



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

i90

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, accidents could happen; you have to make sure that the robot always maintains a safe distance from people during operation.

The robot should be turned off (i.e. the power switch should be on OFF position) when not in use. 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

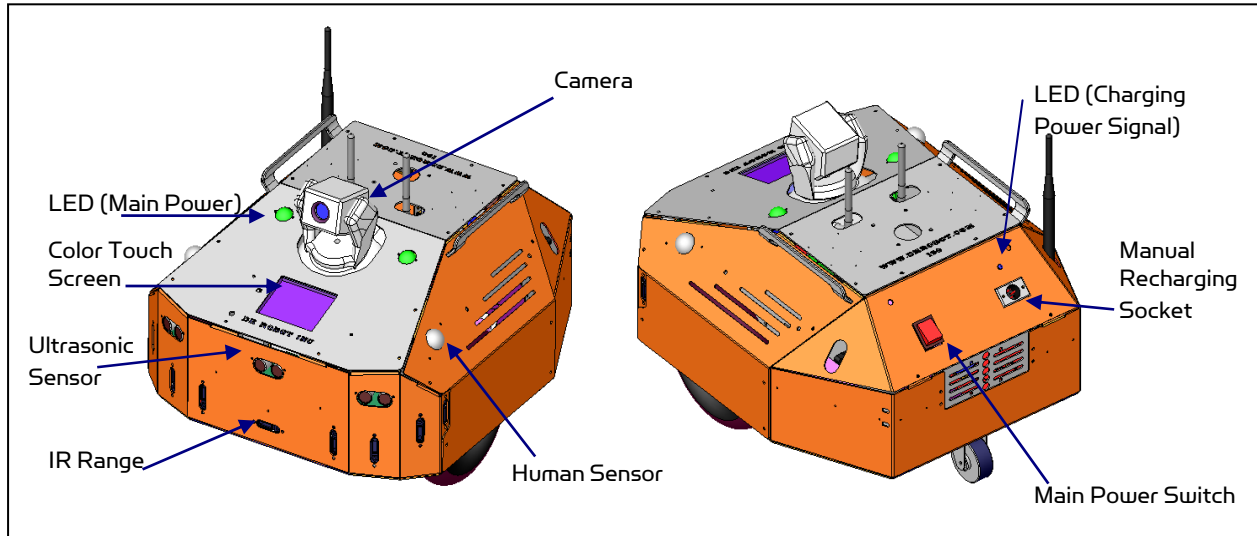
The i90 is the result of extensive efforts to develop a robot that would be fast and strong, while itself remaining lightweight and nimble.

Key Features

- *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 Ultrasonic and 9 IR range sensors*
- *Comprehensive circuit protection*
- *Max payload 10 kg (optional 40 kg) with robot weight of 7 kg*
- *Tele-operation and remote monitoring*
- *Extended operating time. 2 hours nominal operation time for each recharging.*
- *Upgrade options:*
 - *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

