

Programming the iMobot

October 27, 2011

1 The CMobot iMobot Remote Control Library

The **CMobot** library is a collection of functions geared towards controlling the motors and reading sensor values of an iMobot module via the Bluetooth wireless protocol. The functions are designed to be intuitive and easy to use. Various functions are provided to control or obtain the speed, direction, and position of the motors. The API includes C-style functions as well as a C++ class called **CMobot** to facilitate C++ style api function calls.

This documentation introduces the basic computer setup required for controlling the iMobot, as well as several demo programs and a complete reference for all API function provided with the **CMobot** library.

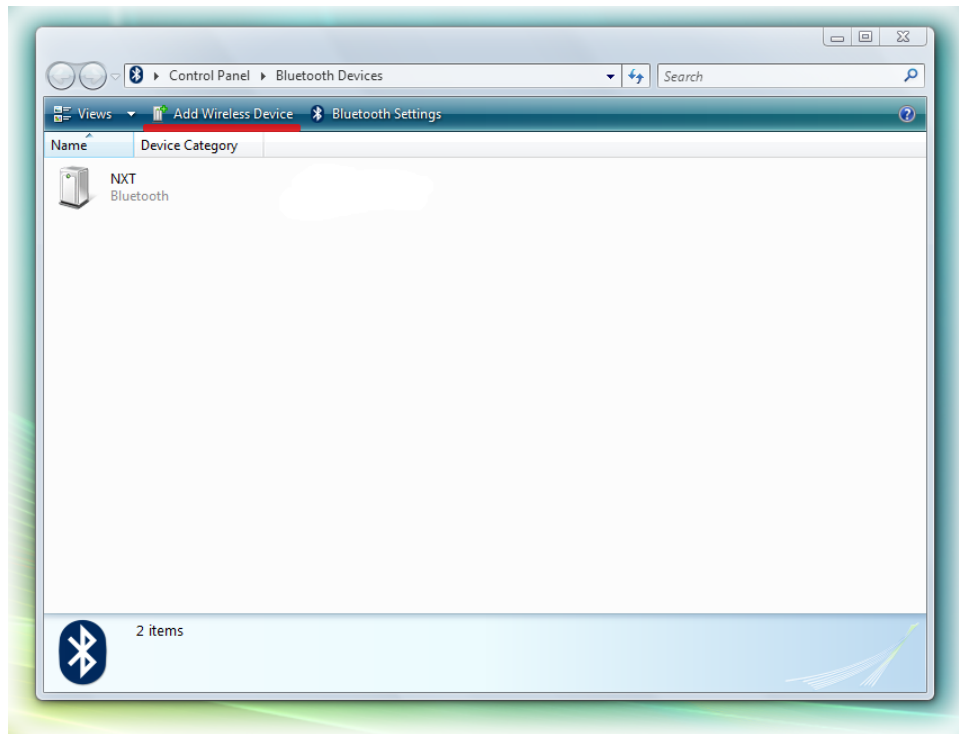
2 Bluetooth Pairing with the iMobot

To control the iMobot with the Bluetooth wireless protocol, the controlling computer must be equipped with Bluetooth. If the computer does not have Bluetooth built-in, an external USB Bluetooth dongle may be used. The following instructions are for a Windows 7 computer with built-in Bluetooth. The basic process is the same for Windows XP and Vista, although the screenshots may appear different.

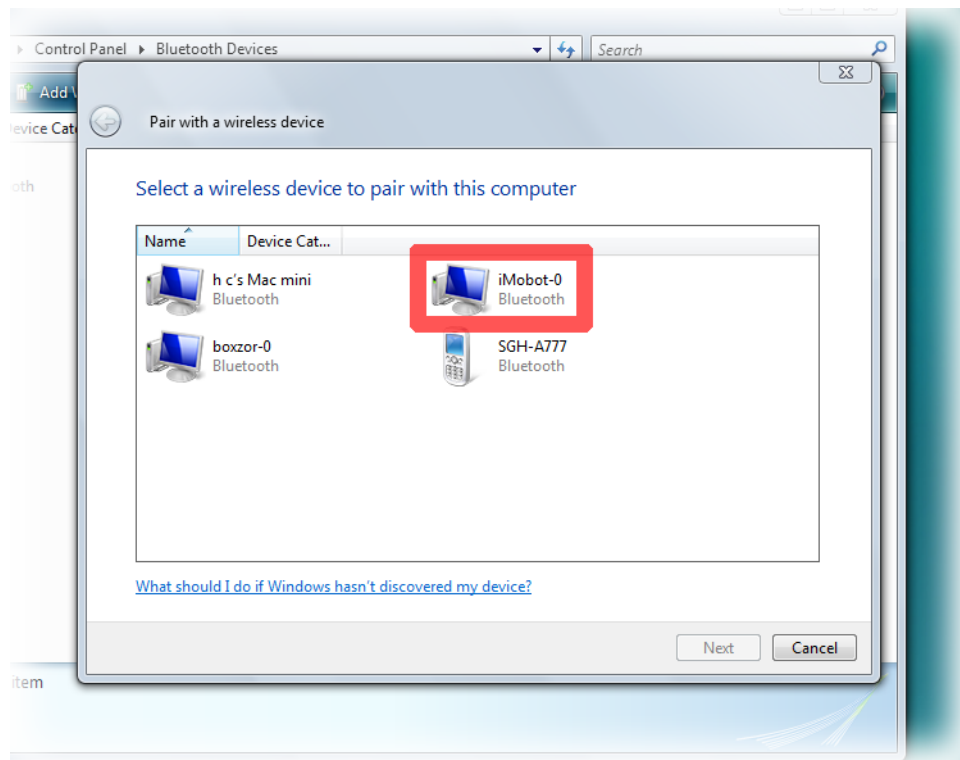
The first step is to open the Bluetooth applet by double-clicking the Bluetooth icon in the applet tray normally found at the bottom right of the screen, as shown highlighted in red in the following figure.



