



Wireless Networked Autonomous Mobile Robot with Dual High Resolution Pan-Tilt-Zoom Camera

Sputnik²

Quick Start Guide



WARNINGS

Do **NOT** power on the robot before reading and fully understanding the operation procedures explained in this manual.

Neither the robot, nor the program is bug free, accident could happen; you have to make sure that the robot always maintains a safe distance from people during operation.

The robot should be turn off (i.e. the power switch should be on OFF position) when not in used. Battery should be fully charged before storage. Battery pack should be recharged every two weeks while in storage.

Failure to follow these warnings could cause serious injury or death and/or damage to the robot.

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Introduction

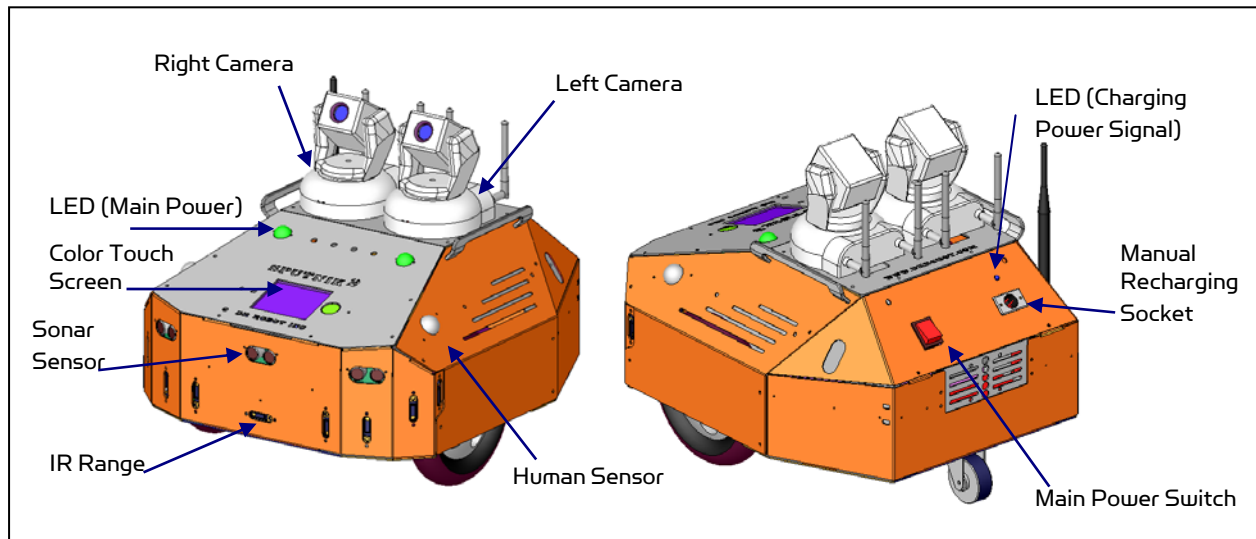
Sputnik² is designed and built on i90 robot base, featuring dual high resolution Pan-Tilt-Zoom cameras.

Key Features

- *Dual Max 704x480 pixels, max 30fps, High Resolution Camera with 2-way audio*
- *3.5 inch color display, playing video (.wmv), audio and displaying images*
- *Dimension 43cm (L) x 38cm(W) x 38cm (H)*
- *Fully wireless networked 802.11g*
- *OS independent application development tools*
- *Max speed of 75cm/sec*
- *Navigation sensors including 3 sonar and 9 IR range sensors*
- *Comprehensive circuit protection*
- *Max payload 10 kg (optional 40 kg) with robot weight of 8 kg*
- *Tele-operation and remote monitoring*
- *Extended operating time. 2 hours nominal operation time for each recharging.*
- *Upgrade options:*
 - 0 *Navigation and localization providing collision-free point-to-point autonomous navigation*
 - 0 *Vision-landmark base indoor localization (indoor GPS, position/orientation) sensor and the landmarks together provide precise position and direction information covering every inch of the floor.*
 - 0 *Auto-docking and recharging station*
 - 0 *Laser scanner*
 - 0 *Power and battery systems for 6 hours operation time are available.*

Sensors and External Components

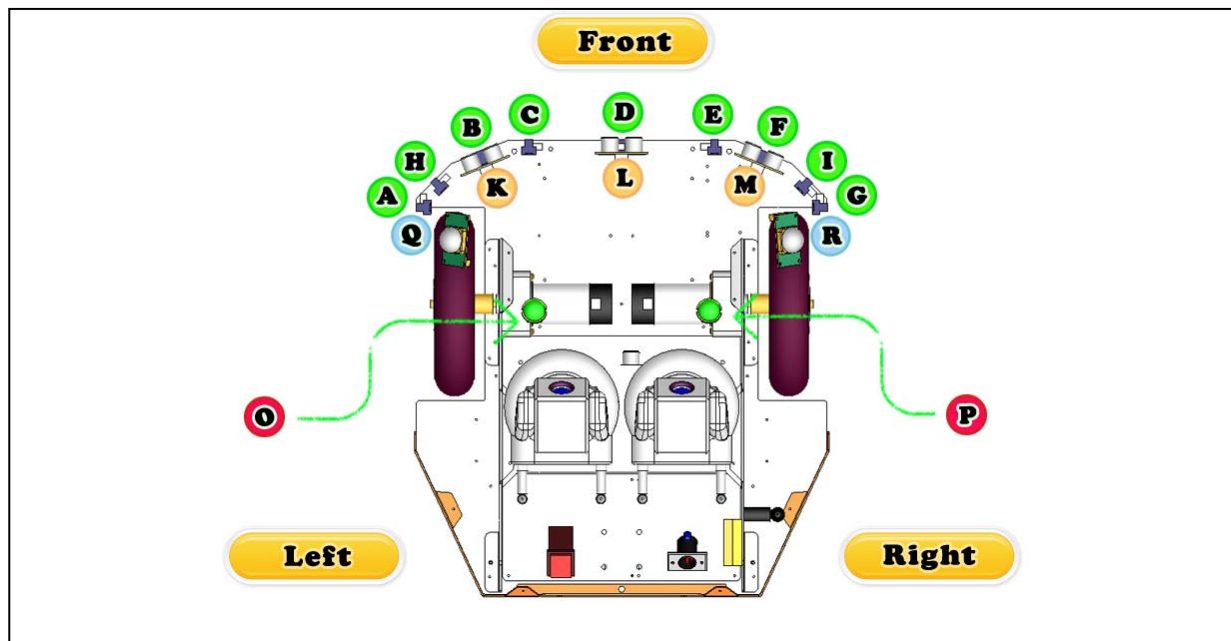
The figure below illustrates the key functional components you will identify on the outside of Sputnik² robot.



