HEXOR USER MANUAL

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1. **Project Startup (3/2005 PBenoit)**

1.1 Setting up Hexor project

This section covers the situation where the Hexor software is not installed on your local PC. Or perhaps you want to take Hexor to an event and need to install the software on a laptop computer. Instructions for installation of the many software components are given here.

1.1.1 Where to find Hexor materials

The driver software referred to in the following instructions can be found in either of the following two locations. The 2004 Hexor team created a CD that contains all of their materials. All of the drivers can be found on this disk. If there is not a copy of this CD in the cupboard where Hexor is kept, Dr Perkowski should have a copy of it. The second location where this software may be found is at the Hexor website created by the 2005 team:

http://www.ece.pdx.edu/~hexor

Hexor itself is stored in a locked cupboard in the Robotics Lab. All of the necessary hardware will be found in the cupboard. See Dr Perkowski to acquire the necessary key.

1.1.2 Installing RF Transceiver driver software

The device used to communicate with Hexor from the PC is a USB device that emulates a “com” port. In the Hexor cupboard you should find a small rectangular box with the word “Baza” on it. This is the RF transceiver. Here are the steps to get this device working:

1. Plug the device into the PCs USB port.
2. Use the wizard that appears and navigate to the driver location. (On the CD this driver is located in a folder labeled USB2.) Double click on the driver icon and the installation should begin.
3. Now you must change the driver settings so that the transceiver emulates the com4 port. Navigate: Start >> Settings >> Control Panel >> System >> Hardware tab >> Device Manager. Expand the “Ports” option and double click on “USB Hexor_Baza”. Go to Port Settings >> Advanced, and set to com4.
4. The simplest way to test for successful installation is to open the Base Station application and click on one of the direction arrows. One of the green LEDs on the transceiver should briefly light each time you click on an arrow.

1.1.3 Installing Video VA11A driver software

Hexor has an X10 wireless video camera installed on its tail. The receiver for the camera is a USB device that connects to the PC. PROCEED CAREFULLY when installing the driver software for this device. DO NOT PLUG IN THE USB DEVICE AT ANY TIME BEFORE THE CORRECT DRIVER HAS BEEN INSTALLED. The driver can be found in the X10 folder on the CD and is called “x10drivers”. Simply double click on the icon to install the software.

1.1.4 Installing XRAY Vision software
The XRAY Vision software allows you to use your PC as a monitor for the X10 camera. This application software can be found on the CD or at the website, or the most recent version may be found at: 
http://www.x10.com/catalog/cat_software.htm. This software installs just like any other Windows application.

1.1.5 Installing PERL software
Go to http://www.activestate.com and navigate to the Perl language information. First fill out the required registration form and then download the latest stable release of Perl 5 for Windows. Run the installation program. Once installed you should use the Package Manager that was installed under the Active State Program Group on the Windows Start Menu. You must download the Eliza Package in order for the Perl GUI to work properly. It should also be noted that there are some image files that are referenced by the Perl software written for Hexor. These should be copied to the source directory for the Hexor Perl GUI.

1.2 Operating Hexor
This section gives information on operating Hexor once the PC has been set up.

1.2.1 The Hexor PC
The 2005 team scrounged a spare PC and donated a monitor so that Hexor could have a dedicated operational platform. This PC is located in the Robotics Lab and has the name “Hexor” on it. The password for the Hexor account is “Hex”. This is also the administrative password for the PC. All of the necessary software should be installed on this PC.

1.2.2 Communicating with Hexor
Plug in the USB device with the word “BAZA” on it. This is the RF transceiver for communicating commands to Hexor. Use the Base Station software or the C++ program called Main to send commands. When successfully communicating with Hexor the send and receive LEDs on the transceiver will flash.

