



Advanced Wireless / Internet Remote Monitoring Robot with Software Development Kit

Sputnik

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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www.DrRobot.com

Contact

General: info@DrRobot.com

Technical Support: support@DrRobot.com

25 Valleywood Drive, Unit 20
Markham, Ontario, L3R 5L9, Canada
Tel: (905) 943-9572 Fax: (905) 943-9197

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Introduction

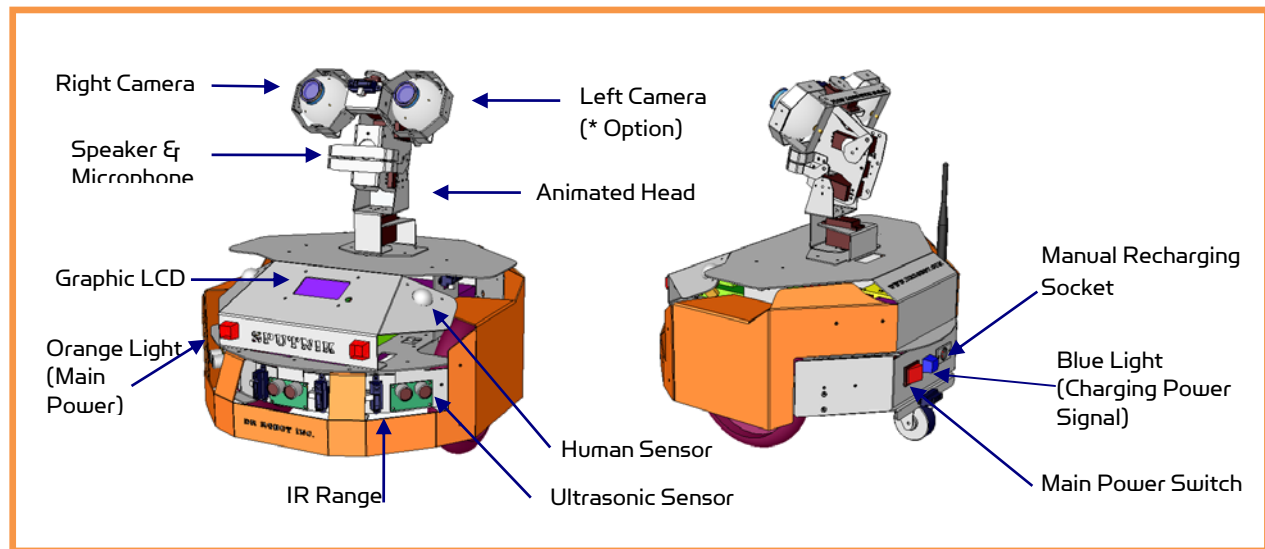
Sputnik is designed and built on X80 robot base, featuring internet remote monitoring and integrated camera animated head.

Key Features

- *5 Servos integrated camera animated head*
- *Pre-programmed fine speed and position control achieved by an integrated PMS5005 module employing two 1200 count per wheel-cycle quadrature encoders*
- *Fully wireless networked 802.11g*
- *OS independent application development tools*
- *Max speed of 1 m/sec*
- *128x64 graphic LCD, Display image , message or sensor data*
- *Collision detection sensors include 3 Ultrasonic range sensors and 8 IR range sensors*
- *Comprehensive circuit protection*
- *Max payload 10 kg (optional 40 kg) with robot weight of 6 kg*
- *Dimension 38cm (L) x 38cm(W) x 46cm (H)*
- *Tele-operation and remote monitoring*
- *Extended operating time. 3 hours nominal operation time for each recharging.*
- *Upgrade options:*
 - *Extra camera at left eye with extra microphone and speaker*
 - *Navigation and localization providing collision-free point-to-point autonomous navigation*
 - *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.*
 - *Auto-docking and recharging station*
 - *Laser scanner*
 - *Power and battery systems for 6 hours operation time are available.*

Sensors and External Components

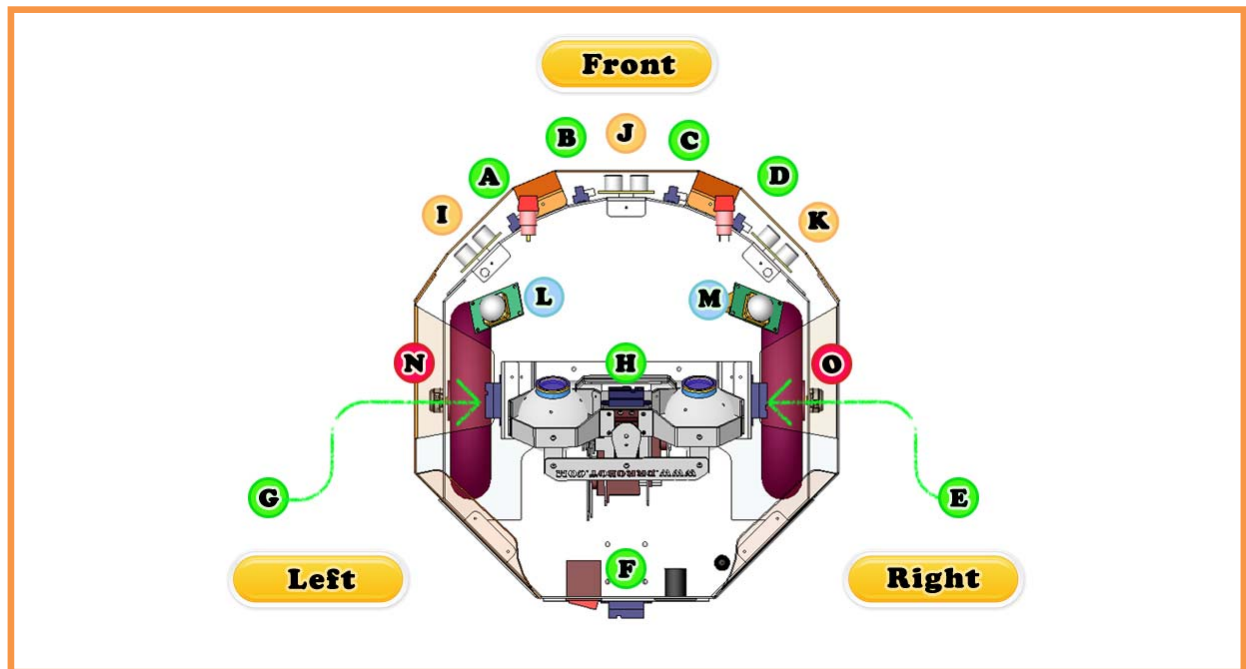
The figure below illustrates the key functional components you will identify on the outside of Sputnik robot.



