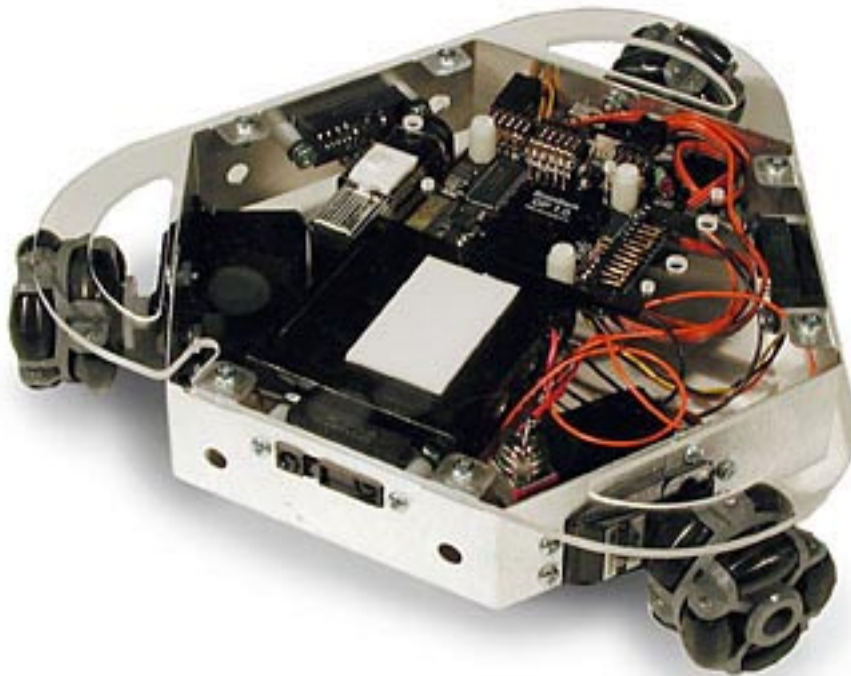


## Deluxe BrainStem™ PPRK



Our goal at Acroname is to provide information and parts for Easier Robotics. We test and investigate everything we offer to make sure you have the knowledge you need to get your projects working quickly with the best possible results.

Please let us know if you find information missing or incomplete. We want to constantly improve the quality of what we offer.

Thank you for using Acroname Inc.

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# The Deluxe BrainStem PPRK

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## Kit Contents

This Deluxe BrainStem PPRK contains the following parts and parts bags. Each separate parts bag will also have a list of the parts included.

1	R61-BTCHR-STD	NiMH & NICAD Charger
4	R59-NIMH-AA	AA NiMH Battery
3	K117-PPRK-DRIVE	4cm Poly Roller Wheel, bb-cont servo
1	K105-PPRK-PLATE	Acrylic Chassis Plate
1	S1-GP-BRD	BrainStem GP1 Controller
1	B001-PPRK-1	PPRK Bag 1
1	B012-PPRK-2-BS	PPRK Bag 2 for BS
1	B014-PPRK-e3-BS	PPRK Easy Bag 3 for BS
1	K205-9V-BATTERY	9v Battery

This kit requires a small phillips and small standard screwdriver for the assembly. We have already done the soldering, gluing and servo modification for you.

## Introduction

The Deluxe BrainStem version of the PPRK allows you to use your robot kit with a Palm, Visor or WinCE handheld. Alternatively, you can skip the handheld altogether and download programs from your Windows or Mac PC via the serial port. This version also includes Acroname's BrainStem GP 1.0 controller, additional battery supply for servo power and 4cm polyurethane omni-wheels for better traction. This version of the kit requires only a screwdriver to put it together.

Please look over the instructions and the parts bags to acquaint yourself with the kit before you begin assembly. This is also a good time to download the BrainStem software so that you are ready to use it when it is time to test the kit. You will need to download PPRK SDK for your platform which contains the following files:

- BrainStem GP 1.0 Application
- BrainStem Console Application
- PPRK Config Application
- PPRK TEA Programs

After the assembly instructions, this book provides you with a quick overview of the BrainStem controller, our TEA programming language and loading TEA programs via the console.

We also have forums on our website for both the PPRK and the BrainStem as well as other topics. The forums are a great place to ask questions or submit ideas to the PPRK or BrainStem communities.