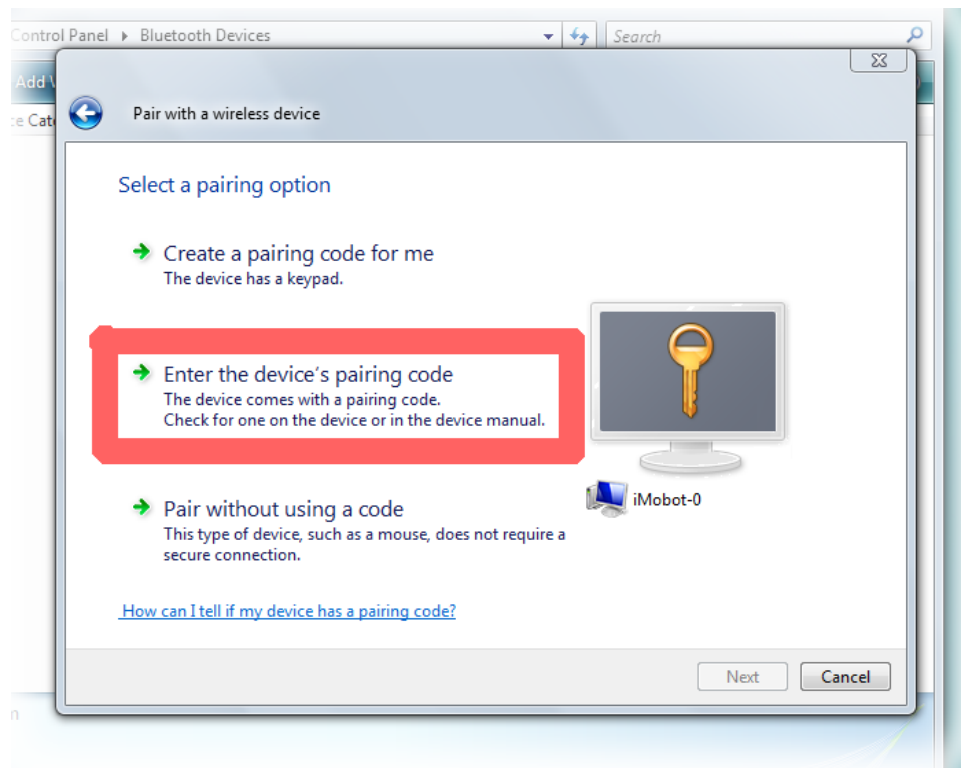
After double-clicking the icon, a new window will appear similar to the following.



