IP-based networks actually just assign a unique address to each and every connected computer; hostnames are optional. Although you may not know it, your network computer uses only that IP address, not the hostname, to actually talk with another network computer. An IP address has four, “dot”-separated numbers, each between 0 and 255. Examples are 192.177.50.44 and 2.243.99.1.

However, particularly with modem dial-up services, you may not know your computer’s IP address because it often gets dynamically assigned each time you connect with the network. That’s bad. It is important to have a consistent hostname or IP address for an WorldLink host. Otherwise, your remote users won’t know its address and therefore won’t be able to connect. Speak with your network administrator or service provider if you have this problem.

Network software like WorldLink also use special network “ports” to communicate with other software. WorldLink’s default network port number is 5757, but the owner or a network administrator may change this. To specify a port number when connecting with a WorldLink host, simply append it to the hostname or IP address following an intervening colon. For example, in the IP address 192.177.8.44:5758, the port number is 5758, and in amigobot.activmedia.com:403, the port number is 403.

Finally, you’ll need a security-access User Name and Password to connect with the WorldLink if the owner doesn’t allow guest access.
There are several ways to obtain the hostname or IP address, user name, and password for someone’s WorldLink host. The best way is to ask its owner. And when you send WorldPass to your friends and family so they can link to your WorldLink host, you will need to include your PC’s hostname as well as a security-access User Name and Password that you assign to them.

**Framegrabbers and Sound Cards**

ActivMedia’s Navigator surveillance hardware—also part of the AmigoBot ePresence system—includes a video camera with integrated microphone, and an audio/video (A/V) transmitter on the robot, and an A/V receiver and framegrabber card for your PC. AmigoBot transmits the sounds its microphone picks up and the video images its camera sees through the onboard A/V transmitter to the receiver. You can connect the audio and video outputs from the A/V receiver to a sound and video monitor directly.

However, the ActivMedia Robotics Basic Suite software Navigator and WorldLink can display live video from the robot on your computer screen along with all the other robot-related features. Audio, too, can be played from the robot through your PC’s audio system. WorldLink needs to have the video and sound put into its host PC in order to broadcast the robot’s live video and audio to others who may connect over the network.

![Framegrabbers and Sound Cards](image)
To do all this, you need to install a PC framegrabber into the computer from which you control your AmigoBot. Also install and attach the video output from the A/V receiver into that framegrabber using the accompanying RCA video cable (yellow RCA plug typically).

Connect the audio output from the A/V receiver to your PC sound card. We don’t supply a sound card as part of the Navigator hardware since most PCs come with a sound card already installed. Sound cards are inexpensive, if you need to purchase one. Given the variety of sound cards available commercially, we leave the installation details to you and your dealer.4

We supply the required framegrabber-driver software for Linux-based PCs on the ActivMedia Robotics Basic Suite CD-ROM. Microsoft Windows9x® owners need to install the driver software that accompanies the framegrabber itself, not included on the CD-ROM.

Make sure to check the framegrabber card’s settings. Navigator and WorldLink let you do that with a special Video button below their Video Display window. The video source typically is the problem if you don’t see an image. When in doubt, choose the popular “Composite” source.

**Joystick**

Most ActivMedia software lets you drive (“teleoperate”) the robot or its simulator with your PC joystick. Sound cards usually have a joystick port or two. We leave the installation details to you and your joystick/sound card manual, and encourage you to use the joystick’s accompanying calibration utilities to set the device up properly. And, we make you calibrate your joystick the first time you try to use it with any of the ActivMedia Robotics Basic Suite programs. Just follow the easy instructions that appear on the screen. Routine calibration is a must for consistent and reliable use.

4 You can’t go wrong with a good SoundBlaster® or compatible.
Chapter 3  **Quick Start**  

You’ve waited long enough to start working with AmigoBot. Here are a quick few of the many things you can do with the intelligent mobile robot. Try them out to get a feel for the way AmigoBot senses and maneuvers within its new world.

But don’t linger here for long—there’s so much more to do with Mapper, WorldLink, Trainer, ...

**Quick Start: Self Wander**

1. Switch ON AmigoBot’s Main Power and listen for the start-up sound. Set AmigoBot on the floor, preferably in three or more square meters (10 square feet or more) of open room.