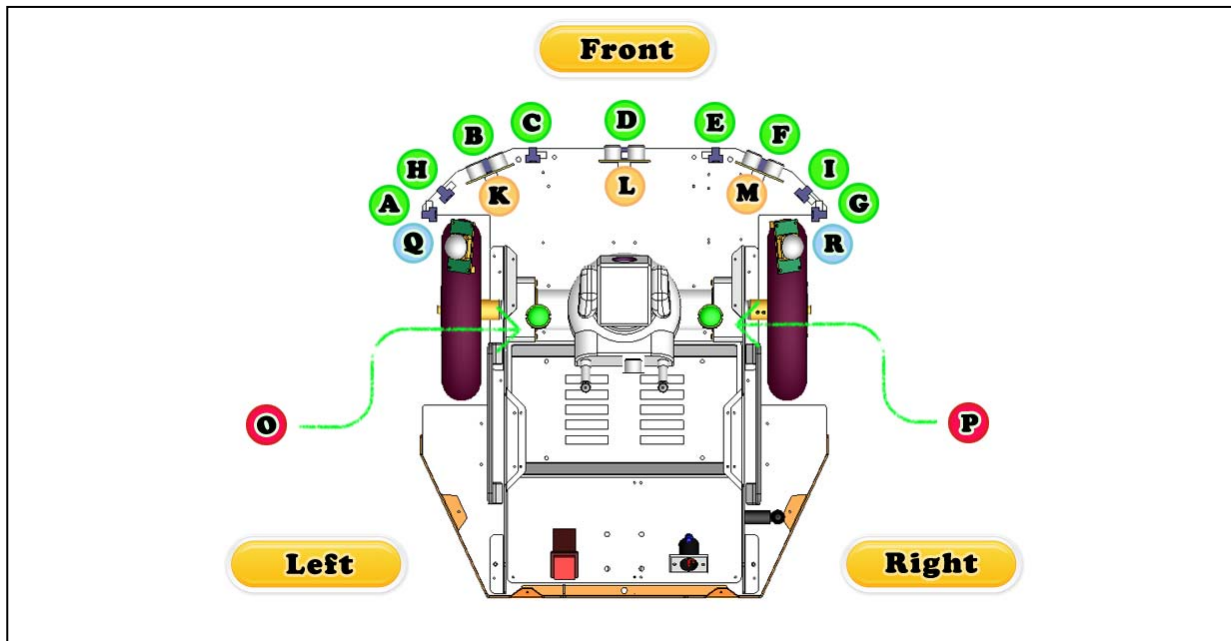
The figure below illustrates the key functional components you will identify on the outside of i90 robot.



i90 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 Ultrasonic and 9 IR range sensors. These range sensors are for environment detection and collision avoidance.



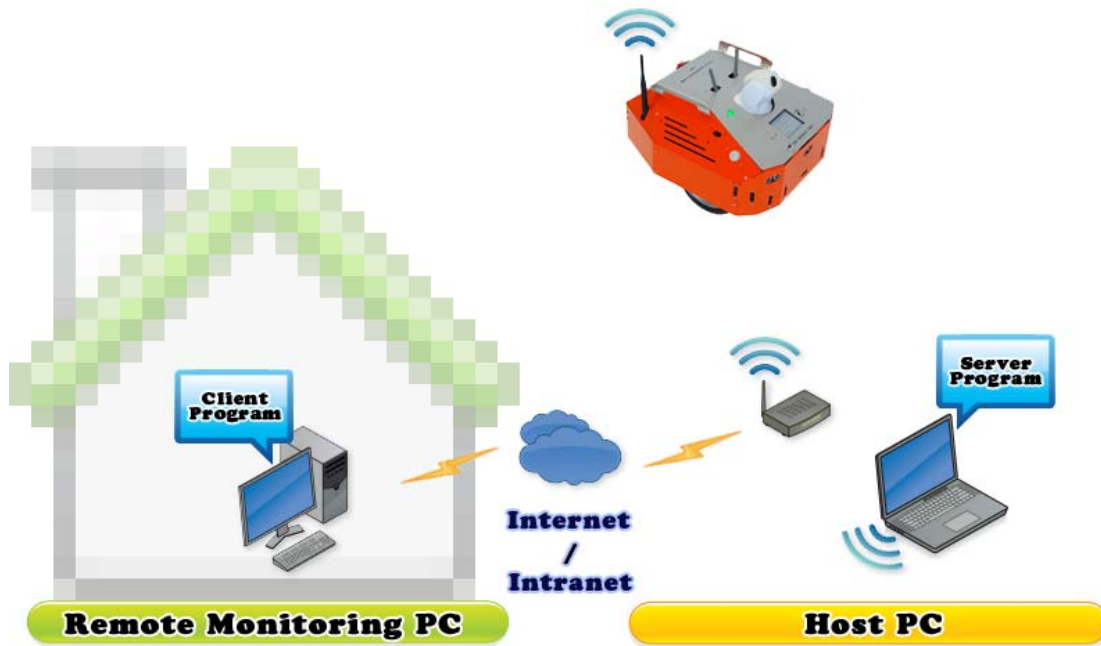
i90 Sensor Module Location (Top View)

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 i90 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 i90 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 Client program from anywhere around the world with Internet connection.