1.2.3 Camera operation
Plug in the USB video receiver device. Power on Hexor. Open the XRAY Vision application and you should be able to monitor the camera.
2. Software Overview (3/2005 JBaranski)

2.1 Base Station Application
The Hexor Base Station is the software that was provided for Hexor by the manufacturer. All interface text and labels with the Base Station are in Polish. This is not the recommend interface to use with Hexor for a number of reasons. If you choose to use this software then make sure that COM Port 4 is selected as well as the baud rate of 115200. Use large arrows in the center of the console to send movement commands to Hexor.

2.2 Perl GUI
This is the preferred method to communicate with Hexor. The Perl GUI was written by Natalie Metzger and provides a nice interface to C++ code that actually processes all data received from Hexor’s sensors as well as sends Hexor movement commands. The Perl GUI should be updated as the C++ code is modified and improved. The large arrows send movement commands to Hexor. The image feed functionality, and camera command interface is not implemented as of 3/2005.

2.3 Intelligent Control Software (C++)
The control software for Hexor is written in C++. It is recommended that any new Hexor team members begin sending software commands to Hexor from the C++ interface. You can use the Visual Studio 6.0 debugger to step through the code and learn how commands are sent to Hexor at the system level and how data is received from Hexor. This interface is superior to the Base Station program because the operator has the ability to step through the source code and debug any communications problems that Hexor may be experiencing. This is also the where more complex intelligent processing will be added. It should be noted that Hexor was designed such that multiple robots can be controlled from a single PC control station. The ID Number that is associated with Portland State’s Hexor Robot is hard coded into the data packets sent by the C++ code. There is a universal override code of 0xFF which broadcasts a command that all robots should obey.

2.3 Hexor On-Board AVR Software (Basic)
The Hexor AVR Software is written in some flavor of Basic. The AVR is used to acquire sensor data, control motors, and communicate with the PC control station. In general the AVR code should only be modified to enhance these capabilities. Due to the resource intensive nature of data processing and decision-making, all processing should occur on the remote PC. The AVR code is simply a means to accomplish this.

3. Hardware Overview (3/2005 PBenoit)

3.1 PC
The Hexor PC in the Robotics lab is an older machine but is completely adequate for the task. It has a 4GB HD and 256MB of RAM. There are 2 USB ports and an Ethernet connection in the back. There is no CD-ROM drive.

3.2 Hexor robot
Hexor is a six-legged walking robot. It currently has 9 servos; 6 for the legs, 2 for the camera (pan & tilt), and 1 for the sonar sensor.
3.2.1 Electronics

All of the electronics are contained on the main board displayed in figure 1. The microcontroller is an Atmel ATMEGA128. Besides this graphic and the MCU datasheet, there is no documentation for this board.

![Figure 1. Hexor’s electronics](image)

3.2.2 Power

Hexor is powered by a 6V SLA (sealed lead acid) battery. The video transmitter is also powered by the battery. The battery must be at full charge for Hexor to perform well. It requires 24 hours on the charger to fully charge after a long period of no use. There is a specific charger for this battery. It is Radio Shack brand and is designed for SLA batteries. We recommend taking the battery out of Hexor and leaving it on the charger between work sessions. There is also a socket on Hexor for recharging, but since there is no power in Hexor’s cabinet we did not use it.

3.2.3 Sensors

Hexor possesses the following sensors:

4 forward IR
4 rear IR
1 forward SRF04 Sonar
2 whisker bump sensors

There is a data sheet for the SRF04 Sonar on the web site. The sonar moves horizontally on a servo to increase its range. Figure 2 shows a rough map of its range.

There is no data sheet for the IR sensor. Their ranges were mapped, however, and are shown in figure 3. The IR sensors are digital and give a very
uneven response outside the edges of their range. These sensors also may be
of limited use due to the fact that some are triggered by the ground in front of
them.

The whiskers are Hexor’s last line of defense in terms of obstacle
avoidance. If the whiskers are depressed, Hexor should stop. Hexor’s whiskers
are not as wide as its legs, so the outer legs could still run into obstacles.