2. Press the black pushbutton (Motors/Test) twice. Watch AmigoBot spin one way and then the other to complete its drive test.

3. Now watch the green LED flash faster as you approach the sonar disc next to the robot’s left wheel with your hand. Press the black push-button to step through each of the eight sonar tests. Sonar ping in clock-wise order around AmigoBot.

4. After the eighth sonar test, AmigoBot automatically will start wandering about on its own. Occasionally, it will stop and, with accompanying sound effects, spin around. Throughout, the robot will avoid bumping into, and will navigate around,
through, and over things it can see with its sonar. Keep an eye on it, though: AmigoBot can’t see down stairs and could take a nasty spill.

**Quick Start 2: Navigator/WorldLink**

1. If AmigoBot is still running the self-wander test, press the red pushbutton (Reset) to stop it. Otherwise, switch AmigoBot’s Main Power ON. Place the robot on the floor, preferably in three or more square meters (10 square feet or more) of open room.

2. If you have the accessory, attach your AmigoWirefree host radio modem to its power module and to a serial port on your PC. Make sure that both the modem and its companion mounted to the bottom of AmigoBot are ON (its green power LED lit continuously).

3. If you don’t have AmigoWirefree, attach your AmigoLeash between a serial port on your PC and the telephone

![Figure 13. Drive AmigoBot with control-mode software on your PC connected with the robot through AmigoWirefree or AmigoLeash.](image)

![Figure 14. Switch AmigoWirefree ON.](image)
socket-like serial connector on top of AmigoBot (not the one on the bottom of the robot).

4. Similarly, although not necessary for operation of the robot, connect the audio and video outputs from your A/V receiver to their respective inputs on your PC’s framegrabber and sound cards or to your TV monitor and amplified speakers.

5. Start up your PC and, if you haven’t done so already, install the ActivMedia Robotics Basic Suite software. Start the ActivMedia program from `/usr/local/ActivMedia/bin/ActivMedia` (Linux users) or select ActivMedia from the Start menu (Windows9x® users). Click to run Navigator or WorldLink.

6. When asked by the start-up dialog, choose to connect with the Robot. And, when asked in another dialog, choose the connection

Figure 15: A successful connection with AmigoBot. Notice the sonar display and Current State values and messages.
serial port that you have AmigoLeash or AmigoWirefree attached to your PC, typically COM1 or /dev/ttyS0. (If you choose incorrectly, fix it in your program’s Setup:Preferences menu.)

7. A successful connection between Navigator or WorldLink and AmigoBot produces audible approval from the robot, embellished with continuous sonar “pings,” and a newly animated display on your PC showing blue emanations from eight spots on the virtual robot.

8. If not successful, informative dialogs will help you solve the serial connection problem. After repairing the difficulty (typically a loose cable or you hadn’t turned something ON), try connecting with the Robot again from the Connect button on Navigator or WorldLink’s console or from the Connect menu. Help is available in the next chapter, too.

9. Click the console arrow keys or the respective keys on your PC’s keyboard to make AmigoBot turn and drive forward and backward (“teleoperate”). Click the red stop button between the arrows or press the space bar to stop AmigoBot. If you have one, hold a fire button on your joystick to take control that way. Release the button to stop the robot.

10. Drive AmigoBot around to get a feel for its maneuverability. Notice how the blue sonar projections in the Main Display change length as the robot gets near objects, and how it won’t let you crash into walls.

Figure 17. Click the teleoperation buttons to drive AmigoBot. Use your keyboard arrow keys (space bar to stop) and joystick, too.

Figure 16. Point and click in the Navigator or WorldLink map to have AmigoBot drive itself to a goal.
or furniture. If you have live video, see how it is to drive from the robot’s point of view.

11. Point your mouse into the Main Display somewhere near the robot icon and click. A green line leading from the robot to your click mark should appear on the screen, designating a “goal” position and the path that Navigator or WorldLink has planned. It then proceeds to drive AmigoBot to that place (intelligent “self-guidance”). The real AmigoBot should turn toward the goal, and then travel the prescribed distance to that goal (default onscreen grid is one meter per unit).