User could also play video, audio and displaying images on the i90 color display.

Software Installation

Server PC

On the Server Computer, you should install the "i90 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 – i90 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 i90.

DrRobotPDASensorClient This program displays i90 sensor information.

Remote Client Program on Client PC

On the client computer, you should install the "i90 Remote Client" 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 – i90 Remote Client

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

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

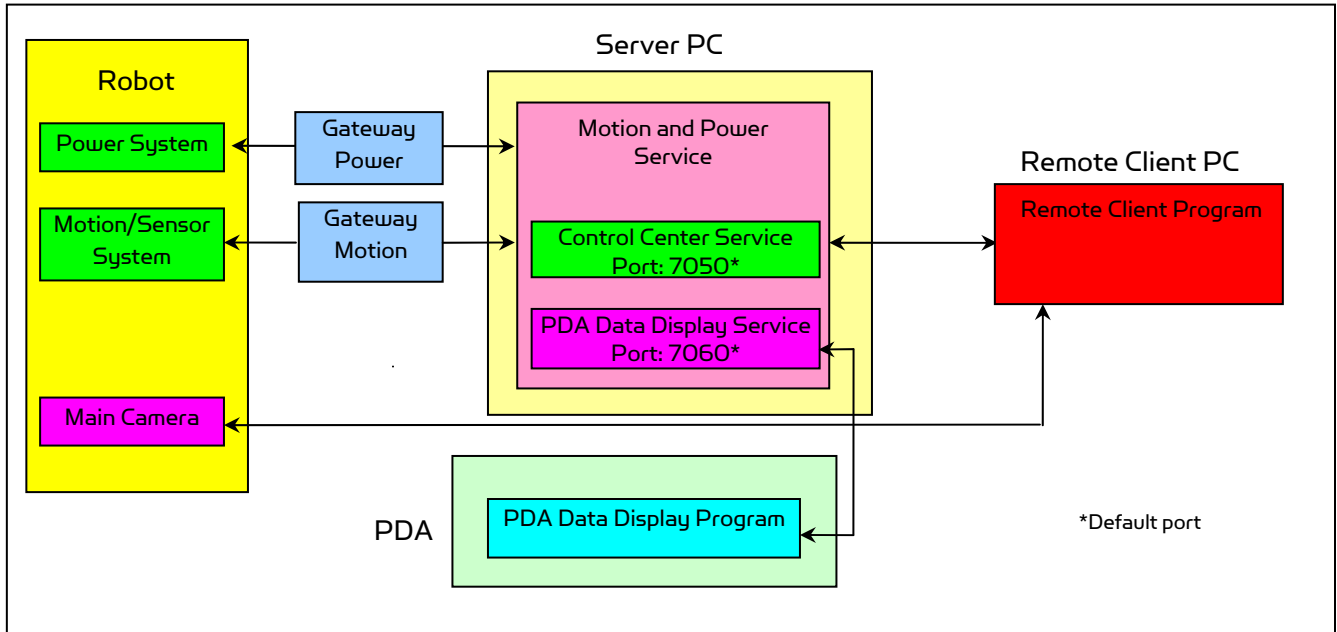
DrRobotServiceConfig.xml

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.