Sputnik² Overview

When the main power switch is on, the main power LED will be lit. When the robot detects input power from the recharging socket, the charging power signal LED will be lit.

The robot comes with 3 sonar and 9 IR range sensors. These range sensors are for environment detection and collision avoidance.



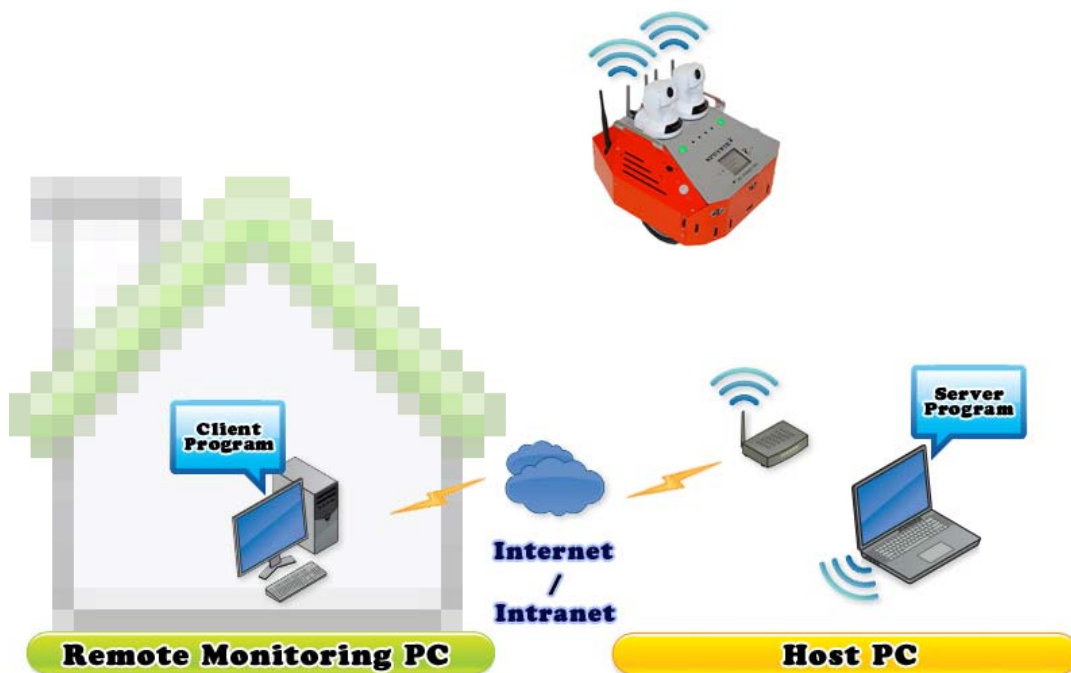
Sputnik² Sensor Module Location (Top View)

Sensor Module	Location
Ultrasonic #1	K - Left front
Ultrasonic #2	L - Middle front
Ultrasonic #3	M - Right front
Human Sensor #1	Q - Left front
Human Sensor #2	R - Right front
Infrared Range Sensor #1	A - Front left
Infrared Range Sensor #2	B - Front left
Infrared Range Sensor #3	C - Front middle
Infrared Range Sensor #4	D - Front middle
Infrared Range Sensor #5	E - Front middle
Infrared Range Sensor #6	F - Front right
Infrared Range Sensor #7	G - Front right
Infrared Range Sensor #8	H - Front left
Infrared Range Sensor #9	I - Front right
DC Motor #1 with quadrature encoder	O - Left , use channel 1
DC Motor #2 with quadrature encoder	P - Right, use channel 2

Operation Scenario

Diagram below shows the typical operation scenario. The Sputnik² is a wireless networked robot. It connects to the wireless AP or router via IEEE 802.11b/g network. The host PC (or called server PC) running the Sputnik-II Control program could connect to this network via either:

- Network cable – Connect the host PC to one of the LAN ports on the back of the router (DO NOT connect to the WAN port), or
- Wireless – To connect the host PC to the wireless router, configure the host PC's wireless settings using the default wireless configuration settings found in the Network Connection session of this manual.



Typical Operation Scenario

Note: The host PC (or called server PC) could also be mounted on the robot instead off the robot if your application requires so.

User could be able to control the robot, see, talk and listen through the robot via the Dr Robot Remote Control program from anywhere around the world with Internet connection.

User could also play video, audio and displaying images on the Sputnik² color display.

Software Installation

Server PC

On the Server Computer, you should install the "Sputnik-II Control" program from the installation CD.

After program installation, you will find the following programs under the "Start-All Programs" list, and they are installed under the "Program Files" folder.

Dr Robot Inc – Sputnik-II Control

Application data folder is set to "C:\DrRobotAppFile\"

You will find the following files in this folder:

<i>DrRobotServiceConfig.xml</i>	It contains the IP and port information about the service programs.
<i>RobotConfig.xml</i>	It contains the robot information, such as WiFi modules' IP, Cameras' IP, robot ID, camera user ID and password.
<i>gatewayConfig.xml</i>	Control Center program will save communication settings in this file. Gateway program will use it to setup communication with the robot.
<i>WiRobotGateway.exe</i>	This communication program will setup communication with robot.
<i>DrRobotPortConfig.xml</i>	
<i>RobotHardWareConfig.xml</i>	

Following sub-directories could be found under "C:\DrRobotAppFile"

.\PathFile\	contains path script files.
.\SensorConfig\	contains the IR Range sensor location information file "IrSensorConfig.xml" and the ultrasonic sensor location information file "UsSensorConfig.xml".
.\Record\	contains all camera video recording files.