12. AmigoBot will drive around simple obstacles—someone standing in the way, for instance—to reach its destination, but it won’t go through walls or find doors to that destination. Navigator can and will plan and execute a complicated path between rooms when you have completed a good map of AmigoBot’s environment.

13. Click the Sounds button on the Navigator console or pull down the Sounds menu and choose to play the various sounds that AmigoBot has stored onboard its audio system. See what combinations of sounds and movements from AmigoBot elicit the best responses from your audience.

And then read on…

Figure 18: Select from over 250 AmigoBot sounds to interact with friends, colleagues, family - even foes.
Chapter 4  OPERATIONS AND MODES

Your AmigoBot Intelligent Mobile Robot has just a few simple buttons, switches, indicators, and connectors that enable a rich variety of operational modes and applications.

Controls, Switches, Indicators, and Sounds

Recharge/Power/Battery

A single slide-switch on the bottom of the AmigoBot near the caster controls power to the entire robot and all of its accessories. The red LED on the top towards the rear of the robot is lit when the AmigoBot has power.

Attach the recommended accessory power charger or equivalent to the Charge port on the bottom of the robot to recharge AmigoBot’s battery. The standard AmigoBot comes with a single, 12-volt DC, 2.2 ampere-hour (26.4 watt-hour) safety-sealed lead/acid battery which supplies ample power for the robot’s drives, electronics, and accessories—typically over 2 hours of operation with continuous activity, and over a day with the drive motors disengaged.

Disengage the motors when recharging AmigoBot, but you may continue operating the robot.
Like the battery in your automobile, severe discharge can damage AmigoBot's battery. We recommend recharging the battery when it falls below 11 volts, even though the robot may continue to operate below 10 volts. To be safe, AmigOS sounds a warning when the battery voltage falls below 11 volts, and the robot automatically stops running, even though power is ON, when the battery voltage falls below 10 volts.

Typical recharge time depends on the charger and the discharge state of the battery. The AmigoBot's standard charger takes overnight (8 hours or more), whereas the two-stage fast charger accessory will fully recharge the AmigoBot battery in 2-4 hours. With the fast-charger, you also may continue to operate AmigoBot while charging its batteries, although that will lengthen the recharge time.

**Reset, Motors/Test Buttons and System/User LED’s**

On top, near the back of AmigoBot next to the red Power LED, are two push-button switches and two additional LED’s. The red pushbutton switch is the Reset button. Press it at any time to reset the AmigoBot controller to its start-up state with motors disengaged and not connected for operation with any software.

The black Motors/Test pushbutton’s function depends on the current operating state of the robot. For instance, after power start-up or reset, press the black Motors/Test button once to enable and a second time to begin AmigoBot’s self-tests. Then, while in self-test mode, pressing the Motors/Test button advances the sonar tests.

When not in self-test mode, pressing the Motors/Test button in combination with the Reset button enables System Mode on the controller to
download sounds and other special activities. When connected with the Navigator software, the Motors/Test button manually enables and disables the motors.

We detail the Motors/Test button’s actions and functions during Self-Tests and other operations where appropriate throughout this guide.

The green System and amber User LEDs indicate AmigOS activities, depending on the current mode of operation. For example, on start-up or after reset, the green LED flashes slowly and rhythmically, while the amber LED is OFF. While connected with software like Navigator, the amber User LED flashes rapidly indicating Control Mode serial communications activity; the green System LED flashes rapidly when the motors are disabled, and slowly when the motors are enabled.

Alternatively, the System LED’s rate of flashing indicates the distance from a target during the sonar’ self-test, for instance. We detail the User and System LED actions and functions during self-tests and other functions where appropriate throughout this guide.

Sounds

As part of its microcontroller, AmigoBot has an onboard audio system capable of reproducing recorded voices, music, and sound effects. Up to 255 sounds can be stored in AmigoBot’s 1MB of onboard FLASH memory, for a total of about 90 seconds of assorted audio playback. The first 49 sounds are dedicated system cues automatically played when the robot is started up or reset, during self-tests, after making a connection with software like Navigator, and so on. The remaining sounds are under user control. Navigator, for instance, lets you play an individual user sound by name through a simple pull-down menu.