Sputnik Overview

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

The robot comes with 3 ultrasonic range sensors and 8 IR range sensors. These range sensors are for environment detection and collision avoidance.



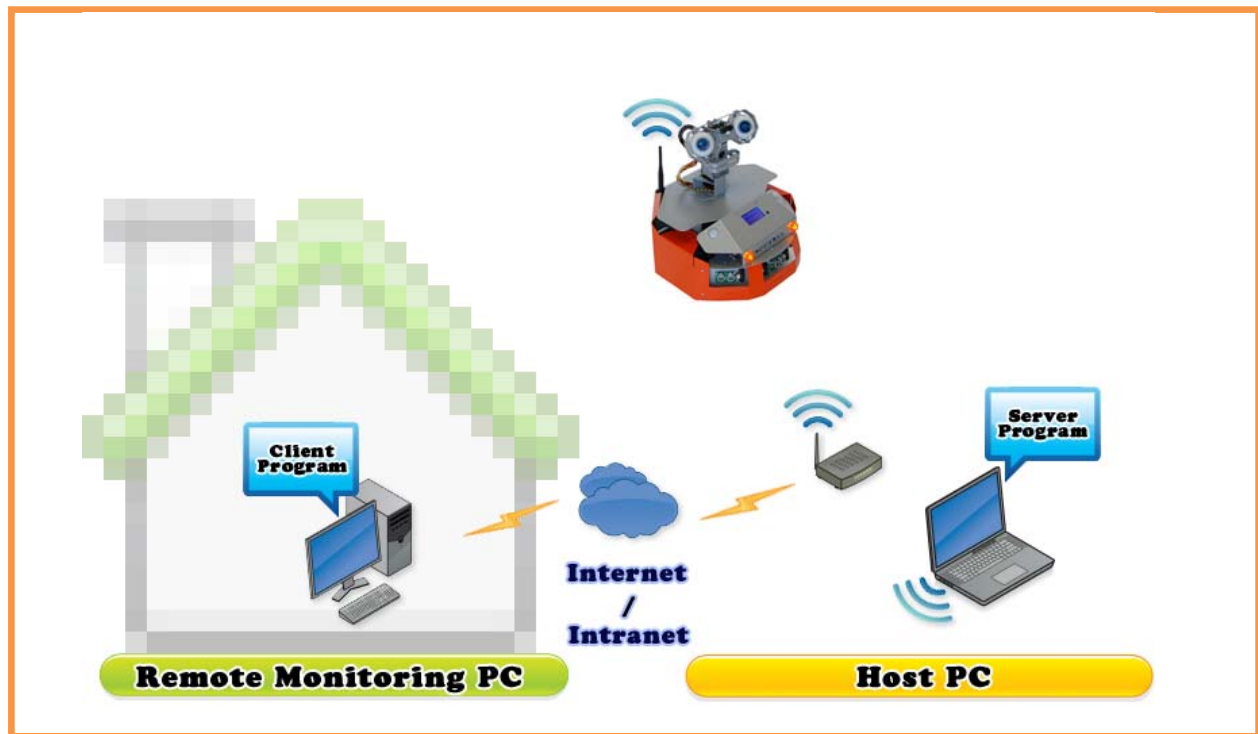
Sputnik Sensor Module Location (Top View)

Sensor Module	Location
Ultrasonic #1	I - Left front
Ultrasonic #2	J - Middle front
Ultrasonic #3	K - Right front
Human Sensor #1	L - Left front
Human Sensor #2	M - Right front
Infrared Range Sensor #1	A – Front left
Infrared Range Sensor #2	B – Front middle
Infrared Range Sensor #3	C – Front middle
Infrared Range Sensor #4	D – Front right
Infrared Range Sensor #5	E – Right
Infrared Range Sensor #6	F – Rear
Infrared Range Sensor #7	G – Left
Infrared Range Sensor #8	H – Front top
Quadrature Encoder #1	N - Left , use channel 1
Quadrature Encoder #2	O - Right, use channel 2

Operation Scenario

Diagram below shows the typical operation scenario. The Sputnik 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 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 audio and displaying images on the Sputnik graphic LCD.

Software Installation

Server PC

On the Server Computer, you should install the "Sputnik 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 Control – Dr Robot Sputnik Control

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

You will find the following files in this folder:

<i>DrRobotPortConfig.xml</i>	* Reserved
<i>DrRobotServiceConfig.xml</i>	It contains the IP and port information about the service programs.
<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>RobotConfig.xml</i>	It contains the robot information, such as WiFi modules' IP, Cameras' IP, robot ID, camera user ID and password.
<i>RobotHardWareConfig.xml</i>	It contains the robot hardware information.
<i>WiRobotGateway.exe</i>	This communication program will setup communication with robot.

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

.\Audio\	contains 8K 16bit audio wav files.
.\HeadMotionFile\	contains head motion script files.
.\PathFile\	contains path script files.
.\Picture\	contains monochrome Bitmap files for Graphic LCD Display.
.\Record\	contains all camera video recording files.
.\SensorConfig\	contains the IR Range sensor location information file "IrSensorConfig.xml" and the ultrasonic sensor location information file "UsSensorConfig.xml".
.\ServoConfig\	contains servos position information file "HeadServoConfig.xml".