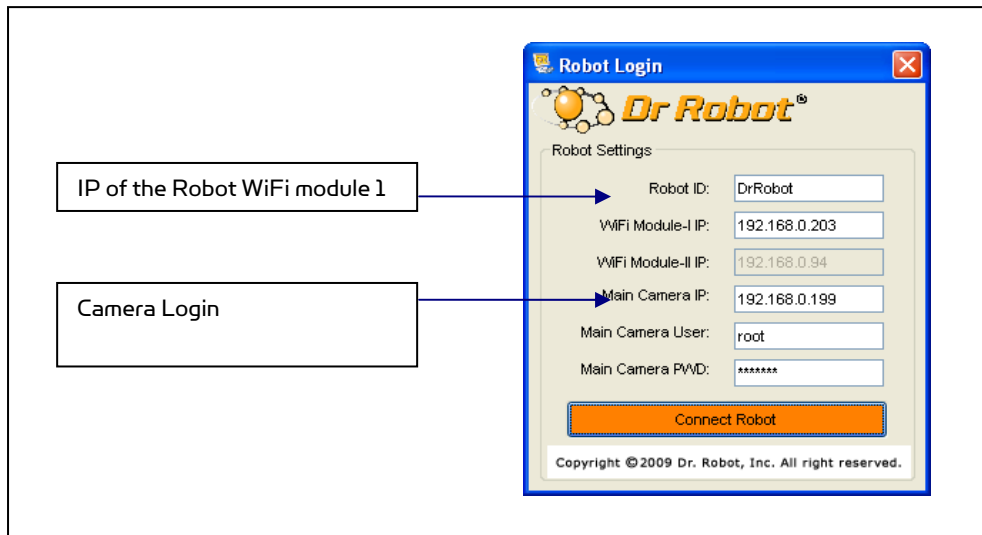
Robot Operations

Step 1: If you have not installed the programs, insert the installation CD to CDROM and run the "Setup.exe" program which under "i90 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.

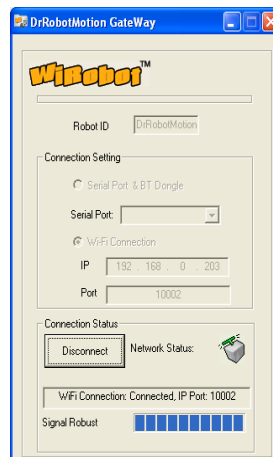
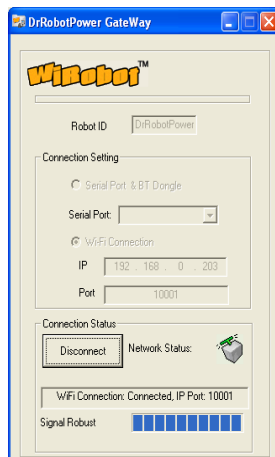
Step 2: Connect the server PC to the wireless router (one of the LAN ports) (the router has IP 192.168.0.200) included in the package.

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 "DrRobot i90 Motion & Power Service" from Start -> All Programs -> Dr Robot Inc -> i90 Control. The "i90 Control" connects 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".



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



DrRobot I90 Motion & Power Service

2009/10/11 00:04:07

Camera Login

Camera

Camera IP: 192.168.0.199
 Camera Port: 8081
 Camera ID: root
 Password: *****
 Connected

Power Status

Battery	Voltage	Temperature	Status
Battery-I	16.21	17.29	Charging
Battery-II	16.32	17.57	Charging
DCIN	17.47		Using

Robot sensor data

Ultrasonic Sensor

#	Distance	#	Distance	#	Distance
#1	0.9m	#2	0.9m	#3	2.55m
#4	2.55m	#5	2.55m	#6	2.55m

IR Sensor

#	Distance	#	Distance	#	Distance	#	Distance	#	Distance	#	Distance
#1	0.81m	#2	0.81m	#3	0.81m	#4	0.54m	#5	0.81m	#6	0.81m
#7	0.81m	#8	0.10m	#9	0.58m	#10	0.81m				

Motor Sensor

	Encoder Position	Encoder Speed	Current Feedback	HeatProtect	StuckState
Left Motor	1231	0	0.00A	False	False
Right Motor	31190	0	0.00A	False	False