Use AmigoSounds to manage and download sets of system and user sounds (“themes”). The software contains details about the system sounds, too. Future versions will let you create your own sound themes.

The audio amplifier and sound decoder are part of the AmigoBot microcontroller, which sends approximately 1 watt of sound through the small speaker on the top towards the rear of the robot, across from the
control buttons and LED’s. Although the native sound system is quite good and loud enough for most settings, a future planned accessory will provide a better, more powerful audio system, as well as live, two-way audio to complement the live ActivMedia Navigator video system.5

**Motors and Position Encoders**

AmigoBot’s drive system uses two high-speed, high-torque, reversible-DC motors. Each includes a high-resolution optical quadrature shaft encoder that provides 9,550 ticks per wheel revolution (approximately 30 ticks per millimeter) that the AmigoBot controller uses to sense and to control distance, direction, and speed.

AmigoBot’s tires are 4 inches in diameter and made of soft, but firm rubber for good traction and low compressibility. Keep them clean and oil- and grease-free to maximize traction for climbing up and down ramps and over sills, and to minimize slippage on smooth surfaces. (Slippage degrades your robot’s ability to know where it is.)

**Sonar**

The AmigoBot comes standard with a single array of eight sonar. The sonar positions are fixed: one on each side, four facing forward, and two at the rear, together providing 360 degrees of sensing.

The sonar firing rate is 25 Hz (40 milliseconds per sonar) and sensitivity ranges from 10cm (6 inches) to more than 3 meters (10 feet). Objects that are 10 cm and closer register as 10 cm away.

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5 Navigator’s hardware includes one-way audio from robot to the receiver. To listen, attach an audio amplifier to the receiver’s audio output port.
**Sonar Sensitivity**

Although calibrated at the factory, sonar sensitivity and range may be adjusted to accommodate differing AmigoBot operating environments. The sonar gain control is a one-turn screw cap accessible through a small hole on the top and near the front of AmigoBot. You may have to remove an accessory to uncover the hole.

Using a small flat-bladed screwdriver, turn the adjustment screw **counterclockwise** to make the sonar less sensitive to external noise and false echoes. Low sonar-gain settings reduce the robot’s ability to see small objects; under some circumstances, however, that may be desirable. For instance, attenuate the sonar if you are operating in a noisy environment or on an uneven or highly reflective floor—heavy shag carpet, for example. If the sonar are too sensitive, they will mistake the carpet immediately ahead of the robot for an obstacle.

Increase the sensitivity of the sonar array by turning the gain-adjustment screw **clockwise**, making the sonar more likely to see small objects or objects at a greater distance. For instance, increase the sonar gain if you are operating in a relatively quiet and open environment with a smooth floor surface.

**Serial and Accessory Ports**

**System Serial Port**

Your AmigoBot’s System serial port is the RJ-11/12 connector on the bottom of the robot. Connect it through the AmigoLeash to a serial port on your PC. With this connection, you can:

- Change sounds
- Download a new AmigOS
- Edit operating parameters

See the ActivMedia Robotics Basic Suite Software Guide for details about downloading AmigoSounds through the system serial port.

Figure 22: AmigoBot’s system serial port cannot be used with control-mode software like Saphira or Navigator.

**Control Serial Port**

If your AmigoBot does not have an AmigoWirefree radio modem, there is an RJ-11/12 connector on top of the robot that is the Control serial port. Connect it through AmigoLeash to a serial port on your PC to run Control-mode software, such as Navigator, WorldLink, ARIA, Saphira, or Ayllu programs.

**Accessory Connector**

Beneath the black rectangular plastic cover near the center of the robot is a high-density IDC latching connector mounted on the AmigoBot controller board. It supports a variety of accessories through its many I/O ports.

We provide attachment details with each accessory that uses the port. Obtain the AmigoBot Technical Manual through ActivMedia Robotics' Robot Store for hardware and software details.

**Modes of Operation**

You may operate your AmigoBot Intelligent Mobile Robot in one of three modes: Self-Test, Control, or System Mode.

**Self-Test Mode**

AmigoBot comes with self-contained programs in its operating system software, AmigOS, which test the robot’s electronics, sensors, and drive...
Use Self-Test Mode to be sure the robot is in good working order, and to diagnose problems.