You can access both the forums and download section from our main web page at:

<http://www.acroname.com>

## Beginning Assembly: Installing the GP2D12 Rangers

To begin, attach the GP2D12 Rangers to the stamped aluminum pieces. There are three such assemblies and all the pieces for this step can be found in Bag One of your kit.

### Step 1

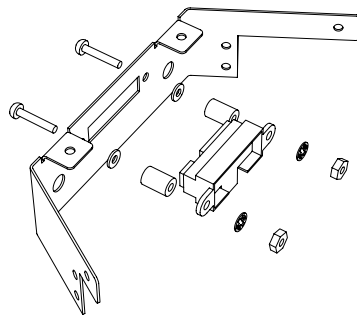
Start by inserting two screws through the stamped aluminum piece. After you have the two screws in place, place the metal frame face down so it lies on the heads of the screws. (This will make it easier to add the other parts.) Next, add the flat nylon washer, then the tubular nylon spacer, and one end of the GP2D12 Ranger. The face of the GP2D12 Ranger will fit into the rectangular opening in the frame. The bottom of the ranger, with the connector housing, faces the bottom of the frame. The top of the frame has the bent tabs. Finally, add the lock washer and the hex nut but don't tighten this side yet, leave it loose.

### Step 2

Now repeat these steps with the other side of the ranger. The ranger should seat in the square hole in the aluminum piece.

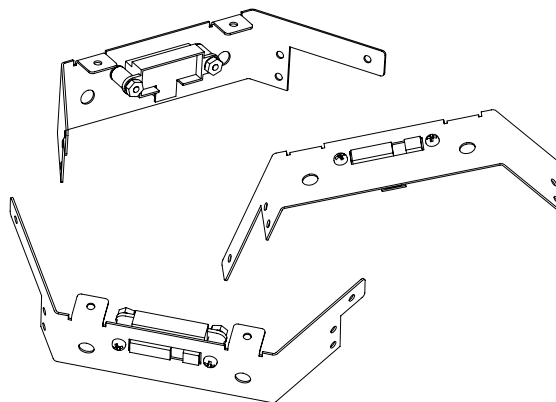
### Step 3

Tighten up both sides moderately, but take care not to tighten the screws too tight. The GP2D12 Ranger is somewhat fragile and needs only to be held in place.



A view of how the pieces should go together.

These three subassemblies should use up all the parts from Bag One. It is possible that Bag One was ripped by one of the stamped aluminum pieces in transit. If so, you may find some of the pieces for this step in the box if they are not in the bag.



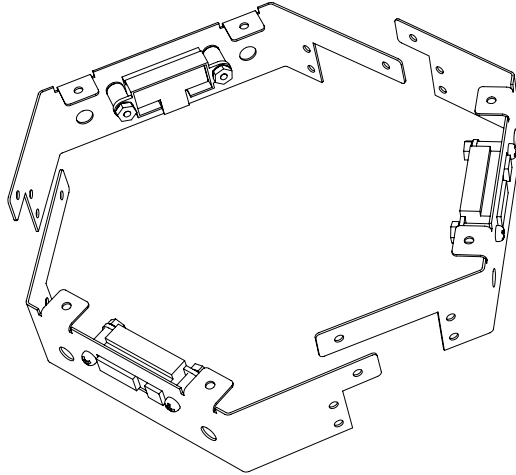
The three completed subassemblies.

## Assembling the frame

In this part, you will assemble the frame for the robot. The parts you will need for this step are the three subassemblies from the previous step and hardware from Bag Two of your kit. You will also need a small Phillips head screwdriver.

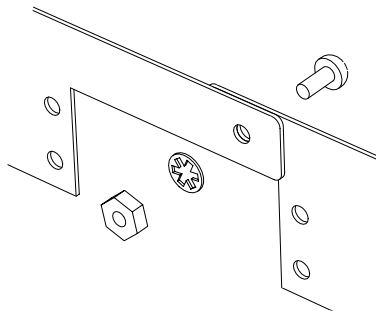
### Step 1

Position the three subassemblies from step one in a hexagonal shape like this:



### Step 2

Bolt these three pieces together. Start with the screw through each aluminum piece, then the washer, and finish with the hex nut. Don't tighten these yet, just put them together. You will tighten them after the servos have been installed.