PDA (Color Touch Screen) on the Robot

Programs have been pre-installed on the PDA (color touch screen) on Sputnik².

DrRobotPDASensorClient This program displays Sputnik² sensor information.

Remote Client Program on Client PC

On the client computer, you should install the "Sputnik-II Remote Control" program from the installation CD.

After program installation, you will find the following programs under the "Start -> All Programs" list, and they are installed under the "Program Files" folder.

Dr Robot Inc – Sputnik-II Remote Client Control

Application data folder is set to "C:\DrRobotAppFile\"

Following sub-directories could be found under "C:\DrRobotAppFile\"

DrRobotPortConfig.xml

DrRobotServiceConfig.xml

It contains the IP and port information about the service programs.

gatewayConfig.xml

Control Center program will save communication settings in this file. Gateway program will use it to setup communication with the robot.

RobotConfig.xml

It contains the robot information, such as WiFi modules' IP, Cameras' IP, robot ID, camera user ID and password.

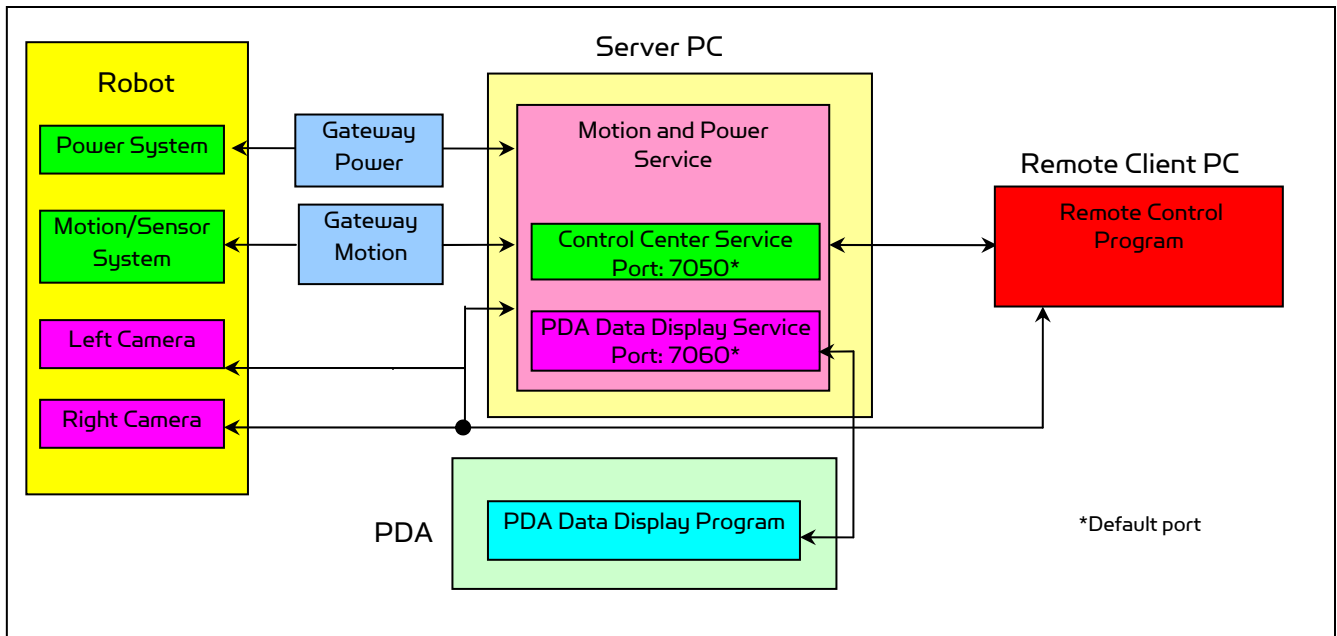
RobotHardWareConfig.xml

WiRobotGateway.exe

This communication program will setup communication with robot.

Following sub-directory could be found under "C:\DrRobotAppFile\"

.\Record\ contains all camera video recording files.



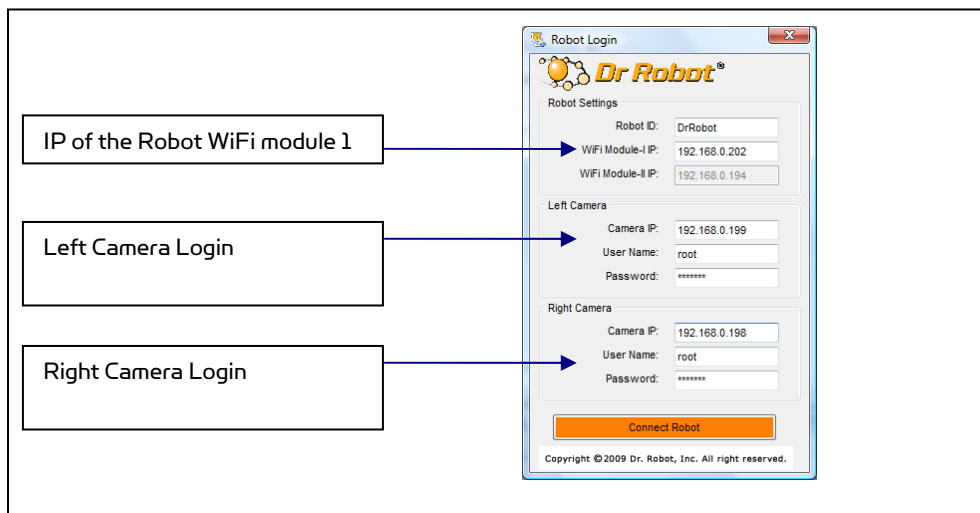
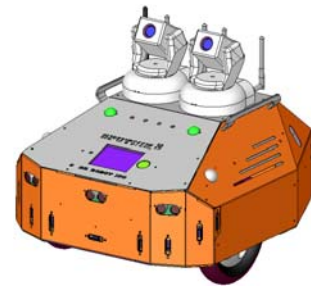
Robot Operations

Step 1: If you have not installed the programs, insert the installation CD to CDROM and run the "Setup.exe" program which under "Sputnik-II Control Installation" folder to a PC (called server PC), set your PC IP to 192.168.0.104, Gateway: 192.168.0.200 and Subnet Mask 255.255.255.0.

