WiFi Mobile Robot Development Platform
with Multi-DOF Gripping Arms

Scout

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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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

Scout is a rugged wheeled WiFi robot equipped with two gripping arms that optionally provide the robot with either one or two wrist-mounted CMOS cameras. Combining mobility and a new ability to grasp and manipulate, SCOUT offers users broad versatility in its application.

Key Features

- 2 Arms and grippers (5-DOF Arm x2 • 1-DOF Gripper x2)
- 550 oz.-inch (40 kg.cm) 12V DC motor with integrated 800 count per cycle optical encoder
- Fully wireless networked 802.11g
- Full color video and two-way audio capability. (CMOS color image module and audio module are fully integrated.)
- OS independent application development tools
- Max speed of 0.75 m/sec
- 128x64 graphic LCD, Display image, message or sensor data
- Collision detection sensors include 3 Ultrasonic range sensors and 6 IR range sensors
- Comprehensive circuit protection
- Max payload 15 kg (optional 40 kg) with robot weight of 4 kg
- Dimension: 40cm (L) x 32cm (W) x 46cm (H)
- Extended operating time: 3 hours nominal operation time for each recharging.
- Joystick Control included
- Upgrade options:
  - 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
  - Second camera at right arm
  - 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 Scout robot.

Scout Overview
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 6 IR range sensors. These range sensors are for environment detection and collision avoidance.

<table>
<thead>
<tr>
<th>Sensor Module</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultrasonic #1</td>
<td>G - Left front</td>
</tr>
<tr>
<td>Ultrasonic #2</td>
<td>H - Middle front</td>
</tr>
<tr>
<td>Ultrasonic #3</td>
<td>I - Right front</td>
</tr>
<tr>
<td>Infrared Range Sensor #1</td>
<td>A – Front left</td>
</tr>
<tr>
<td>Infrared Range Sensor #2</td>
<td>B – Front middle</td>
</tr>
<tr>
<td>Infrared Range Sensor #3</td>
<td>C – Front right</td>
</tr>
<tr>
<td>Infrared Range Sensor #4</td>
<td>D – Rear right</td>
</tr>
<tr>
<td>Infrared Range Sensor #5</td>
<td>E – Rear middle</td>
</tr>
<tr>
<td>Infrared Range Sensor #6</td>
<td>F – Rear left</td>
</tr>
<tr>
<td>Quadrature Encoder #1</td>
<td>J - Left, use channel 1</td>
</tr>
<tr>
<td>Quadrature Encoder #2</td>
<td>K - Right, use channel 2</td>
</tr>
</tbody>
</table>
**Operation Scenario**

Diagram below shows the typical operation scenario. The Scout 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 Scout 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 Local PC to the wireless router, configure the Local PC’s wireless settings using the default wireless configuration settings found in the Network Connection session of this manual.

Note: The Local PC could also be mounted on the robot instead of 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® Control program.

User could write his own remote control program or contact support@DrRobot.com for further support.

Typical Operation Scenario
Software Installation

You should install the “ScoutControl” 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 - Scout Control
- Dr Robot Inc - ScoutArm Control
- Dr Robot Inc - WiRobotGateway.exe

“ArmControlSourceCode” folder contains a copy of Scout Arm control sample code for Visual Studio 2008. It is located under default installation folder (such as “C:\Program Files\Dr Robot Inc\Dr Robot Scout Control\ArmControlSourceCode”)

Robot Operations

Robot Control Program

Step 1: If you have not installed the demo and support programs, insert the installation CD to CDROM and run the “Setup.exe” program that is under “Scout Control Installation” folder.

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

Step 3: Push red power switch on the front to turn on the robot.

Step 4: Run the “DrRobotScoutControl.exe” from Start -> All Programs -> Dr Robot Inc -> Scout Control, and then click “Connect Robot”.

Two gateway programs will be called up to establish communication connections with the electronic system on the robot.
Camera display and multimedia control

Select 128x64 monochrome bitmap file to display on LCD

Voltage display on LCD

Sensor data

LightBox, Signal Light and Front Light control

Camera display and multimedia control

Select 128x64 monochrome bitmap file to display on LCD

Voltage display on LCD

Sensor data

LightBox, Signal Light and Front Light control
Power on/off the subsystems (detail in Appendix I)

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 subsystems (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

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

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

Power information

Simple motion control:
- drive forward
- backward
- left
- right
- stop

Motor PWM control

Motor speed control

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).

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 collision avoidance feature
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.

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.

Map displaying robot location and via points

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

Via points displayed here. Via points can be manually modified here.
The Path Editor opened from the "Path Control" allows you to edit a path file such as the charging and patrol path. This path via point list allows you to modify the motion specification of each via point. 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" feature. 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. You could create a new path file or save the edited path file from here. This path via point display window shows the via point location. You could drag the point to the location you want the robot to go.
Range (sonar and IR) sensor object distance measurement

* Reserved for Sputnik with indoor GPS sensor upgrade option
Arm Control Program

Run the "scout_arm.exe" from Start -> All Programs -> Dr Robot Inc -> ScoutArm Control

Type in the IP and Port number, click "Connect"

Select demo "Motion" script; click "Go" to run.