**CAUTION!**
Place AmigoBot on the floor and have everyone step back before engaging Self-Test Mode.

To initiate self-test mode:
- Remove AmigoLeash. (AmigoWirefree may be ON or OFF)
- Place AmigoBot in an open, safe, one square meter (three square feet) area on the floor, away from obstacles.
- Switch main power ON or press Reset if AmigoBot already is ON.
- Press and release the black Motors/Test button.

A system sound should warn you that you have initiated Self-Test Mode. Press the Reset button to cancel the tests at any time. Within five seconds, press the Motors/Test button once again to actually start the tests. (If after five seconds you don’t engage self-tests, AmigoBot will automatically revert to its startup state)

**Motors Test**

The first self-test exercises the robot’s motors. The left wheel drives forward first, so that your AmigoBot turns in place counterclockwise about 1-1½ full turns. Then it drives the right wheel, turning the robot clockwise about 1-1½ full turns.

**Sonar Test**

After completing the motors tests, the robot stops and immediately begins testing its sonar. AmigOS “pings” each sonar in order from left to right, beginning with the side sonar next to the left wheel. The green System LED blinks more rapidly as you move a target—your hand, for instance—closer to the sonar under test.

Press the Motors/Test button to move on to the next test sonar.
Wander Test

Press the Motor/Test button after the last sonar test to initiate self-wandering. This is a simple, yet robotically sophisticated program that has AmigoBot drive entirely on its own around and through rooms avoiding obstacles, climbing ramps, over bumps, through doors, and so on, somewhat randomly like a curious infant. Every few minutes, AmigoBot in self-wander test will stop, play sounds, spin in place, and then continue on its otherwise aimless journey.

Self-wander is a good demonstration and test of AmigoBot’s innate robotic abilities—sensors and onboard intelligence—without having to connect with a PC-based robotics application as you do in Control Mode (see next section). However, self-wander is a very simple robotics program with very limited capabilities as compared with Navigator or other PC-based robotics applications.

WARNING!
Be careful that the robot doesn’t drive over a steep ledge or down a flight of stairs when wandering.

Press Reset or switch Power OFF at any time to cancel self-wander.

Control Mode

Use Control Mode to operate the robot from an off board program (such as Navigator) running on a PC. The robot’s onboard systems go into Control Mode when you first turn Power ON or whenever you Reset the robot. The amber User LED is OFF and the green System LED flashes slowly and rhythmically.

Sophisticated robotics programs like WorldLink establish control of the robot through the Control serial port. Accordingly, you must have an AmigoLeash or the AmigoWirefree radio modems attached between the controlling PC’s serial port and the robot’s Control Port.
Once a connection is made between the robot and the controlling program, the System LED blinks if the motors are disengaged and stays lit when the motors are engaged. Some robotics programs have a menu item or button that lets you engage and disengage the motors. Others, like WorldLink, engage the motors automatically. In all cases, you may control the motors manually by pressing the Motors/Test button.

**System Mode**

The AmigOS onboard software, related robot-operating parameters, and sounds all are stored in AmigoBot’s FLASH memory. These data and programs are permanent and persist after you remove power, but with special tools can be changed and updated. AmigoSounds, for example, downloads new sound files to AmigoBot’s 1MB of FLASH.

You make changes to the AmigoBot’s onboard software and data when the robot is in System Mode. System-related software tools running on a PC communicate with AmigoBot through its system serial port. Accordingly, attach AmigoLeash to that alternative serial port on the bottom of the robot.

A special sequence of button-presses puts AmigoBot into System Mode:

- Press and hold in the black Motors/Test button.
- Press and release the red Reset button.
- Release the black Motors/Test button.

When in System mode, the amber User LED stays lit continuously and the green System LED, while mostly lit, flashes very quickly when you are downloading data to the controller’s FLASH.

Press Reset or switch Power OFF to end System Mode. Any data downloaded to the controller during a System Mode session will remain there permanently until changed during another System Mode session. However, if you prematurely end a System Mode session before all the
data are downloaded from the PC to the controller (only half of a sound file, for example), then not only are the downloaded data corrupted, but the system tool will have erased the original data, in preparation for the new information. Fortunately, the remedy is simple: download the data again until it is complete.