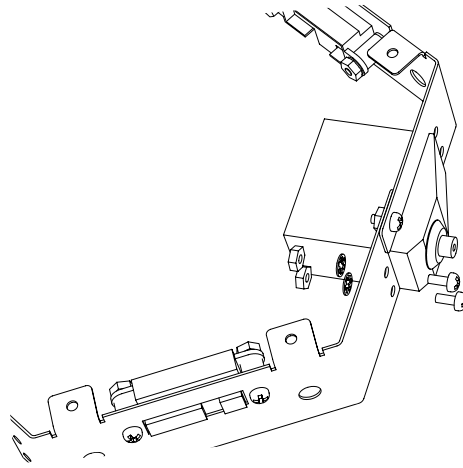
Detail of subassembly bolting.

## Installing the servos

In this part, you will add the servos to the robot. This part requires the frame from the previous section, hardware from Bag Two, and the servos from your kit box.

### Step 1

Bolt each of the three servos into place in the interior of the frame using a 1/4" screw, lock washer, and hex nut. Note that the servos are offset in the chassis. You want to end up with the servo horn nearest the center of the face in the hexagon where the servo mounts.



Detail of Servo Mounting.

### Step 2

Once you get all the servos loosely mounted, set the frame down on a flat surface and make sure it lies flat on all three aluminum panels as you tighten up the three frame screws and the servo mounting screws.

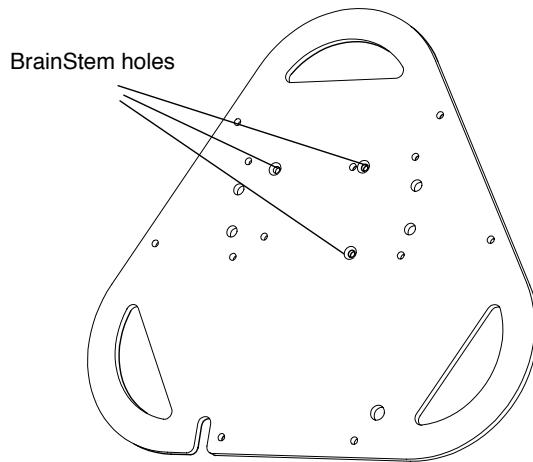
You can set the completed frame aside for the next step, as you will be working on the top deck.

## Attaching the controller to the deck

In this part, you will work with the BrainStem and top deck of the robot. This step uses the acrylic deck and fasteners from Bag Two of your kit. You will need a small standard screwdriver.

### Step 1

Peel off all the paper covering from the acrylic. We leave it on so the acrylic doesn't scratch in shipping.

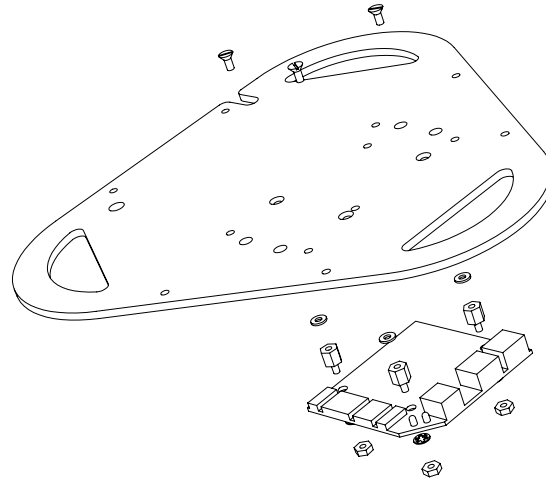


Detail of holes used for the BrainStem.

### Step 2

Find the 3/8" hexagonal nylon spacers. The small threaded ends go through the holes in the top of the BrainStem board. Secure the hex spacers with a lock washer followed by a hex nut. Locate the top of the acrylic deck. This side has three counter-sunk holes. These holes will line up with the spacers attached to the BrainStem when it is placed underneath the deck.

Fasten the spacers to the deck with the nylon slotted screws and be sure to include the thin nylon washers between the hex spacers and the lid. The nylon screws will be flush with the top of the deck when installed.