Position Information

Dead Reckoning: (0.90, 0.16, 42.63) GPS: 0 Enable GPS Sensor

Robot position and direction estimated by dead reckoning

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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

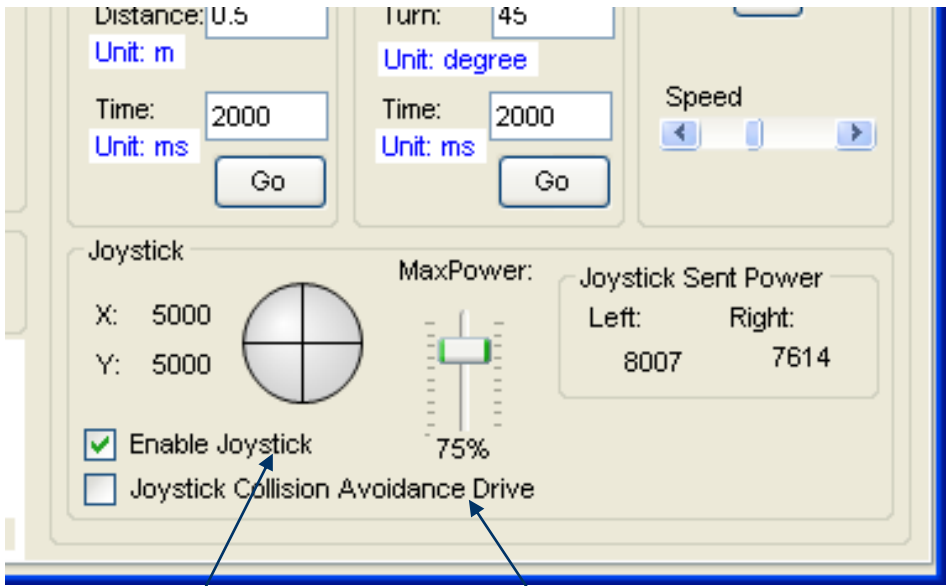
Simple motion control:
drive forward, backward, left, right and stop

To turn within set time

Drive forward (set distance) within set time

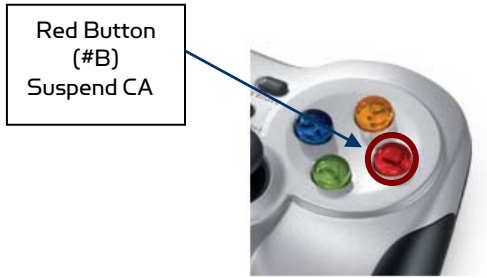
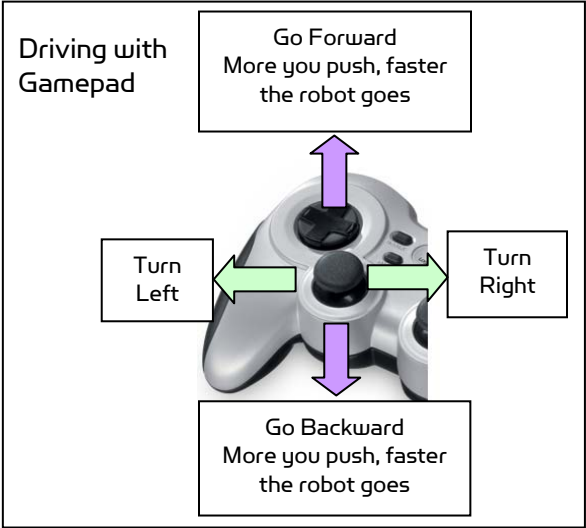
When checked, autonomous collision avoidance feature will be activated during the Gamepad control