Step 2: Connect the server PC to the wireless router (one of the LAN ports) (the router has IP 192.168.0.200) included in the package.

Step 3: Turn on the robot main power switch on the back. NOTE: Always keep a safe distance from the robot.

Step 4: Run the "DrRobotSputnik-IIMotionPowerControl" from Start -> All Programs -> Dr Robot Inc -> Dr Robot Sputnik-II Control. The "DrRobotSputnik-IIMotionPowerControl" connect to robot via the DrRobotMotion gateway & DrRobotPower gateway programs. It requires robot information which can be found in "Networking Connection and Login Information" section. After entering or confirming the information, then click "Connect Robot".



IP of the Robot WiFi module 1

Left Camera Login

Right Camera Login

Robot Login

Dr Robot®

Robot Settings

Robot ID: DrRobot

WiFi Module-I IP: 192.168.0.202

WiFi Module-II IP: 192.168.0.194

Left Camera

Camera IP: 192.168.0.199

User Name: root

Password: *****

Right Camera

Camera IP: 192.168.0.198

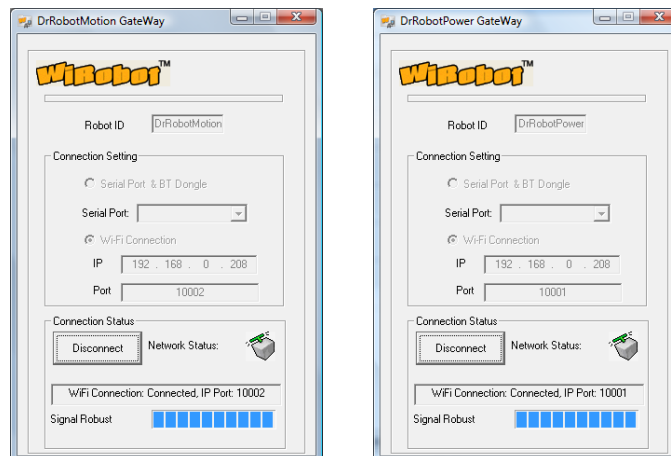
User Name: root

Password: *****

Connect Robot

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Two gateway programs will be called up to establish communication connections with the electronic system on the robot.



DrRobotMotion GateWay

Winobot™

Robot ID: DrRobotMotion

Connection Setting

Serial Port & BT Dongle

Serial Port: [Dropdown]

WiFi Connection

IP: 192.168.0.208

Port: 10002

Connection Status

Disconnect

Network Status: [Icon]

WiFi Connection: Connected, IP Port: 10002

Signal Robot: [Bar Chart]

DrRobotPower GateWay

Winobot™

Robot ID: DrRobotPower

Connection Setting

Serial Port & BT Dongle

Serial Port: [Dropdown]

WiFi Connection

IP: 192.168.0.208

Port: 10001

Connection Status

Disconnect

Network Status: [Icon]

WiFi Connection: Connected, IP Port: 10001

Signal Robot: [Bar Chart]

Cameras Login

Click to Increase Cameras Display Size

Robot sensor data

Robot position and direction estimated by dead reckoning

Dr Robot Sputnik-II Motion & Power Service

Main Sensor Info & Control
Path Control
Localization/GPS & SensorMap & Remote Control

Left Camera
IP: 192.168.0.199 Port: 8081
ID: root P/W: *****
Connecting
Disconnect

Right Camera
IP: 192.168.0.198 Port: 8082
ID: root P/W: *****
Connecting
Disconnect

2009/01/22 11:43:13

2009/01/22 11:43:13

Ultrasonic Sensor

#1	1.44m	#2	1.49m	#3	2.55m
#4	2.55m	#5	2.55m	#6	2.55m

IR Sensor

#1	0.81m	#2	0.81m	#3	0.81m	#4	0.53m	#5	0.81m
#6	0.81m	#7	0.81m	#8	0.10m	#9	0.81m	#10	0.81m

Motor Sensor

	Encoder Position	Encoder Speed	Current Feedback	HeatProtect	StuckState
Left Motor	0	0	0.00A	False	False
Right Motor	0	0	0.00A	False	False

Position Information
Dead Reckoning: (0.00, 0.00, 0.00) GPS: 0 ☐ Enable GPS Sensor

Power Status

	Voltage	Temperature	Status
Battery-I:	13.44	1730	Using
Battery-II:	13.33	1705	Using
DCIN:	0.00V		Using

Power Path Control
☐ PowerByBattery-I ☐ PowerByBattery-II ☐ PowerByDCIN

Charge Path Control
☐ Charge Battery-I ☐ Charge Battery-II
Charge Timer: Stop

Charge Current Control
☒ Full Current ☐ Half Current ☐ 1A Current ☐ Trickle Current

Power Switch Control

Channel-I	Channel-II	Channel-III
☒ ON ☐ OFF	☒ ON ☐ OFF	☒ ON ☐ OFF

Motion Control

Set Drive Power
Left: 26384
Right: 6384
0-32767 16384 Stop Go

Set Drive Speed
Left: 200
Right: -200
Go

Chassis Control

Set Drive Distance
Distance: 0.5
Unit: m
Time: 2000
Unit: ms
Go

Set Rotation
Turn: 45
Unit: degree
Time: 2000
Unit: ms
Go

Joystick
X: 4960 Y: 5000
☒ Enable Joystick ☐ Joystick Collision Avoidance Drive

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Exit

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Cameras Control

Click to Decrease Cameras Display Size

Click to Send Sound to Cameras

Dr Robot Sputnik-II Motion & Power Service

Left Camera

Right Camera

Login
Control

Power Status

	Voltage	Temperature	Status
Battery-I:	13.03	17.88	Using
Battery-II:	12.85	16.95	Using
DCIN:	0.00V		Using