This nearly completes the chassis assembly. The only remaining thing to do is fasten the deck to the frame but it is easiest to do this after the wiring is complete. Next we will add all the wiring to the BrainStem from the rangers to the servo motors.

### Connecting the wires to the BrainStem

In this part, you will assemble and connect the sensor and servo wires to the BrainStem, then attach the deck to the frame.

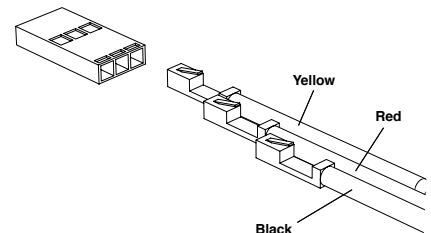
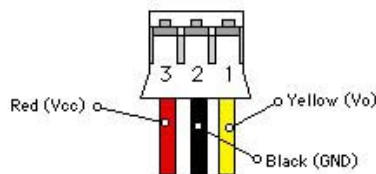
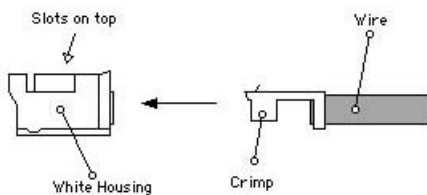
#### Step 1

In this step, you will assemble three sensor connector assemblies. First, locate the nine 8" wires with crimps on each end. There are three black, three yellow, and three red wires. Each wire has two types of crimps, one on each end. The small crimps fit in the white connector housings. The large (longer) crimps fit in black connector housings. Locate the three small white connector housings. Carefully note the following diagram and plug the smaller crimped ends of a red, black, and yellow wire to each white connector housing. The wires must be plugged in the correct order, as shown in the diagram. The crimp will click when it is completely seated in the connector housing.

After the white connector housing has been plugged, we recommend braiding the three attached wires. This is not necessary, but helps to organize the wiring.

Finally, locate the three small black connector housings. Carefully note the diagrams below and plug a red, black, and yellow wire to each black connector (after braiding, if you like). Again, feel for the click when the crimps are seated.

Before moving on, double check all the colors and connector housings to make sure the wires are completely plugged and in the correct order. This is essential for proper operation later.



Make sure your crimp looks like this.

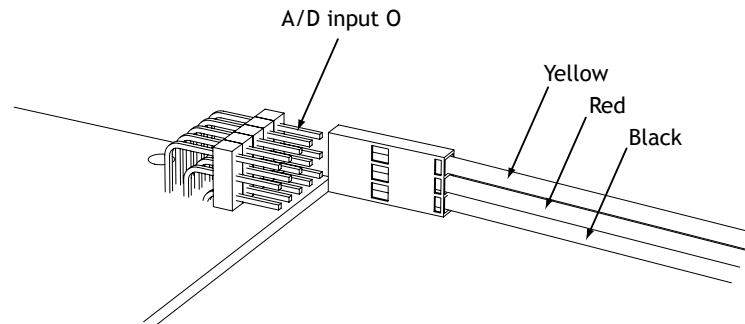
Plug the wires in with these colors.

Detail showing how to plug the crimp into the black Molex housing.

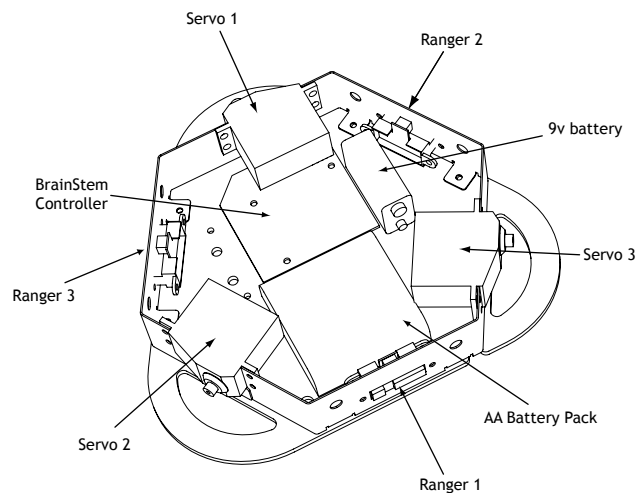
## Step 2

The next step connects the wire assemblies between the BrainStem and the rangers. Plugging the rangers into the appropriate BrainStem™ ports is necessary for the programs to operate properly when the robot is complete.