Max power output when Gamepad is fully pushed



To Enable Gamepad Control

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



Red Button (#B) Suspend CA

* Reserved for i90 with indoor GPS sensor upgrade option

* Reserved for i90 with automatic charger upgrade option

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

TargetX	TargetY	TargetDir	St	FinalPostui	TargetTime	TargetTol	MaxTurnSj	CAEnable	ReverseDr	TargetDirT	SeqNo
0.3	-0.09	1.64	0	<input type="checkbox"/>	200	0.1	90	<input type="checkbox"/>	<input type="checkbox"/>	5	1
1.51	0.06	1.25	0	<input type="checkbox"/>	200	0.1	90	<input type="checkbox"/>	<input type="checkbox"/>	5	2
2.82	0.06	3.51	0	<input type="checkbox"/>	200	0.1	90	<input type="checkbox"/>	<input type="checkbox"/>	5	3

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

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

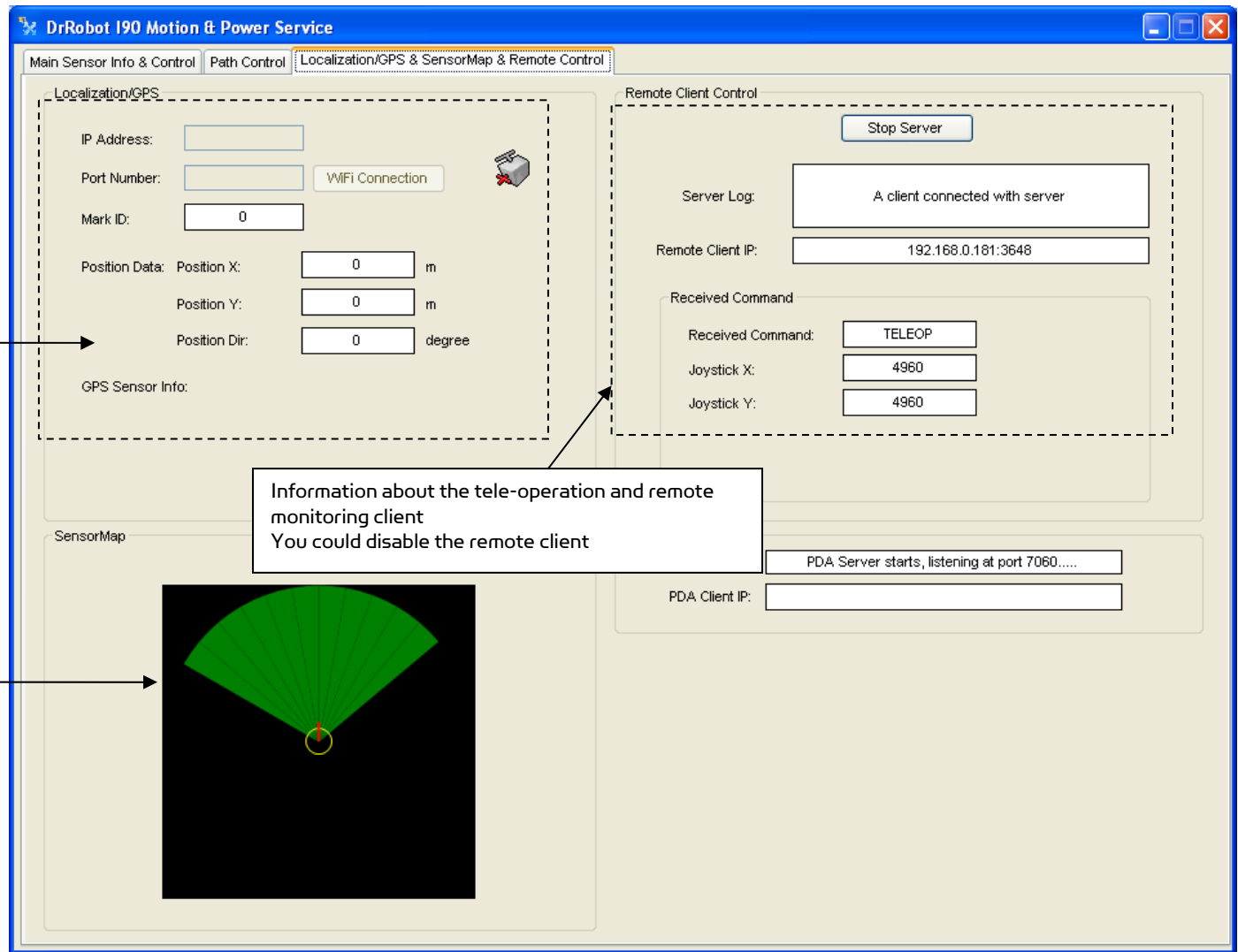
Zooming in/out of the map

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 several callout boxes:

- Top Callout:** "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)
- Left Callout 1:** "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)
- Left Callout 2:** "This path via point list allows you to modify the motion specification of each via point." (Points to the main table of motion specifications)
- Bottom Callout:** "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)