Remote Client Program on Client PC

On the client computer, you should install the "Sputnik 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 – Dr Robot Sputnik Remote Control

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

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

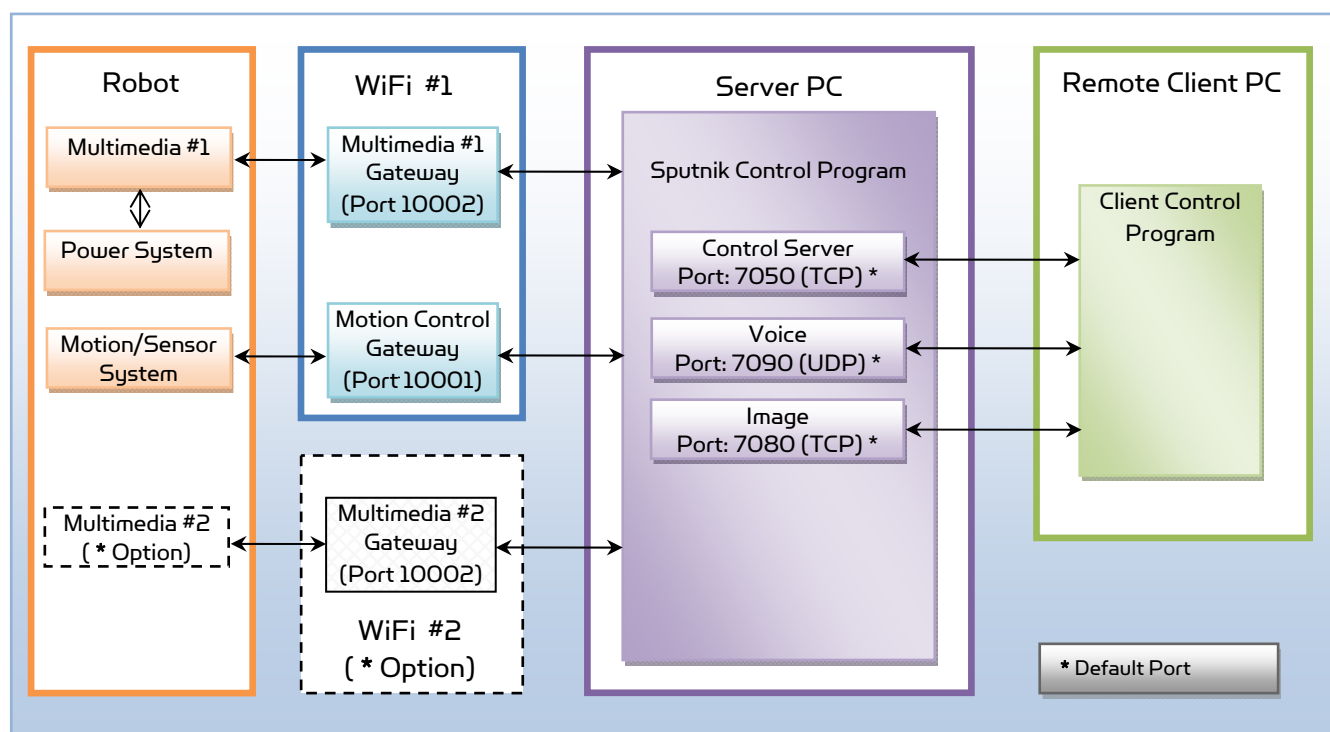
DrRobotServiceConfig.xml

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

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

.\Record\

contains all camera video recording files.



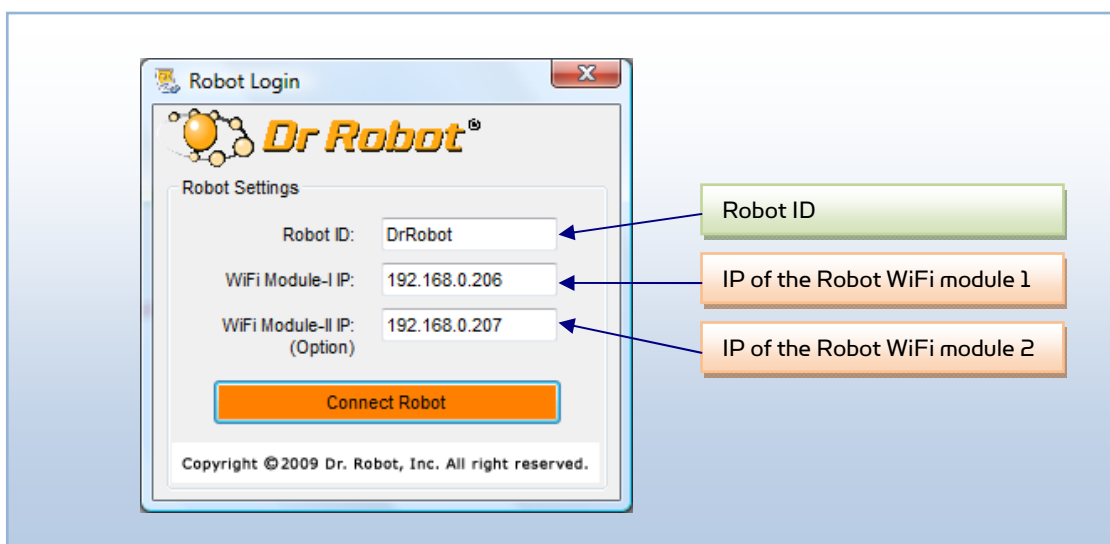
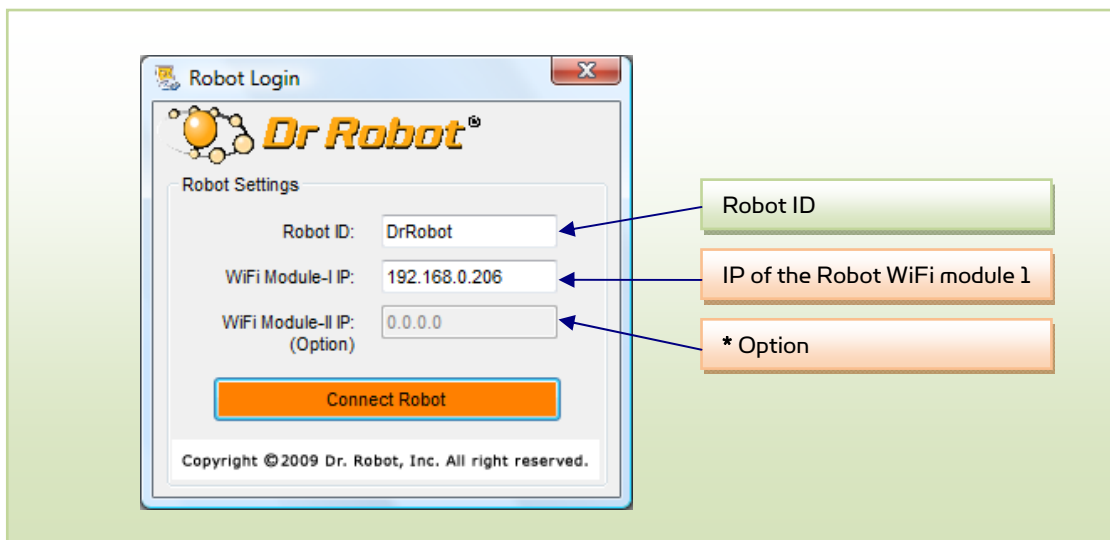
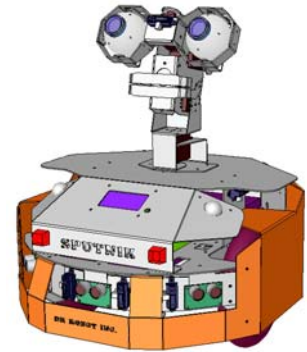
Robot Operations