You may enable System Mode at any time, even when connected with a PC-based controlling program like ActivMedia Trainer. System Mode overrides all other modes, thereby automatically disconnecting the robot from any other controlling program.

**Safety Features**

AmigoBot contains several features that make it safe to use in many environments, even around infants and small pets.

**Pick It Up!**

AmigoBot is light, weighing approximately three kilograms (seven pounds), so it can be easily picked up and moved out of trouble. With normal use, it won’t cause damage if it falls or runs into something.

Accordingly, if it’s headed for trouble, such as toward a flight of downstairs, simply grab the robot and pick it up! Place it down elsewhere, out of trouble, or press **Reset** to start over.

**CAUTION!**

Keep wheels away from long hair or fur.

**Watchdog**

When in Control Mode, an AmigOS “watchdog” constantly monitors the robot’s serial connection with the controlling program on your PC. If for some reason the robot doesn’t hear from the program after a short period of time (typically two seconds), such as when radio interference temporarily disrupts AmigoWirefree communication, AmigoBot will
automatically stop moving and wait until communications with the controlling program are restored.

Low Battery

Like the battery in your car, AmigoBot’s battery doesn’t like to be discharged too severely. When its power gets low (typically around 11 volts), the robot will begin to complain, repeating a low-battery lament. If you ignore its complaint and let AmigoBot’s battery discharge to below 10 volts, the onboard systems will go into shutdown. Although it is not able to shut off its power entirely, AmigoBot will stop moving (motors take a lot of power) and wait for you to come to its rescue.

Low-battery shutdown is not a failsafe. If you leave AmigoBot ON for several days, its systems will eventually drain the battery and may damage it. See Chapter 6, “Maintenance and Repair,” for details.
CHAPTER 5 AmigoBot Software

AmigoBot comes with state-of-the-art intelligent mobile-robotics software that runs on your Linux®- or Windows®-based PC.

ActivMedia Robotics Basic Suite

The software that comes with AmigoBot currently has seven main components:

- **NAVIGATOR** is the crown jewel—a sophisticated graphical-user control program with which you access your ActivMedia robot's many intelligent capabilities, from guarded teleoperation (including live audio and video with the e-Presence system), to self-guided navigation along a planned path to a goal that you select onscreen with a click of the mouse.

- **WORLDLINK** is Navigator on the network. It has all the features of Navigator, and in addition as control host of an ActivMedia robot, WorldLink lets you remotely connect, then operate the robot from virtually anywhere around the world. You can see and hear from afar what your robot sees and hears through its ePresence camera and microphone. WorldLink even lets you chat and exchange audio and video with others who may be connected simultaneously.

- **WORLDPASS** is a free version of Navigator that lets you share your WorldLink robot with your colleagues, friends, and family.

You get either Navigator or WorldLink; not both.
WorldPass provides all the networking and remote-control functionality of Navigator, including network video and audio, but only connects with a robot through a WorldLink host, not to one directly.

- **Mapper** provides the tools you need to construct a map of your robot’s real operating space (“world”). Navigator and WorldLink need and use a world map to self-guide your ActivMedia robot in complicated spaces.

- **Trainer** is a programming editor and robot interface in which you create and perfect your own intelligent mobile robot-control programs with the simple, yet very powerful Colbert programming language.

- **Simulator** is a virtual replacement for your robot that lets you test Colbert programs, new worlds, and so on, when the real robot isn’t practical or available.

![Diagram of a robot navigating a space](image)

Figure 26. With a click of the mouse, ActivMedia Basic Suite Software will independently guide your robot through complicated spaces to a goal, such as to retrieve a snack from the food goal.
AMIGOSOUNDS currently is for AmigoBot only. With AmigoSounds, you assemble recorded sounds stored on your PC’s disk into a playlist of sounds for your AmigoBot. With AmigoSounds, you give AmigoBot different audio-based personalities.

The ActivMedia (.exe) program itself is a convenient way to select and run one of the programs in the ActivMedia Robotics Basic Suite. All of the AmigoBot robotics programs (and more) are found in the in the ActivMedia directory of your ActivMedia software distribution. Microsoft Windows9x® users may or may not see the various three-letter suffixes in the filenames depending on how you have set your Folder Options.