![Figure 2. Sonar sensor map](image1)

![Figure 3. IR sensor](image2)

**3.3 Claws**

The 2004 team designed claws to be added to Hexor. They are made of
aluminum and were constructed courtesy of the School of Mechanical Engineering.
An illustration of the claw appears below.

![Claw Illustration](image3)

The 2005 team believes these claws are scaled 2 to 3 times too large to be of
practical use on Hexor. Though not yet tested, we think their size will severely
handicap Hexor’s ability to walk. Attachment of these to Hexor has not yet been
attempted.

**3.4 Flashing Hexor’s AVR**

You will need to know how to reprogram Hexor’s on-board AVR chip. Here are
the steps:

1. Install the Bascom AVR application if not already installed.
2. Launch Bascom-AVR and open the .bas file you want to flash.
3. Compile the program to produce a .hex file.
4. Connect the ribbon cable from the BAZA transceiver box to the Hexor socket labeled 'M128 Programming' in figure 1.
5. In the Bascom app select: Options >> Programmer. Make the settings as in figure 4. The program path in figure 4 is to the programming application which is called 'AVRprog'.

![Figure 4](image1)

![Figure 5](image2)

6. Select: Program >> Send to chip. The dialog in figure 5 appears.
7. Browse for your .hex file. Set the Device as shown.
8. Click 'Program' in the Flash box.

There is a complete tutorial for this process entitled 'AVR flash programming tutorial.doc'. You can find this on the 2004 CD.
4. Project Documentation (Jbaranski)

The URL for the Hexor Project Website is http://www.ece.pdx.edu/~hexor. All information pertaining to this project can be found on this site. Dr. Perkowski or Martin should know the password to the Hexor account that resides on the ECE UNIX system. The device drivers are not made publicly available on this site in order to avoid any licensing violations that may be incurred in doing so. Said software is in a compressed file in Hexor’s home directory on the UNIX system.

All correspondence with Maciej is published on the web. He is generally exceptionally helpful and has been quick to respond to all queries made by both the 2004 and 2005 project teams. Please review this information before contacting him to ensure that your question has not already been answered. Source code for the AVR chip, the PERL GUI, and C++ control program are available on the web as well. It should also be noted that there is a CD that was created by the Hexor 2004 team. This CD contains all of the information that is available on this website.
5. Troubleshooting (PBenoit)

1. Hexor does not do anything when I turn it on. (2/2005 PB)
   Hexor's legs should twitch when you power it on. If they don't the battery is probably not fully charged. Hexor uses a 6V rechargeable Sealed Lead Acid (SLA) battery that can be deep-cycled. When the battery is fully charged 4 LEDs on the main board shine brightly. If Hexor hasn't been operated recently the battery may need to be charged for up to 24 hours. There is a special charger for the SLA battery. It is made by Radio Shack and has red and black clamps at the end. I recommend taking the battery out of Hexor and leaving it on the charger when not in use.

2. Hexor doesn't respond to remote computer commands. (2/2005 PB)
   There are several possible reasons for this. First make sure you are successfully transmitting from the Hexor-BAZA transceiver. The easiest way to check this is by opening the Base Station software (the one with Polish commands) and clicking on the direction arrows. One of the green LEDs on the transceiver should light each time you click on an arrow. If it doesn't, the driver may have been installed incorrectly. Or you may not be correctly set up to emulate the "com4" serial port.

   The second reason may be a comm failure from Hexor. The 2005 team was plagued with this problem. The small comm board, with the coax antennae attached, apparently failed before we started our leg of the project. We tested the AVR MCU itself by directly coding commands to it. Once we saw that it functioned ok on its own, we had to assume failure of the comm board.

3. I can't get a video signal from the X10 camera. (2/2005 PB)
   The video signal is monitored from a program called Xray Vision, not from the base station software. The drivers for the camera must be correctly installed. The camera transmitter is lashed on to the under-belly of Hexor. It runs off the SLA battery. When the battery was fully charged, we got a good signal from the camera. Make sure the drivers are installed correctly.