Step 1: If you have not installed the programs, insert the installation CD to CDROM and run the "Setup.exe" program which under "Sputnik 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.

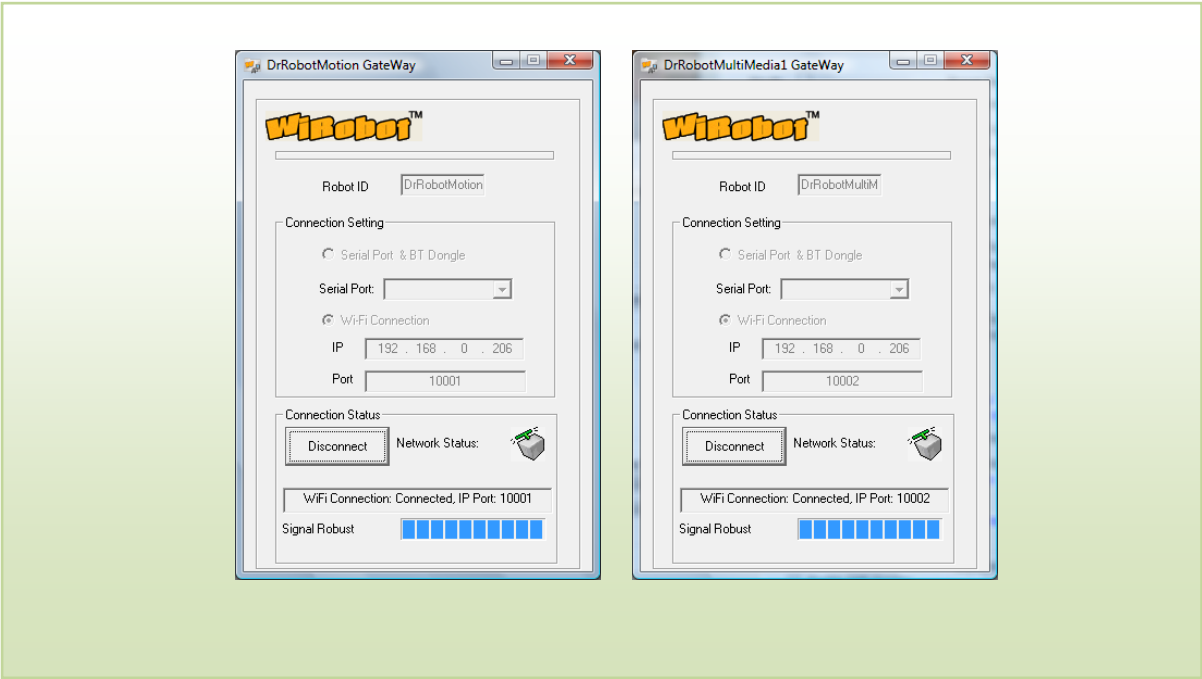
Step 2: Connect the server PC to the wireless router (one of the LAN ports) (the router has IP 192.168.0.200) included in the package.