Arm control section

Right arm camera (* option)
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 Scout 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:


**WiRobotGateway.exe**

**DrRobotSensorMapBuilder.dll**: This dll file provides functions to build the environmental map for collision avoidance feature.

**DrRobotP2PSpeedDrive.dll**: This dll file provides functions to drive a robot form one specific point to another.

**DrRobotGPS.dll** Scout 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

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

<table>
<thead>
<tr>
<th>SSID</th>
<th>WEP</th>
<th>KEY</th>
<th>Router LAN</th>
<th>192.168.0.200</th>
</tr>
</thead>
<tbody>
<tr>
<td>dri</td>
<td>128bits</td>
<td>112233445566778899AABBCCDD</td>
<td>admin</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open Key</td>
<td>Password</td>
<td>drraybot</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Name</th>
<th>IP</th>
<th>192.168.0.202</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel-I</td>
<td>115200, 8,N,1, flow control, UDP, Datagram 01, remote IP:0.0.0.0</td>
<td></td>
</tr>
<tr>
<td>(10001)</td>
<td>Channel-II</td>
<td></td>
</tr>
<tr>
<td>Channel-II</td>
<td>115200, 8,N,1, flow control, UDP, Datagram 01, remote IP:0.0.0.0</td>
<td></td>
</tr>
<tr>
<td>(10002)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Name</th>
<th>IP</th>
<th>192.168.0.203</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel-I</td>
<td>115200, 8,N,1, no flow control, TCP, Datagram 01, remote IP:0.0.0.0</td>
<td></td>
</tr>
<tr>
<td>(10001)</td>
<td>Channel-II</td>
<td></td>
</tr>
<tr>
<td>Channel-II</td>
<td>115200, 8,N,1, no flow control, TCP, Datagram 01, remote IP:0.0.0.0</td>
<td></td>
</tr>
<tr>
<td>(10002)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 turned On / Off or reset individually through the “DrRobotScoutControl.exe” program.

<table>
<thead>
<tr>
<th>Channel-I</th>
<th>Channel-II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DC-DC board</td>
</tr>
<tr>
<td>Channel-II</td>
<td>WiFi Module Power (3.3V)</td>
</tr>
<tr>
<td></td>
<td>Reset only</td>
</tr>
<tr>
<td>PMB5010 Main Power (5V)</td>
<td>Reset only</td>
</tr>
<tr>
<td>PMS5005 Main Power (5V)</td>
<td>Reset only</td>
</tr>
<tr>
<td>SSC-32 Board (5V)</td>
<td>Reset only</td>
</tr>
<tr>
<td>GPS Sensor (5V) (*Option)</td>
<td>Reset only</td>
</tr>
<tr>
<td>Channel-III</td>
<td>DC-DC board</td>
</tr>
<tr>
<td></td>
<td>Servo Power (6V)</td>
</tr>
<tr>
<td></td>
<td>On / Off</td>
</tr>
</tbody>
</table>

Appendix II LightBox, Signal Light and Front Light control reference

LightBox & Signal Light
Using Extended Output IO port, 8 bit
“1” – on, “0” -off
Tri-Color LED and Turning Signal Lights are controlled by extended IO port.

<table>
<thead>
<tr>
<th>Extended IO output</th>
<th>Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit0</td>
<td>Not used</td>
</tr>
<tr>
<td>Bit1</td>
<td>Not used</td>
</tr>
<tr>
<td>Bit2</td>
<td>Red Led ‘1’ – On, ‘0’ Off</td>
</tr>
<tr>
<td>Bit3</td>
<td>Left Turn Led ‘1’ – On, ‘0’ Off</td>
</tr>
<tr>
<td>Bit4</td>
<td>Blue Led ‘1’ – On, ‘0’ Off</td>
</tr>
<tr>
<td>Bit5</td>
<td>Right Turn Led ‘1’ – On, ‘0’ Off</td>
</tr>
<tr>
<td>Bit6</td>
<td>Green Led ‘1’ – On, ‘0’ Off</td>
</tr>
<tr>
<td>Bit7</td>
<td>Not used</td>
</tr>
</tbody>
</table>
Front Light
Using PWM channel 3
Use "motionControl.DcMotorPwmNonTimeCtr" to control it. The value should be bigger than 22000.

Appendix III IR Sensor control reference

Using AD Extended Port
A--- AD extended port 3
B--- AD extended port 4
C--- AD extended port 5
D--- AD extended port 6
E--- AD extended port 7
F--- AD extended port 8

Appendix IV SSC-32 Board connection

Right Arm using channel 0 – channel 5
Left Arm using channel 16 – channel 21

Support Team Contact Information:
Email: support@drrobot.com
Phone: 1-(905) 943-9572