- Bottom Callout:** "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." (Points to the map area)

TargetK	TargetY	TargetDir	StopTime	ForwardSp	Forgetable	NonStop	FinalPostur	TargetTime	TargetTol	MaxTurnSp	CAEnable	ReverseDr	TargetDirT	SeqNo
0.3	-0.09	1.64	0	0.8	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	200	0.1	90	<input type="checkbox"/>	<input type="checkbox"/>	5	1
1.51	0.06	1.25	0	0.8	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	200	0.1	90	<input type="checkbox"/>	<input type="checkbox"/>	5	2
2.82	0.06	3.51	0	0.8	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	200	0.1	90	<input type="checkbox"/>	<input type="checkbox"/>	5	3
1.53	0.06	178.21	0	0.8	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	200	0.1	90	<input type="checkbox"/>	<input type="checkbox"/>	5	4



* Reserved for i90 with indoor GPS sensor upgrade option

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

Range (Ultrasonic and IR) sensor object distance measurement

Remote Monitoring and Tele-operation

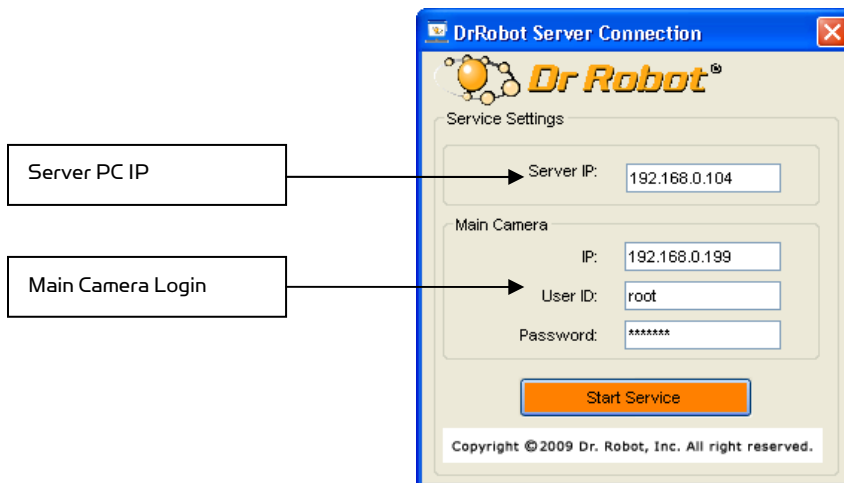
Step 1: If Internet remote monitoring/control is required, you need to connect the wireless router WAN port to your broadband Internet modem. You need to find out the public IP assigned by your ISP. (You should be able to find this information from the router status page) This IP will be used by the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