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

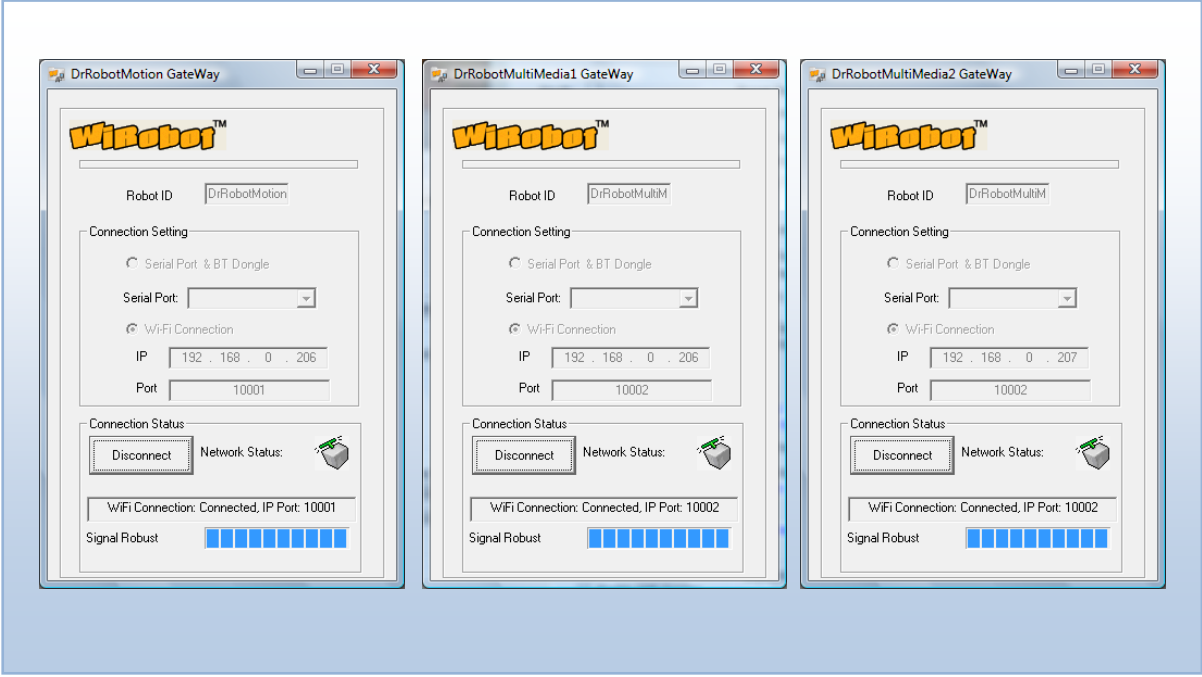
Step 4: Run the "DrRobotSputnikControl.exe" from Start -> All Programs -> Dr Robot Inc -> Sputnik Control -> Dr Robot Sputnik Control. The "DrRobotSputnikControl.exe" connects to robot via the DrRobotMotion gateway & DrRobotMultimedia1 gateway programs. It requires robot information which can be found in "Networking Connection and Login Information" section. After entering or confirming the information, then click "Connect Robot".



For using one WiFi module case, two gateway programs will be called up to establish communication connections with the electronic system on the robot.



For using two WiFi modules case, three gateway programs will be called up to establish communication connections with the electronic system on the robot.



Camera display
and multimedia
control

Animated head control

With option camera

Dr Robot Sputnik Control

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

Left Camera (Option) Right Camera

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JPEG Q: 75 SnapShot

Start Listen

JPEG Q: 75 SnapShot

Start Listen

Talk To Robot

Play

Head Control

HeadPan: [Slider]

HeadTilt: [Slider]

Mouth: [Slider]

EyePan: [Slider]

EyeTilt: [Slider]

Time: 1000 Disable

HeadMotionFile: [Text] Reset

Go

Human Sensor

Motion Alarm

Left: 2025 2038

Right: 2033 2036

Extended IO

Input: 255

Output: 0 Set

Encoder Speed Current Feedback HeatProtect StuckState

0 0.00A False False

0 0.00A False False

Power Status

	Voltage	Temperature	Status
Battery-I:	12.68	19.52	Using
Battery-II:	12.63	19.37	Using
DCIN:	0.00V		Using

Power Path Control

☐ PowerByBattery-I ☐ PowerByBattery-II ☐ PowerByDCIN

Charge Path Control

☐ Charge Battery-I ☐ Charge Battery-II

Charge Timer: [Slider] Stop

Power

Board Power: 4.73V Motor Power: 12.27V

Power Switch Control

Channel-I Channel-II Channel-III

☐ ON ☐ OFF ☒ ON ☐ OFF ☒ ON ☐ OFF

Motion Control

Set Drive Power

Left: 6384

Right: 26384

0-32767 16384 Stop Go

Set Drive Distance

Distance: 0.5

Unit: m

Time: 2000

Unit: ms Go

Set Drive Speed

Left: -200

Right: 200

Go

Set Rotation

Turn: 45

Unit: degree

Time: 2000

Unit: ms Go

Chassis Control

[Up] [Down] [Left] [Right]

Speed: [Slider]

Joystick

X: 5000 Y: 5000

MaxPower: 75%

Joystick Sent Power Left: 0 Right: 0

☒ Enable Joystick ☐ Joystick Collision Avoidance Drive

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Exit

Voltage display on LCD



Select 128x64
monochrome bitmap file
to display on LCD

Sensor data

Dr Robot Sputnik Control

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

Left Camera (Option) Right Camera

Head Control

HeadPan: HeadTilt: Mouth: EyePan: EyeTilt: Time: 1000 HeadMotionFile: Go

Power Status

	Voltage	Temperature	Status
Battery-I:	12.68	19.52	Using
Battery-II:	12.63	20.37	Using
DCIN:	0.00V		Using

Power Path Control

Charge Path Control

Power

Board Power: 4.73V Motor Power: 12.27V

Power Switch Control

Channel-I Channel-II Channel-III

Motion Control

Set Drive Power

Left: 6384 Right: 26384

Set Drive Speed

Left: -200 Right: 200

Chassis Control

Set Drive Distance

Distance: 0.5 Unit: m

Set Rotation

Turn: 45 Unit: degree

Joystick

X: 5000 Y: 5000

MaxPower: 75%

Joystick Sent Power

Left: 0 Right: 0

Exit

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Dr Robot Sputnik Control

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

Left Camera (Option)
 JPEG Q: 75 | SnapShot
 Start Listen

Right Camera
 JPEG Q: 75 | SnapShot
 Start Listen
 Talk To Robot
 Play

Head Control
 HeadPan: [Slider]
 HeadTilt: [Slider]
 Mouth: [Slider]
 EyePan: [Slider]
 EyeTilt: [Slider]
 Time: 1000 | Disable
 HeadMotionFile: [Text] | Reset
 Go

Power Status

	Voltage	Temperature	Status
Battery-I:	12.68	1952	Using
Battery-II:	12.63	2037	Using
DCIN:	0.00V		Using