Other AmigoBot Software

ActivMedia robotics has produced and also licenses several robotics-application development environments for our robots. The AmigoBot Technical Manual, available for separate purchase, comes with a set of utilities that let you examine and change the operating characteristics of your AmigoBot, as well as update the robot’s onboard operating software, AmigOS.

Saphira, including the Colbert language, is a full-featured robotics control environment designed by SRI’s Artificial Intelligence Center. Saphira forms the robotics control foundation for much of the ActivMedia Robotics Basic Suite. The complete Saphira Robotics Development Environment, transparent to C/C++ and including GUI interface and libraries, is available to ActivMedia Robotics customers for separate purchase.

Ayllu is a product of ActivMedia Robotics. Developed by Barry Werger, it too is a robotics application-development environment, but differs from Saphira in two ways. First, it implements a subsumption-like robotics control scheme made popular by research from Rod Brooks of MIT. Ayllu also excels for multi-robot coordination and multi-agent tasks.

ActivMedia Robotics Interface for Applications (ARIA) might be called “Saphira Lite.” It distills the many low-level client interface and management features of Saphira into an easy-to-use, easy to program C++ language environment.
All software is available for licensing and Internet download. See http://www.amigobot.com or write to sales@activmedia.com for details.
Chapter 6  MAINTENANCE & REPAIR

Your AmigoBot is built to last a lifetime and requires little maintenance.

**Drive Lubrication**

The drive motors and gearbox are sealed and self-lubricating, so you need not fuss with grease or oil. An occasional drop or two of oil on the axle bushings between the wheels and the metal chassis won’t hurt.

Keep the axles clear of carpet or other strings that may wrap around and bind up AmigoBot’s drive. Occasionally wipe the tires with a damp cloth, and especially remove any dirt or debris that may accumulate on the tires—these will degrade the robot’s performance.

**AmigoBot Batteries**

The lead-acid battery in your AmigoBot lasts longest when kept fully charged, just like the one in your car. In fact, severe discharge is harmful to the battery. So be careful not to operate the robot if the battery voltage falls below 11 volts or so. In other words, heed your robot’s incessant whining when its batteries are weak.

Severe discharge is harmful to the battery.
Store the battery fully charged.

It’s also a good idea to store the robot plugged into the charger when it’s not going to be used for a day or two. Charge the battery fully, then store the robot in a cool, dry place if you intend not to use the robot for any longer period of time (a pity!), such as for a week or more. Of course, if you have an AmigoDock, not to worry—the robot will take care of charging itself, as described in the AmigoDock manual.

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7 The robot is programmed to stop working at 10 volts.
Manually Charging the Battery

If you have the standard or the high-speed charger accessory, insert it into a common 120-volt (European 240) AC power socket. Then insert the charger's cable into the Charge socket that is next to AmigoBot's Power switch on the underside of the robot. With the high-speed charger accessory, its LEDs indicate charge status, as marked on its case.

If the robot's power supply is depleted, fully recharging takes fewer than 12 hours. If the robot is only 1 volt below fully charge, recharging will take only 3 hours. The high-capacity-charger accessory completely recharges AmigoBot in just an hour or two.

With the high-speed charger, you do not have to turn off your robot. In fact, we encourage you to plug in the charger while you are programming the robot. Just make sure to disable the robot's motors so it doesn't drive off while tethered. For better protection, put it the robot on blocks if you place it on a table for charging. And realize that the charging time will roughly double if you continue to operate your robot while charging.

Factory Repairs

If after reading this guide, you're still having problems with your AmigoBot and you're sure that it needs repair, contact us:

All repair problems should be addressed to:

amigobot-support@activmedia.com
(603) 924-2184 fax

In the body of your e-mail or fax message, provide your robot's serial number found on its underside and describe the problem you are having in as much detail as possible. Also include your name, e-mail and mail addresses, as well as phone and fax numbers.

Some users may require a special power-socket adapter that accompanies the charger.
We will try to resolve the problem through communication. If the robot must be returned to the factory for repair, obtain a repair authorization code and shipping details from us first.