The five analog inputs on the BrainStem are located on the top left corner of the board. Plug one of the black housings from a sensor connector assembly to the three pins lined up over the analog port 0. The black wire should be closest to the printed circuit board, as shown in the following diagram.



orient your assembly to match the diagram below. Using the diagram of the ranger and servo placement as a guide, now plug the other end of this connector assembly into ranger 1. The white housing fits snugly and can only be oriented one way when plugging.



Bottom view of robot showing servo and ranger numbering.

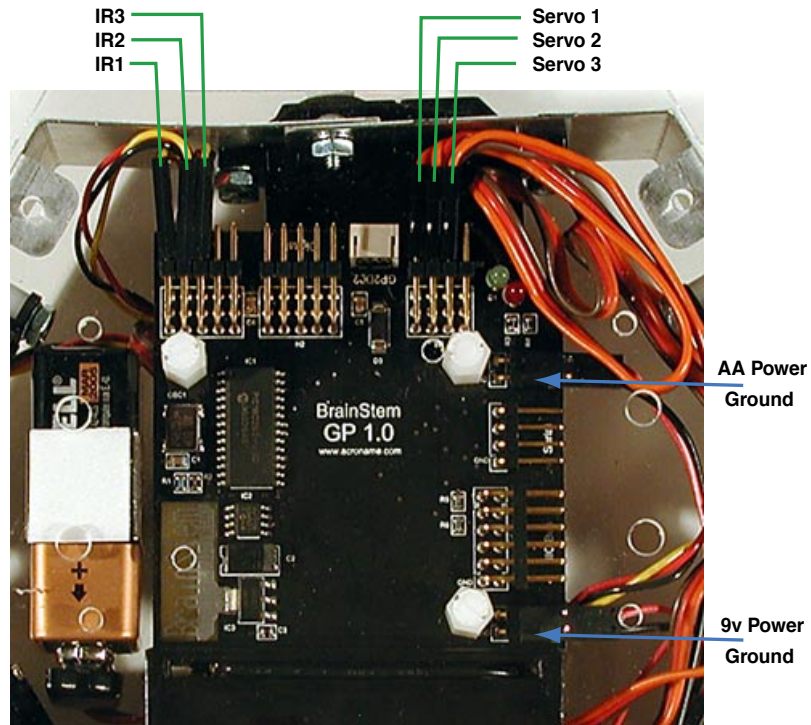
## Step 3

Repeat the above process plugging the black housing of another sensor connector assembly into analog port 1 (marked IR2 in the photo) of the BrainStem and the white end into ranger 2. Similarly, connect BrainStem™ analog port 2 (IR3) to ranger 3.

## Step 4

Follow with the servos. Take the connector dangling from servo 1 and plug it into the three pins at the servo port marked 0 on the BrainStem. The wire nearest the board should again be the darkest of the servo's wires (typically brown or black). Servo 2 will plug into servo port 1, and servo 3 will plug into servo port 2.

After these steps, the only remaining electrical connections are the power supply connections from the battery packs. The red and black wires from the 9 volt battery will plug into logic power in the bottom corner of the BrainStem. The black wire plugs into ground, the pin nearest the edge (bottom) of the board. The red and black wires from the AA battery pack

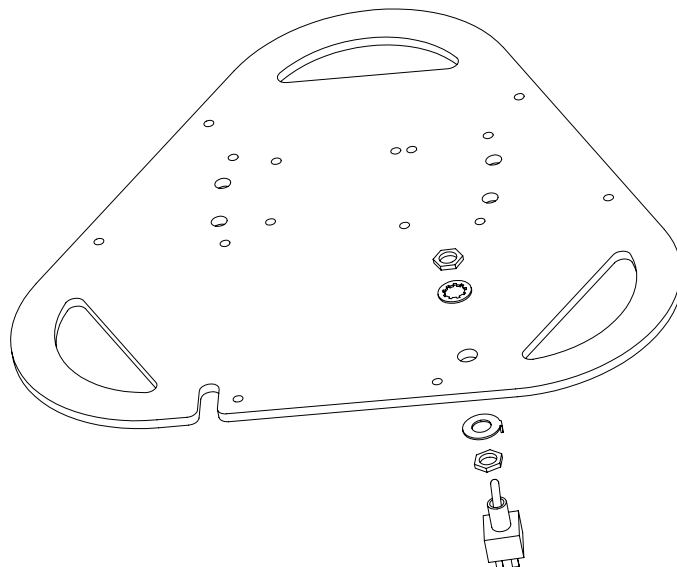


Detail of the BrainStem connections.

will plug into servo power, again black plugs into ground (nearest board bottom). There should be no remaining wires left hanging out of the robot at this point.