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

Charge Path Control
☐ Charge Battery-I ☐ Charge Battery-II
 Charge Timer: [Slider] Stop

Power
 Board Power: 4.73V Motor Power: 12.27V

Power Switch Control
 Channel-I: ☐ ON ☐ OFF Channel-II: ☒ ON ☐ OFF Channel-III: ☒ ON ☐ OFF

Motion Control
 Set Drive Power: Left: 6384 Right: 26384
 Set Drive Speed: Left: -200 Right: 200
 Set Drive Distance: Distance: 0.5 Unit: m
 Set Rotation: Turn: 45 Unit: degree
 Time: 2000 Unit: ms
 Go

Chassis Control
 [Directional Pad]
 Speed: [Slider]

Joystick
 X: 5000 Y: 5000
☒ Enable Joystick
☐ Joystick Collision Avoidance Drive
 MaxPower: [Slider] 75%
 Joystick Sent Power Left: 0 Right: 0

Ultrasonic Sensor
 #1 2.55m #2 0.62m #3 0.61m

IR Sensor
 #1 0.81m #2 0.44m #3 0.49m #4 0.50m #5 0.81m
 #6 0.81m #7 0.81m #8 0.43m #9 0.10m #10 0.10m

Motor Sensor

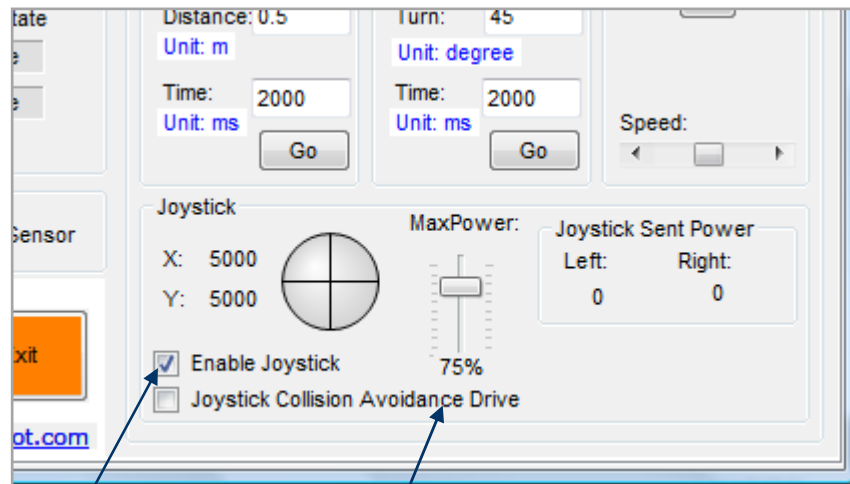
	Encoder Position	Encoder Speed	Current Feedback	HeatProtect	StuckState
Left Motor	0	0	0.00A	False	False
Right Motor	32766	0	0.00A	False	False

☒ Enable Motor Protection

Position Information
 Dead Reckoning: (0.00, 0.00, -0.10) GPS: 0 ☐ Enable GPS Sensor

Callout Boxes:

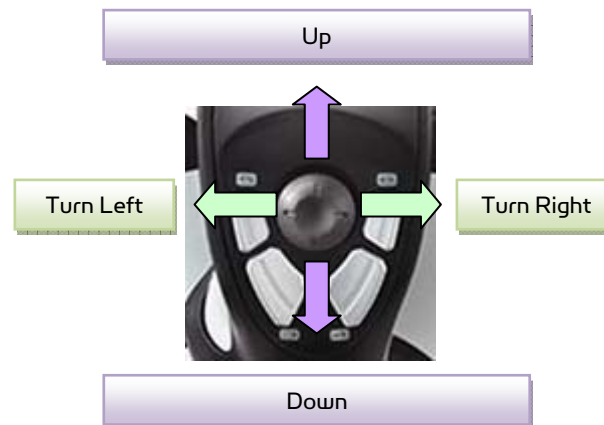
- Showing status of all power sources: Battery I, II and external DC input
- From where the system will take power from: Battery I, II or external DC input
- To control which battery or both to be charged and the max charging time
- Power information
- Power on/off the sub-systems (detail in Appendix 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
- Max power output when joystick is fully pushed
- When checked, autonomous collision avoidance feature will be activated during the joystick control



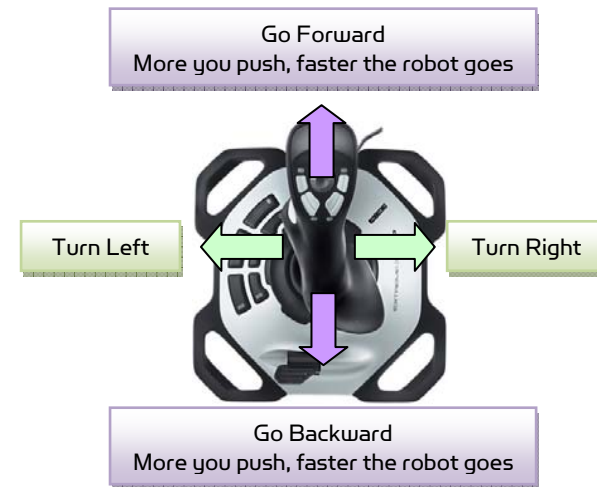
To Enable Joystick Control

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)

Control Head with Joystick



Driving with Joystick



Side Button (#2)
Suspend collision
avoidance feature



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

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.