Power Path Control

2009/01/22 11:49:12

HTTP AV Full-duplex

2009/01/22 11:49:13

HTTP AV Full-duplex

	Encoder Position	Encoder Speed	Current Feedback	HeatProtect	StuckState
Left Motor	0	0	0.00A	False	False
Right Motor	0	0	0.00A	False	False

Position Information

Dead Reckoning: (0.00, 0.00, 0.00) GPS: 0 ☐ Enable GPS Sensor

Unit: ms Time: 2000 Unit: ms Go

Unit: degree Time: 2000 Unit: ms Go

Speed

Joystick

X: 4960 Y: 5000

☒ Enable Joystick ☐ Joystick Collision Avoidance Drive

MaxPower: 75% Joystick Sent Power Left: 0 Right: 0

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Showing status of all power sources:
Battery I, II and external DC input

From where the system
will take power from:
Battery I, II or external
DC input

To control which battery
or both to be charged and
the max charging time

Charging speed/mode
control

Power on/off the sub-
systems (detail in
Appendix I)

Motor PWM control

Motor speed control

Simple motion control:
drive forward, backward,
left, right and stop

To turn within set time

Drive forward (set
distance) within set time

When checked, autonomous collision avoidance
feature will be activated during the joystick control

Max power output when
joystick is fully pushed

Dr Robot Sputnik-II Motion & Power Service
Close

Main Sensor Info & Control
Path Control
Localization/GPS & Sensor/Map & Remote Control

Left Camera

IP: 192.168.0.199 Port: 8081

ID: root PW: *****

Connecting DisConnect

Right Camera

IP: 192.168.0.198 Port: 8082

ID: root PW: *****

Connecting DisConnect

Login
Control





Ultrasonic Sensor

#1	1.44m	#2	1.49m	#3	2.55m
#4	2.55m	#5	2.55m	#6	2.55m

Power

Board Power: 4.81V

Motor Power: 12.76V

Human Sensor

Left: 1989	Alarm: 2003
Right: 1993	Alarm: 2010

IR Sensor

#1	0.81m	#2	0.81m	#3	0.81m	#4	0.53m	#5	0.81m
#6	0.81m	#7	0.81m	#8	0.10m	#9	0.81m	#10	0.81m

Motor Sensor

Encoder Position	Encoder Speed	Current Feedback	HeatProtect	StuckState
Left Motor: 0	0	0.00A	False	False
Right Motor: 0	0	0.00A	False	False

Position Information

Dead Reckoning: (0.00, 0.00, 0.00)

GPS: 0

Enable GPS Sensor



Exit

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Power Status

	Voltage	Temperature	Status
Battery-I:	13.44	1780	Using
Battery-II:	13.33	1705	Using
DCIN:	0.00V		Using

Power Path Control

☐ PowerByBattery-I
 ☐ PowerByBattery-II
 ☐ PowerByDCIN

Charge Path Control

☐ Charge Battery-I
 ☐ Charge Battery-II

Charge Timer:

Stop

Charge Current Control

☒ Full Current
 ☐ Half Current
 ☐ 1A Current
 ☐ Trickle Current

Power Switch Control

Channel-I

Channel-II

Channel-III

☒ ON ☐ OFF
 ☒ ON ☐ OFF
 ☒ ON ☐ OFF

Motion Control

Set Drive Power

Left: 26384 Right: 6384

Go

Set Drive Speed

Left: 200 Right: -200

Go

Set Drive Distance

Distance: 0.5 Unit: m

Time: 2000 Unit: ms

Go

Set Rotation

Turn: 45 Unit: degree

Time: 2000 Unit: ms

Go

Chassis Control

Speed

Joystick

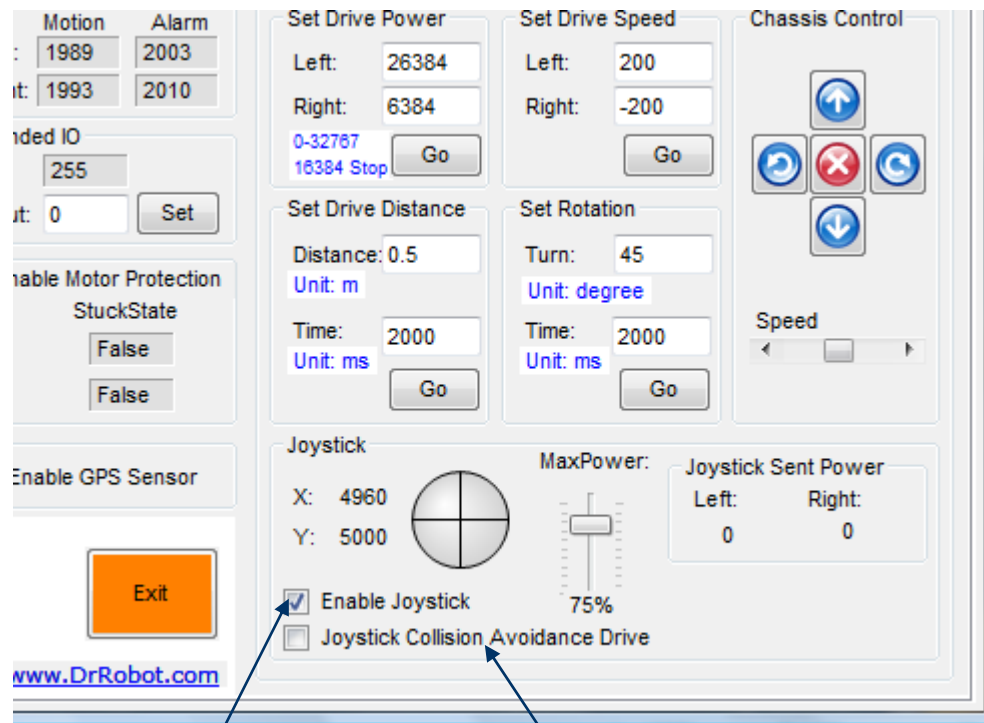
X: 4960 Y: 5000

MaxPower: 75%

Joystick Sent Power

Left: 0 Right: 0

☒ Enable Joystick
 ☐ Joystick Collision Avoidance Drive



To Enable Joystick Control

Robot base collision avoidance feature is enabled by default. During joystick operation, you could temporarily disable this feature by holding the side button (#2) on the joystick handle (as shown above)

Driving with Joystick

Go Forward
More you push, faster the robot goes

Turn Left

Turn Right

Go Backward
More you push, faster the robot goes

Side Button (#2)
Suspend CA



Via points displayed here.
Via points can be manually modified here.