### ATTENTION!

Obtain a Repair or Replacement Authorization Code before returning any defective items.

Though ActivMedia Robotics is not responsible for shipping damage or loss, we will assist you in tracking your robot through the shipper.
APPENDIX
Specifications

Physical Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>33 cm</td>
</tr>
<tr>
<td>Width</td>
<td>28 cm</td>
</tr>
<tr>
<td>Height (body)</td>
<td>13 cm</td>
</tr>
<tr>
<td>Body clearance</td>
<td>3 cm</td>
</tr>
<tr>
<td>Weight</td>
<td>3.6 Kg</td>
</tr>
<tr>
<td>Payload</td>
<td>1 Kg</td>
</tr>
</tbody>
</table>

Construction

<table>
<thead>
<tr>
<th>Component</th>
<th>Material/Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body</td>
<td>Molded polycarbonate</td>
</tr>
<tr>
<td>Chassis</td>
<td>1.6mm CNC fabricated aluminum</td>
</tr>
<tr>
<td>Assembly</td>
<td>Allen hex screws (metric)</td>
</tr>
</tbody>
</table>

Power

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery</td>
<td>12V lead-acid</td>
</tr>
<tr>
<td>Charge</td>
<td>24.2 watt-hr</td>
</tr>
<tr>
<td>Run time</td>
<td>3+ hours</td>
</tr>
<tr>
<td>Recharge time (trickle)</td>
<td>12 hrs</td>
</tr>
<tr>
<td>Recharge time (high-capacity)</td>
<td>4 hrs</td>
</tr>
</tbody>
</table>

Mobility

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive wheels</td>
<td>2 solid rubber, with caster balance</td>
</tr>
<tr>
<td>Wheel diameter</td>
<td>10 cm</td>
</tr>
<tr>
<td>Wheel width</td>
<td>3 cm</td>
</tr>
<tr>
<td>Steering</td>
<td>Differential</td>
</tr>
<tr>
<td>Gear ratio</td>
<td>19.5:1</td>
</tr>
<tr>
<td>Swing radius</td>
<td>33 cm</td>
</tr>
<tr>
<td>Turn radius</td>
<td>0 cm</td>
</tr>
<tr>
<td>Translate speed max</td>
<td>750 mm/sec</td>
</tr>
<tr>
<td>Rotational speed max</td>
<td>300 degrees/sec</td>
</tr>
</tbody>
</table>
Traversable step max: 1.5 cm
Traversable terrain: All wheelchair accessible

Sensors
- Sonar: 8 total, 1 each side, 4 forward, 2 rear
- Position encoders: 2 (one each motor), 9,550 ticks per wheel revolution, 30 ticks per mm

Electronics
- Processor: 20 MHz Hitachi H8
- Position inputs: 4
- Sonar inputs: 1 x 8 (multiplexed)
- Digital I/O: 8-bit logic ports
- A/D: 4 @ 0-5 VDC
- Digital timer inputs: 6 @ 1µsec resolution
- Comm port: 3 RS-232 serial
- FLASH: 64 KB uP, 1MB external
- RAM: 16 KB uP

Controls and Ports
- Main Power: Robot/accessories power ON/OFF
- Charge: System power/battery recharge
- RESET: Warm reboot/download
- MOTORS/TEST: Motors/download/self-tests
- Radio: Power and serial
- Speaker: 8-ohm
- Serial comm ports: 3 x RS232 (Control/System/AUX)
WARRANTY & LIABILITIES

Your AmigoBot is fully warranted against defective parts or assembly for 90 days after it is shipped to you from the factory. Accessories are warranted for 90 days. This warranty explicitly does not include damage from shipping or from abuse or inappropriate operation.

The developers, marketers, and manufacturers of AmigoBot shall bear no liabilities for operation and use of the robot or any accompanying software except that covered by the warranty and period. The developers, marketers, or manufacturers shall not be held responsible for any injury to persons or property involving AmigoBot mobile robots in any way. They shall bear no responsibilities or liabilities for any operation or application of the robot, or for support of any of those activities. Under no circumstances will the developers, marketers, or manufacturers of AmigoBot take responsibility for support of any special or custom modification to AmigoBot or its software.
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