#### Step 5

The power switch is next. Remove the two hex nuts from the switch as well as the lock washer and the flat washer. Start with a hex nut spun down about 2/3 of the threads on the switch. Follow with the flat washer with the little tab facing toward the switch. Next, put the switch through the deck so the toggle is on top of the robot. Follow with the lock washer and finally the other hex nut. Tighten this up once it is all in place.



Switch hardware detail with switch inserted from deck bottom.

## Step 6

Finally, mount the batteries into the robot. There is a piece of double-sided adhesive tape on the back of the 9V battery and the AA battery pack. Before you remove the adhesive backing, try positioning the batteries in the robot.

Position the chassis over the deck and line up the deck mounting holes.

The AA battery pack should fit with a small amount of extra room in the triangle formed by servos 2 and 3 and the BrainStem board.

The 9 volt battery will fit in the space above servo 3 and next to ranger 2.

Make sure the wires route under the servos and that the power connectors can reach the BrainStem's power receptacles.

Now remove the adhesive backing and carefully stick the battery packs down against the bottom of the lid. Press firmly with your hands both on the top of the deck and against the battery packs.

## Step 7

Next, attach the deck to the frame you built in previous steps. The controller sits inside the frame and the bent-down tabs in the frame hold the deck in place. Take care to keep all the wires cleanly inside the frame and between the servos and the deck where possible.

Insert six 1/4" screws from the top of the deck through the acrylic and the tab. Follow with lock washers and nuts inside the frame to firmly attach the deck. Again, get all six fasteners started loosely before tightening each.

You only have a couple of final steps to complete your robot!

### **Final assembly steps**

In this part, you complete the robot. You will use the batteries and the roller wheels. The only tool required is a small Phillips screwdriver.

#### Step 1

If you will be attaching a Palm, Visor or WinCE handheld to your PPRK, route the serial connector cable from the slot in the bottom of the deck between the servos and the deck to the BrainStem controller and plug it in to the controller. The wire marked on the 4-conductor ribbon cable lines up with ground (nearest the bottom of the board).

#### Step 2

The wiring should now be complete and connected. Take care to tuck up the wires so none hang down while the robot is moving around. If you have braided the ranger wires, everything should fit nicely under the robot.

#### Step 3

Attach the wheels using the small black servo horn screws. Start by aligning the white servo horn with the splines on the servos and then follow with screws to hold the wheels in place. The screws are a tight fit so make sure you get the wheels on nice and snug.

You are done! Charge up the batteries and add them to the robot. If the servo wheels twitch when you add the batteries, the switch is in the "on" position so switch it off. If the batteries start to warm up, you likely have one of the power connections backward so disconnect both power connectors and fix the problem.

## BrainStem and TEA Overview

The BrainStem™ controller and TEA were designed and produced by Acroname. One of the many benefits of using the BrainStem is its cross-platform compatibility. This Deluxe version of the PPRK can be used not only with your Palm or Visor handheld, but also via the serial connection on your Windows or Mac PC. The BrainStem uses a 40 MHz RISC processor and has a RS-232 serial port and a 1Mbit IIC port, which allows easy interfacing to IIC devices such as compasses, displays and sonar. It has 10 program-storage locations and can run four concurrent TEA programs.

For the complete overview on the BrainStem, please check out the BrainStem section of our site at:

<http://www.acroname.com/brainstem/brainstem.html>

### The programming language called TEA

TEA stands for Tiny Embedded Application. TEA is a lightweight programming language intended for extremely small processing environments. It is a compiled language that runs on the TEA VM, a virtual machine that is easily ported to most computers. The language was designed to be consistent with the syntax of C and Java and allows simple, concurrent tasks to run on the BrainStem. TEA also runs on the PalmOS, Macintosh, Windows, WinCE and Linux.