* Reserved for Sputnik² with indoor GPS sensor upgrade option

* Reserved for Sputnik² with automatic charger upgrade option

Manual path test tool:

1. Open the path file, via points on the path will be displayed on the display above; via points can be manually modified.
2. Select the type of task that robot to accomplish with the selected path:
 - a. **P2P task** – robot will run from the first via point on the path to the last one and stop
 - b. **Wander task** – robot actually don't use the path, and runs on its own.

TargetX	TargetY	TargetDir	S
0.3	-0.09	1.64	0
1.51	0.06	1.25	0
2.82	0.06	3.51	0

FinalPostu: ☐ TargetTime: 200 TargetTol: 0.1 MaxTurnS: 90 CAEnable: ☐ ReverseDr: ☐ TargetDirT: 5 SeqNo: 1

P2P PointNum: P2P Status: P2POver P2P Control: Left Wheel Cmd: 0 Right Wheel Cmd: 0 P2P Cmd Time: 0

C:\DrRobotAppFile\PathFile\patrol.xml

P2P Task Type: Wandering Speed:

☐ Mouse Point To Move

Once checked, a via point will be generated and shown in the via point display above when the mouse clicks on the map below. Robot will drive to this point when the GO button is clicked

Zooming in/out of the map

The Path Editor opened from the "Path Control" allows you to edit a path file such as the charging and patrol path

The screenshot shows the Path Editor window with the following components and callouts:

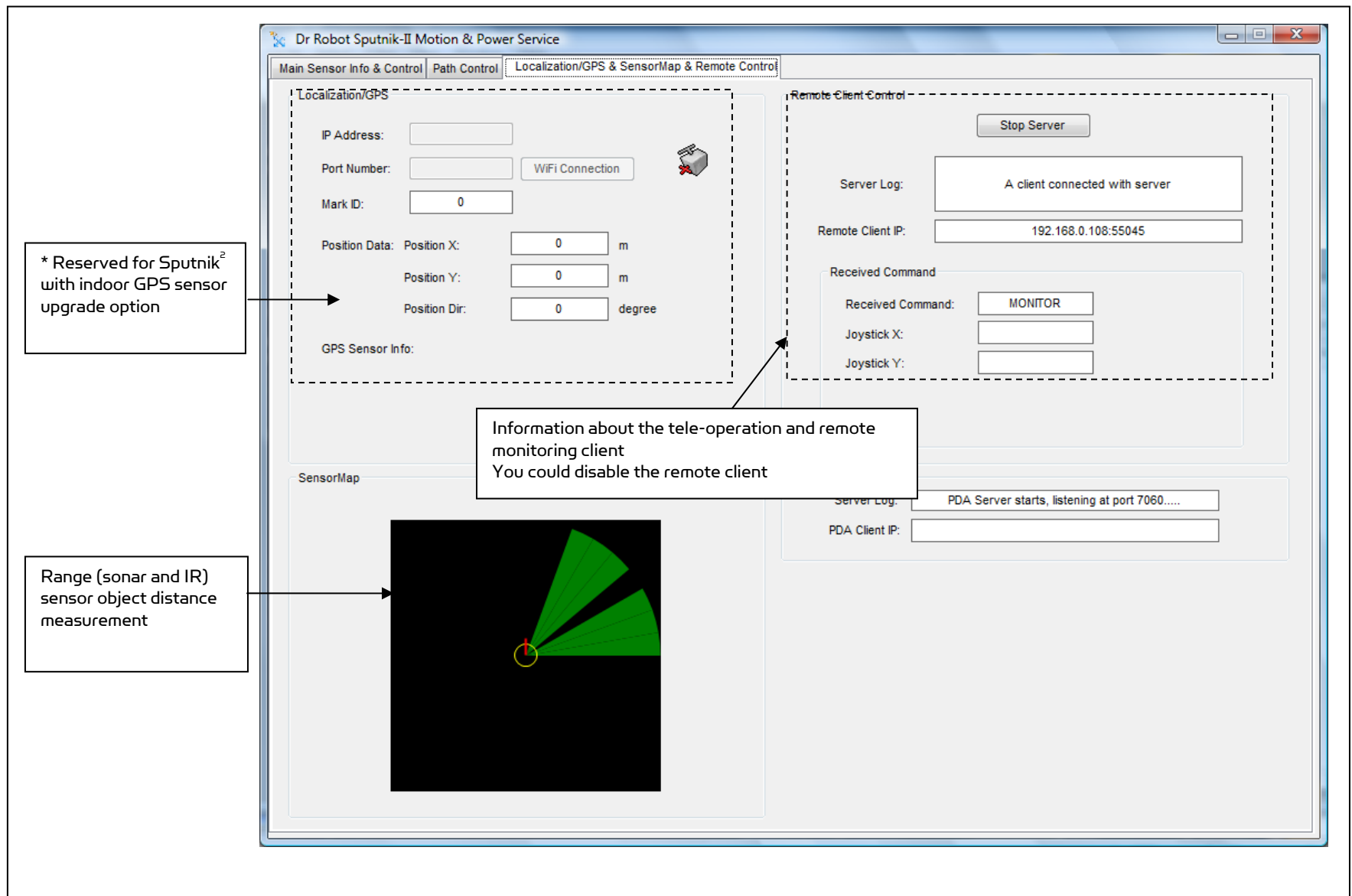
- Record File Name:** A text input field for naming the path file.
- Buttons:** New, Edit, Delete, and Save buttons for file management.
- Path Motion Table:** A table listing loaded path files.