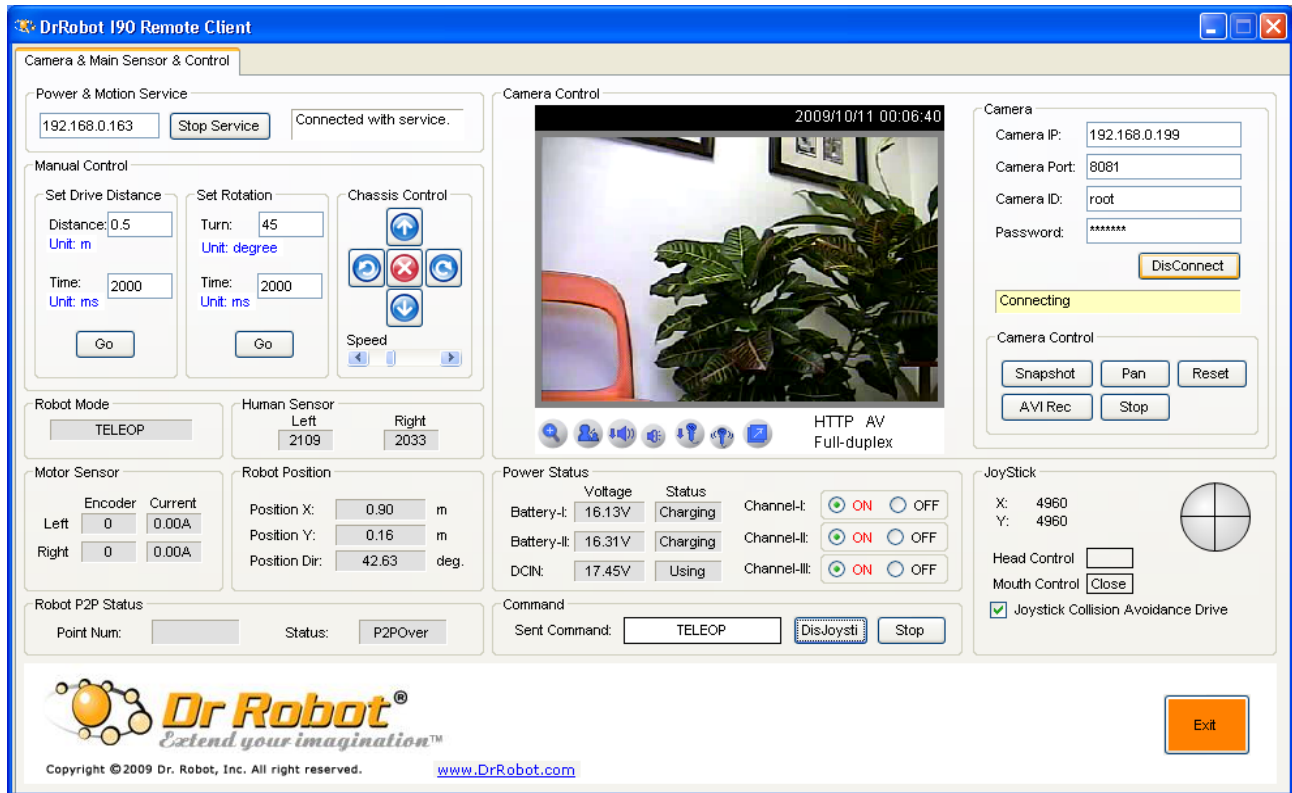
Step 2: Installing the i90 Remote Client program from the installation CD. "i90 Remote Client" program allows you to remotely control the robot, obtain main robot sensor information, view, listen and talk through robot.

Step 3: Run the i90 Remote Client 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 i90 Remote Client 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 i90 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**: i90 robot uses the ultrasonic 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**: i90 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 i90 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
I90 Remote Client program	7050,7070	TCP/IP	192.168.0.104
Main Camera	8081	TCP/IP	192.168.0.199

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	192.168.0.208 (or labeled on robot)
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
Main Camera	192.168.0.199 (8081)	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 "i90 Remote Client" Program.

Channel-I	DC-DC board -I	Main Camera (12V)
Channel-II	DC-DC board -I	1. PMS5005 Main power (5V)
		2. PDA, LED 5V
Channel-III		



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