Map displaying robot location and via points

* Reserved for Sputnik with indoor GPS sensor upgrade option

* Reserved for Sputnik with automatic charger upgrade option

Dr Robot Sputnik Control

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

	TargetX	TargetY	TargetDir	StopTime	ForwardS	Forgetable	NonStop	FinalPostu	TargetTime	TargetTole	MaxTurnS	CAEnable	ReverseDr	TargetDirT	SeqNo
▶	-0.35	0.03	-2.52						200	0.1	90	<input type="checkbox"/>	<input type="checkbox"/>	5	1
	1.16	-1.16	5.11						200	0.1	90	<input type="checkbox"/>	<input type="checkbox"/>	5	2
	1.16	1.11	0						200	0.1	90	<input checked="" type="checkbox"/>	<input type="checkbox"/>	5	3

C:\DrRobotAppFile\PathFile\patrol.xml

AutoRun:

Zoom:

P2P Task Type:
Wandering Speed:

☐ Mouse Point To Move

DetectVol:

Map X0:

Zooming in/out of the map

This will bring up a tool called "Path Editor" allowing you to edit a path

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

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 several callout boxes explaining its functionality:

- Top Left:** "You could create a new path file or save the edited path file from here." (Points to the Record File Name field and New, Edit, Delete, Save buttons)
- 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." (Points to the Path Motion table)
- Middle Left:** "This path via point list allows you to modify the motion specification of each via point." (Points to the main table of path points)
- Bottom Left:** "This path via point display window shows the via point location. You could drag the point to the location you want the robot" (Points to the map area)
- 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”" (Points to the Robot Position fields and Add Point button)

Path Motion Table:

FileName	PointNum
Charge.xml	4
patrol.xml	2

Main Path Table:

	TargetX	TargetY	TargetDir	Stop Time	ForwardSp	Forgetable	NonStop	FinalPostur	Target Time	Target Tole	MaxTurnSp	CAEnable	ReverseDr	TargetDirT	SeqNo
▶	-0.41	0.18	0	2	0.5	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	200	0.2	75	<input checked="" type="checkbox"/>	<input type="checkbox"/>	5	1
	-0.78	0.17	0	2	0.3	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	200	0.2	90	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	2
	-1	0.175	0	2	0.3	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	200	0.2	90	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	3
	-1.3	0.175	0	2	0.2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	200	0.2	45	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	4

Robot Position Fields: Robot Position X: -3.98, Robot Position Y: -3.93, Robot Orientation: -0.6

Map Area: Shows a grid with a red dot representing the robot and four blue dots representing path points labeled 1, 2, 3, and 4.

* Reserved for Sputnik with indoor GPS sensor upgrade option


Range (sonar and IR) sensor object distance measurement

Dr Robot Sputnik Control

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

Localization/GPS

IP Address:

Port Number: WiFi Connection 

Mark ID:

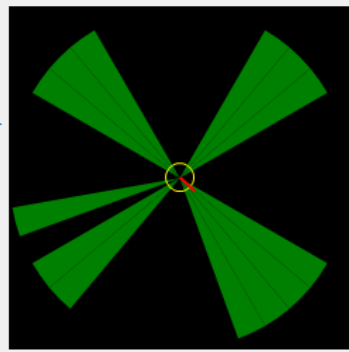
Position Data: Position X: m

Position Y: m

Position Dir: degree

GPS Sensor Info:

SensorMap



Remote Client Control

Stop Server

Server Log: A client connected with server

Remote Client IP:

Received Command

Received Command:

Joystick X:

Joystick Y:

Joystick Pos:

Image Server

Remote Client IP:

Server Log: A client connected with server

Voice Server

Server Log: Success: Voice socket opened

Information about the tele-operation and remote monitoring client
You could disable the remote client

Remote Monitoring and Tele-operation

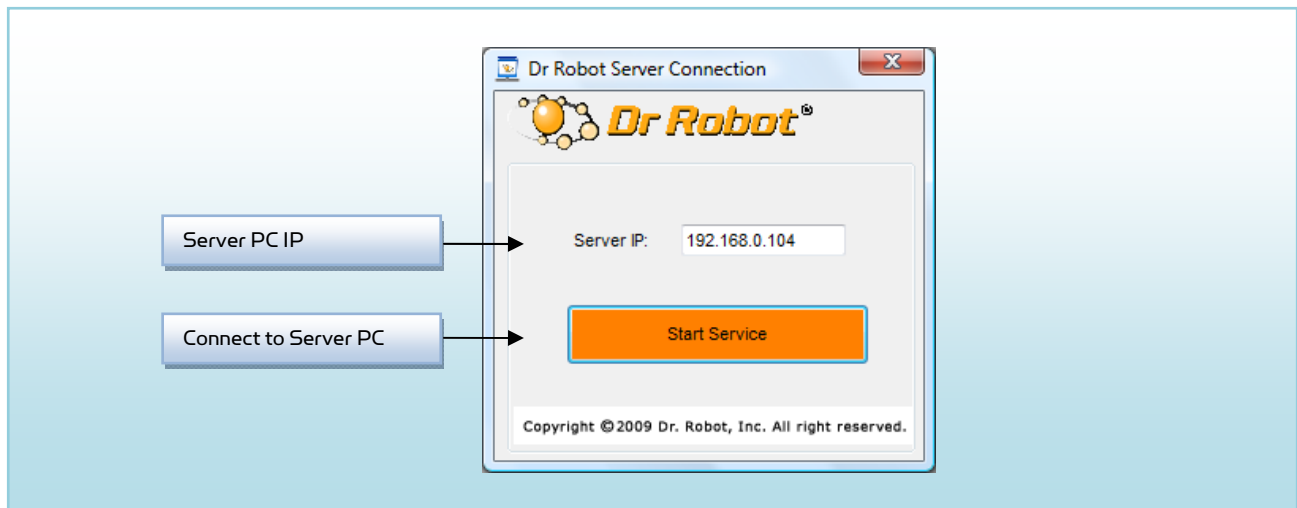
Step 1: If Internet remote monitoring/control is required, you need to connect the wireless router WAN port to your broadband Internet modem. You need to find out the public IP assigned by your ISP. (You should be able to find this information from the router status page) This IP will be used by the 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 7050, 7080 and 7090 on the server and remote client sides are not blocked for the Internet remote monitoring/control tasks to operate properly.