FileName	PointNum
Charge.xml	4
patrol.xml	2
- Via Point List Table:** A table for editing motion specifications for each via point.

TargetX	TargetY	TargetDir	StopTime	ForwardSp	Forgetable	NonStop	FinalPostur	TargetTime	TargetTole	MaxTurnSp	CAEnable	ReverseDr	TargetDirT	SeqNo
-0.41	0.18	0	2	0.5	☐	☐	☒	200	0.2	75	☒	☐	5	1
-0.78	0.17	0	2	0.3	☐	☐	☒	200	0.2	90	☐	☒	5	2
-1	0.175	0	2	0.3	☐	☐	☒	200	0.2	90	☐	☒	5	3
-1.3	0.175	0	2	0.2	☒	☒	☐	200	0.2	45	☐	☒	5	4
- Robot Position Fields:** Robot Position X: -3.98, Robot Position Y: -3.93, Robot Orientation: -0.6.
- Map View:** A grid-based map showing the robot's current position (red dot) and the path via points (blue dots numbered 1 to 4).
- Buttons:** Add Point and Delete Point buttons for map interaction.
- Map Coordinates:** Map X0: 471, Map Y0: 170, and Zoom controls.

Callout Boxes:

- Top Right:** All path files are listed here, when double clicking on the file, the via points will be loaded onto the via point list for editing.
- Left (Top):** You could create a new path file or save the edited path file from here.
- Left (Middle):** This path via point list allows you to modify the motion specification of each via point.
- Bottom Center:** You could position the robot to the location you like the robot to go. The robot location will be displayed here. You could add this location into the path by using the "Add Point"
- Bottom Left:** This path via point display windows shows the via point location. You could drag the point to the location you want the robot to go.



Remote Monitoring and Tele-operation

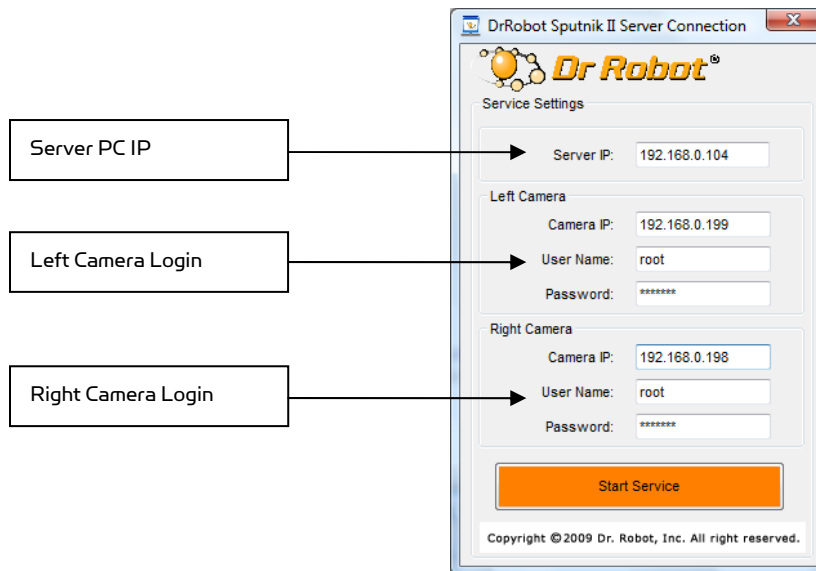
Step 1: If Internet remote monitoring/control is required, you need to connect the wireless router WAN port to your broadband Internet modem. You need to find out the public IP assigned by your ISP. (You should be able to find this information from the router status page) This IP will be used by the remote client to connect to the host PC and the devices on the robot.

If firewall is in-place in your network, you also need to make sure all the network ports used by the wireless devices (e.g. the 8081, 8082 for cameras), 7030 and 7040 on the server and remote client sides are not blocked for the Internet remote monitoring/control tasks to operate properly.

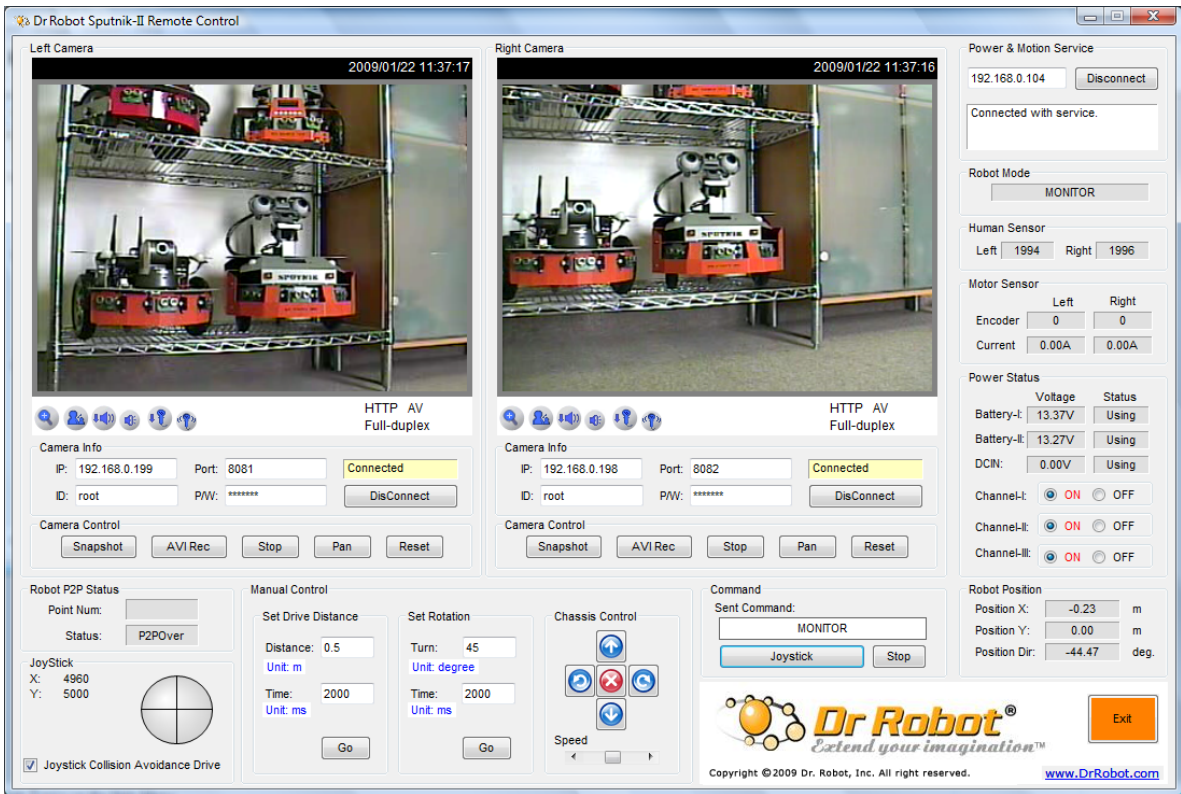
Step 2: Installing the Sputnik-II Remote Control program from the installation CD. "DrRobotSputnik-IIRemoteControl" program allows you to remotely control the robot, obtain main robot sensor information, view, listen and talk through robot.