For more info on TEA, check out our site at:

<http://www.acroname.com/brainstem/TEA.html>

### Using the BrainStem software

The BrainStem version of the PPRK utilizes four following software elements:

The config program shows you a drawing of the PPRK. Running this program will allow you to see that the IR rangers and servos are hooked up correctly and are working. For the IR rangers, you can see the "IR beam" detecting range as you move your hand to and from the rangers. For the servos, click or press on the drawing of each wheel and the corresponding wheel on your PPRK will turn.

The GP is a graphical interface that allows you to easily test your servos, IR rangers and the analog and digital ports on the BrainStem. Sometimes you may find that a servo is not fully centered and the wheel turns slightly when there is no program running. Using the GP, you can easily center the servo to stop the wheel from turning and then preserve this setting in the BrainStem's EEPROM.

The console is the portal into BrainStem modules as well as the graphical user interface for compiling TEA code. In addition, the console offers a shell for running TEA programs, as it includes a TEA VM within the application. This is what you will use to compile your .tea files. A compiled .tea file produces a .cup file. The .cup file is the program that will run on the BrainStem.

The PPRK TEA programs will be the files that get your PPRK going. We currently have the following files:

```
simple.tea
wallHug.tea
chase.tea
runAway.tea
```

### Downloading PPRK Software Essentials for PalmOS

This section describes downloading and preparing the software for PalmOS. You can skip this section if you are not using the PalmOS.

You should have already downloaded the BrainStem PPRK SDK for the PalmOS. This download is available in either MacOS or Windows formats. The files will all be in one folder.

You will need to hotsync all the files that end in .pdb or .prc. If you are unsure of how to do this, refer to the PalmOS documentation on how to install programs on your handheld. These files are the actual programs and shared libraries they require to run.

## Loading TEA files

Because the PalmOS doesn't have a file system, we use the memo pad to store TEA programs, library files, and the configuration file. These file are all the files that end in .tea or .config in the PPRK SDK directory.

The easiest way to load these into your memo pad on your handheld is first open the file on your desktop machine with either SimpleText (MacOS) or Notepad (Windows). Select all the text and then copy it. Now, with the Palm Desktop software, choose Create > Note. A Note window will open up. In the Title box, type in the file name (ex. simple.tea). Click in the main text box and paste in the contents of the file. Create a new note and do the same with the remaining .tea and .config files. Once you have copied and pasted the files into the Palm notes, perform a HotSync and these files will be loaded into the Palm's Memo Pad. Go to your Palm or Visor and open Memo Pad. You should see the .tea and .config files in the list.

Now you are ready to load the programs onto the BrainStem. You can skip to Getting Started with the Software.

## Downloading PPRK Software Essentials for Windows and MacOS

The software is compressed in an archive when you download it. Uncompress it (using Stuffit or WinZip) and place it on your machine's hard drive in a place of your choice. This will create several folders under a main folder called "brainstem" in the location you selected.

The aBinary folder contains the programs and the aUser folder contains the .tea files. All your .tea files will need to be stored in the aUser folder as you work. The aSystem and aObject folders contain system libraries and your compiled programs respectively and you need not worry about them.

Now you are ready to load the programs onto the BrainStem. You can skip to Getting Started with the Software

## Downloading PPRK Software Essentials for WinCE

The software is compressed in an archive when you download it. Uncompress it (WinZip) and place it on your machine's hard drive in a place of your choice. This will place several folders under a main folder called "brainstem" in the location you selected.

Next, using ActiveSync with your PDA connected, select "Explore" from the File menu and copy the entire brainstem folder into your PDA under:

My Pocket PC/Program Files/

This location is important as WinCE uses hard-coded paths for all files. In the brainstem directory, you will find several subfolders.

The aBinary folder contains the programs and the aUser folder contains the .tea files. All your .tea files will need to be stored in the aUser folder as you work. The aSystem and aObject folders contain system libraries and your compiled programs respectively and you need not worry about them.

Now you are ready to load the programs onto the BrainStem. You can skip forward beyond the preparation instructions for the other platforms.