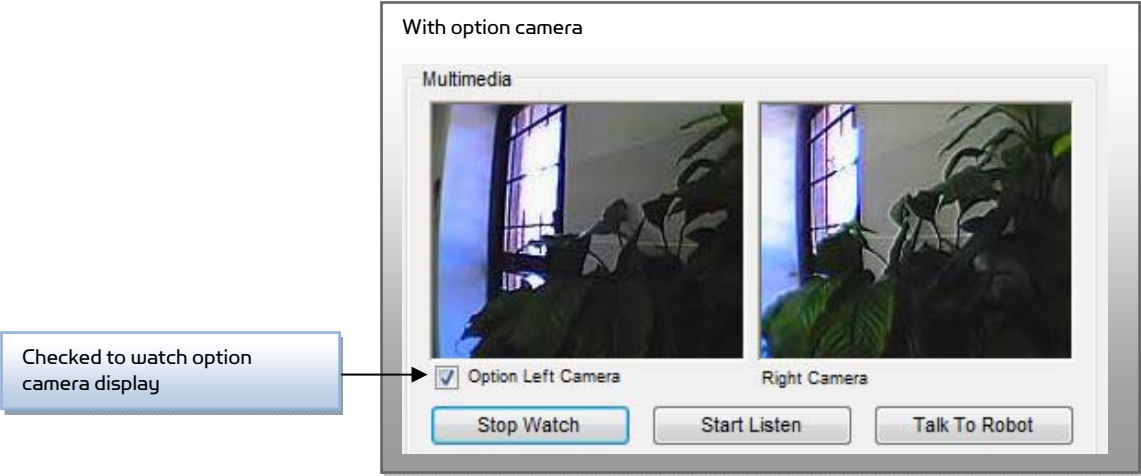
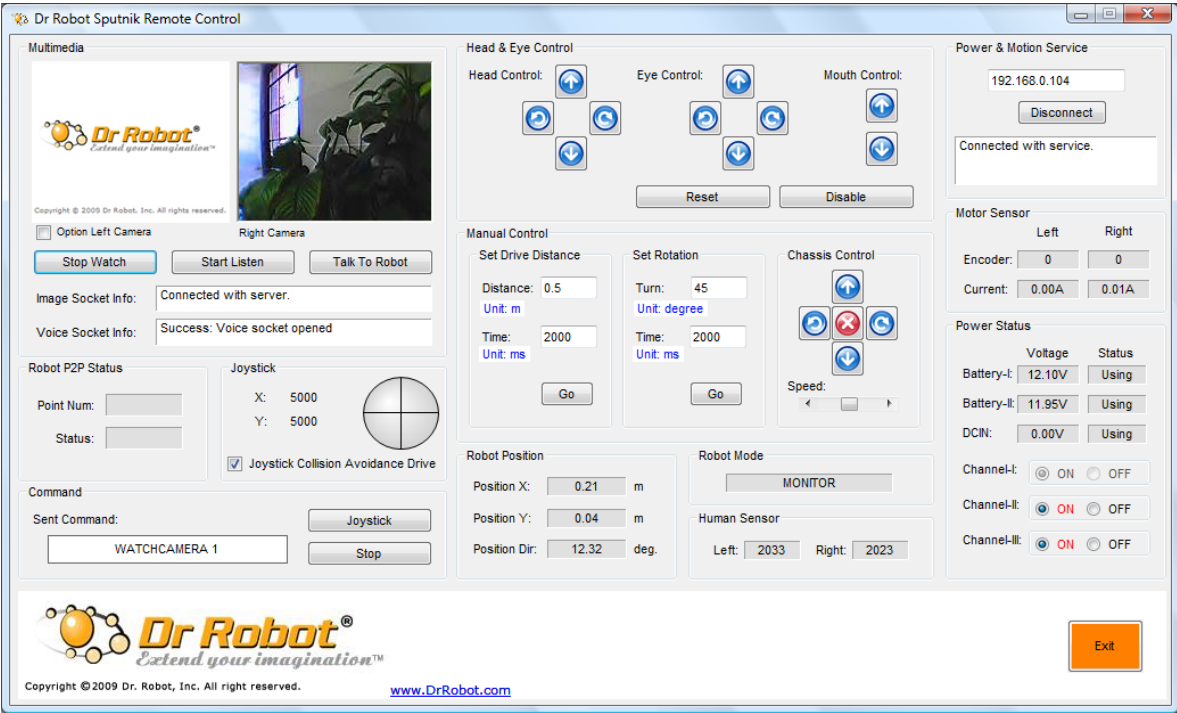
Step 2: Installing the Sputnik Remote Control program from the installation CD. "DrRobotSputnikRemoteControl.exe" program allows you to remotely control the robot, obtain main robot sensor information, view, listen and talk through robot.

Step 3: Run the DrRobotSputnikRemoteControl.exe.

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 "Start Service".



Step 5: After login, the DrRobotSputnikRemoteControl 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 Sputnik 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. **DrRobotGPS.dll** Sputnik 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.

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 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 Remote Control program	7050, 7080, 7090	TCP/IP	192.168.0.104

WiFi module 1 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	192.168.0.206
Channel-I (10001)	115200, 8,N,1, 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

WiFi module 2 (* option) connects to serial devices through channel II (TCP/IP port 10002). It is pre-configured as below:

Name	Robot WiFi Module 2 (* Option)	IP	192.168.0.207
Channel-I (10001)	Reserved	Channel-II (10002)	115200, 8,N,1, flow control, UDP, Datagram 01, remote IP:0.0.0.0

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 / Off or reset individually through the "DrRobotSputnikControl.exe" or "DrRobotSputnikRemoteControl.exe" Program.

Channel-I			
Channel-II	DC-DC board -I	WiFi Module Power (3.3V)	Reset only
		PMB5010 Main Power (5V)	Reset only
		Extra PMB5010 Main Power (5V) (* Option)	Reset only
Channel-III	DC-DC board -I	PMS5005 Main Power (5V)	On / Off
		Servo Power (6V)	On / Off