Step 3: Run the DrRobotSputnik-IIRemoteControl program.

Step 4: Enter or confirm the remote server and other devices' IP. When you are connecting from public network, your server IP must be a public IP, and with the pre-configured router settings, all the devices on the robot will share the same public IP with the server IP. Then click the "Connect".



Step 5: After login, the DrRobotSputnik-IIRemoteControl program will look as below.



Recharging

To keep the battery at ideal condition, we recommend recharging the robot at least once every two weeks during storage (e.g. robot is not in use).

Plug the charging plug from the portable charger onto the secondary recharging socket on the back of the robot, **and then turn on the robot**. The charging process will normally take about 2 hours if the battery power is totally exhausted. The charging process will automatically stop when completed.

Further Development & Programming

The Sputnik² Control program is written with C# program with Visual Studio 2008 express under .Net 3.5 framework. You could download the development tools (Visual Studio 2008 express under .Net 3.5 framework) free from Microsoft. Please refer to the “Dr Robot Application Development Notes on C# Programming for Robot Control” for further information.

The control program uses the supporting components and libraries that should have been installed when you install the control program from the installation CD:

1. **DRROBOTSentinelCONTROL.OCX**: Please refer to “WiRobot SDK API Reference Manual.pdf” for detail.
2. **WiRobotGateway.exe**
3. **DrRobotSensorMapBuilder.dll**: This dll file provides functions to build the environmental map for collision avoidance feature.
4. **DrRobotP2PSpeedDrive.dll**: This dll file provides functions to drive a robot from one specific point to another.
5. **DrRobotConstellation.dll**: Sputnik² robot uses the sonar based Constellation indoor GPS localization system(option). This dll file provides the functions to locate the robot position with the Constellation system.
6. **DrRobotGPS.dll** Sputnik² use the vision-landmark based indoor GPS localization system(option). This dll file provides the functions to locate the robot position with vision based GPS system.
7. **VitaminControl.dll** This is the camera control component for the Pan-Tilt-Zoom camera (P/N: AV-PTZ-VH) used for i90 series robots such as Sentinel², Sentinel³, Sputnik² and Sputnik³. Please refer to “PTZ Camera ActiveX Control Reference Manual.pdf” for detail.

For support on development using Microsoft Robotics Studio, operation system other than MS Windows, or raw communication protocol, please contact support@DrRobot.com.

Network Connection and Login Information

Network Settings

As default, your PC running the Sputnik-II Control program should have IP settings as below:

Name	Server PC	IP (Port)	192.168.0.104
Gateway	192.168.0.200(Router IP)	Subnet Mask	255.255.255.0

The included pre-configured wireless 802.11 b/g router has the following pre-set settings:

SSID	dri	Router LAN	192.168.0.200
WEP	128bits	Login ID	admin
KEY	112233445566778899AABBCCDD	Password	drrobot
Key Type	Open Key		

with virtual server settings as followings:

Virtual Server	Port	Protocol	Server IP
Sputnik-II Remote Control program	7050,7070	TCP/IP	192.168.0.104
Left Camera	8081	TCP/IP	192.168.0.199
Right Camera	8082	TCP/IP	192.168.0.198

WiFi module connects to two serial devices through channel I and II (TCP/IP port 10001 and 10002 respectively). They are pre-configured as below:

Name	Robot WiFi Module 1	IP	192.168.0.202
Channel-I (10001)	115200, 8,N,1, no flow control, UDP, Datagram 01, remote IP:0.0.0.0	Channel-II (10002)	115200, 8,N,1, flow control, UDP, Datagram 01, remote IP:0.0.0.0

Other wireless devices settings are listed below:

Name	IP (Port)	Login	Password
Left Camera	192.168.0.199 (8081)	root	drrobot
Right Camera	192.168.0.198 (8082)	root	drrobot

Advanced Network Settings

It's possible to use different network settings (e.g. IP) for the server PC, but the "Virtual Server" settings on the router must also be changed accordingly in order for the Internet remote monitoring feature to work properly.

You could also change the router settings such as IP and SSID etc. If you need to do so, you are required to change the network settings on the WiFi modules on the robot by following the guidelines as illustrated on the WiFi Module manual.

Appendix I Power Switching Control

Three power sub-systems as defined below could be turn on or off individually through the "DrRobotMotionPowerControl" or "DrRobotSputnik-IIIRemoteControl" Program.

Channel-I	DC-DC board -I	Main Camera (12V)
Channel-II	DC-DC board -I	1. PM55005 Main power (5V)
		2. PDA, LED 5V
Channel-III		