## Getting Started with the Software

First, connect the serial interface cable between your host (PDA or desktop) machine and the BrainStem in your PPRK.

Turn on the power to the kit and wait for the green light on the BrainStem to stop blinking quickly. You should see a red light on the serial interface cable (except for HandSpring) that indicates the interface cable is getting power.

## The Config Program

The config program is simple but it helps ensure you have things connected correctly and that all is well. If you pass this test, the remaining programs should work well.

Open up the config program. Several things should happen. First, the yellow light on the interface cable should light up. This indicates that the serial port on the host computer is up and running (except for HandSpring). The green heartbeat light on the BrainStem™ board should begin blinking shortly showing an established connection. There should also be a drawing of the PPRK on your host computer with three triangles that represent the ranger feedback. Move your hands in front of the rangers and you should get corresponding feedback from the screen.

If you don't get the yellow light on the serial cable, you likely have some sort of serial conflict. Make sure you are plugged into the correct serial port on your host machine and also make sure there is no conflicting software such as something that uses the modem or hotsync software for a PDA.

Make sure the correct rangers give the feedback. If not, you may have the rangers plugged into the wrong BrainStem analog ports or plugged incorrectly.

Also, click the small radio buttons at the corners. These should turn on the servos in the appropriate positions. Again, if not, the servos are probably plugged into the wrong BrainStem servo ports or plugged incorrectly.

Now is the time to make adjustments if things aren't working; everything else relies on the connections this program demonstrates.

## The GP 1.0 Program

This program allows you to view and manipulate most of the I/O on the BrainStem. You will only need to use it if you are curious or if one of your servos needs tuning.

If, when you turn on the PPRK, the servos move slowly with no programs running on the host, no connection with the serial cable, and no programs running on the BrainStem™, you probably need to tune the servos.

Plug in the serial port as you did for the config program and start up the GP 1.0 program. Click on the servo tab and select the "Config" button for the servo that is moving. This will bring up a small dialog. Using the slider, adjust the offset parameter until the servo stops moving and click done in the dialog. Repeat this step if any of the other servos are moving and then click "Save Settings to EEPROM" when done to commit these settings.

## The Console Program

Your PPRK is now built, tuned, configured, and ready to run. Next, we will take one of the downloaded TEA programs and run it on your PPRK's BrainStem controller.

Make sure neither config nor GP 1.0 are running and start up the console program. You should get a window with a larger output area and a small command line area below it. You should also get a blinking heartbeat indicator on both the BrainStem and the console window. This indicates that data is cleanly flowing between the console application and the BrainStem module.

Type this command, then hit Enter (return):

```
steep "simple.tea"
```

The steep command tells the console to compile (steep) the .tea file, which then creates a .cup file in the aObject folder (or memo pad for PalmOS). The .cup file is the program file that will run on the BrainStem's TEA VM.

To store the program on the BrainStem module, use the load command. There are several file "slots" on each module and they are numbered starting at zero. For example, the GP 1.0 BrainStem module has 10 slots (numbered 0-9). To load the program, type:

```
load "simple.cup" 2 0
```

This will load slot 0 on module 2 with the file "simple.cup."

Now you are ready to run the program. To run the program, you use the launch command within the console. Type:

```
launch 2 0
```

This will start the program in slot 0 on module 2. Unplug the robot from the serial connection and set it down on the ground with about 3 feet of space around it. Wait until the robot stops moving and then wave your hand in front of each ranger slowly. One of the rangers will initiate a simple movement program that should move away from your hand, turn around, and come back.

Take a look at the simple.tea program and try to figure out how the behavior corresponds to the program's text.

You can compile, load and run the other three .tea files and see other behaviors. When you turn off the PPRK, the programs stop running but remain stored on the BrainStem™. You can store the other .cup files produced by the steep command in other file slots on the BrainStem module and run them when connected to the host via the interface cable.

This should get you started. There is still a lot to learn such getting programs to automatically run when you turn on the PPRK (boot sequence), modifying the programs, and writing your own. Remember, you always go through the same sequence to set up a program for running:

```
steep, load, launch
```

The BrainStem Reference is the next place to go for more information on these and other features in your BrainStem PPRK. It can be found (and downloaded) in the main BrainStem™ web area at:

<http://www.acroname.com/brainstem/brainstem.html>