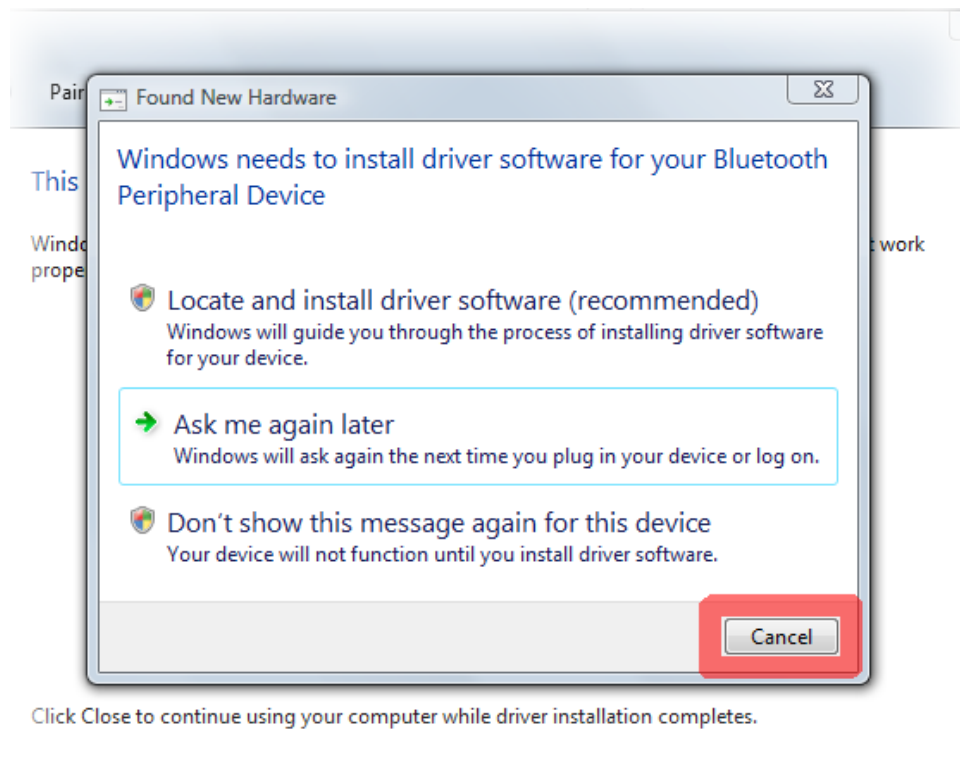
Next, click on the button labeled "Add Wireless Device" towards the top of the window. This will bring up the following dialog.



This dialog shows a list of all Bluetooth wireless devices that are in range. Among them should be the iMobot you wish to connect to. If the iMobot does not appear on this list, please ensure that the iMobot is within 10 meters of the connecting computer and that the iMobot is powered on. Double click on the icon representing the iMobot to proceed. Once you have double-clicked the icon, the following dialog box should appear.

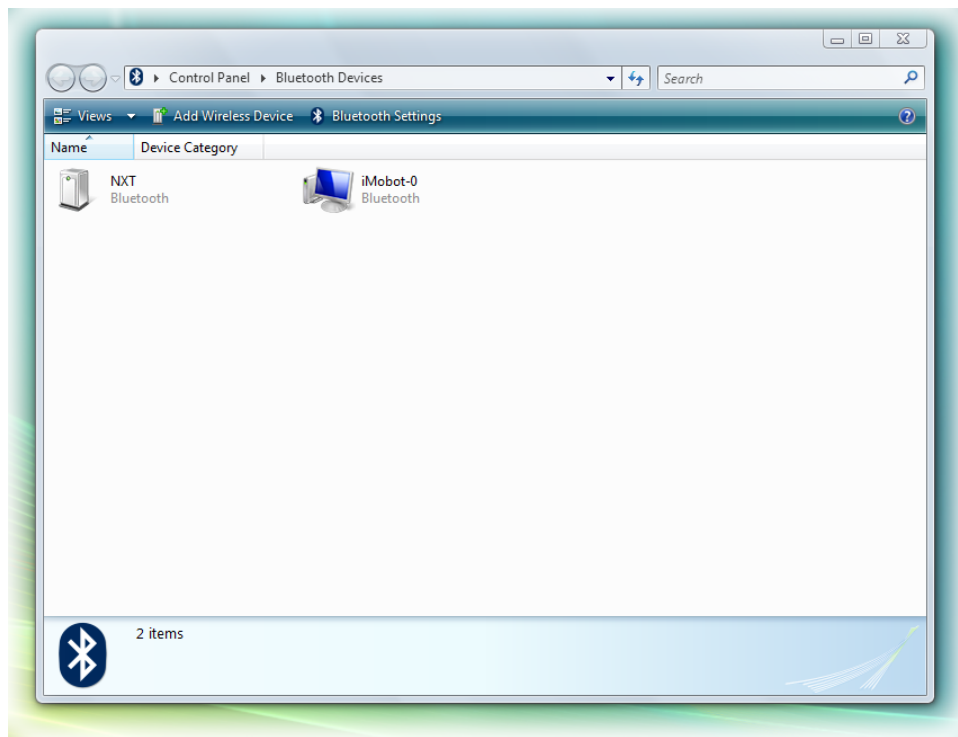


Select the second option, labeled “Enter the device’s pairing code”. iMobot modules come hard-coded with a default pairing code. When prompted for the pairing code, enter “1234”. Once the computer is paired with the iMobot, the following dialog box may pop up asking to install drivers.

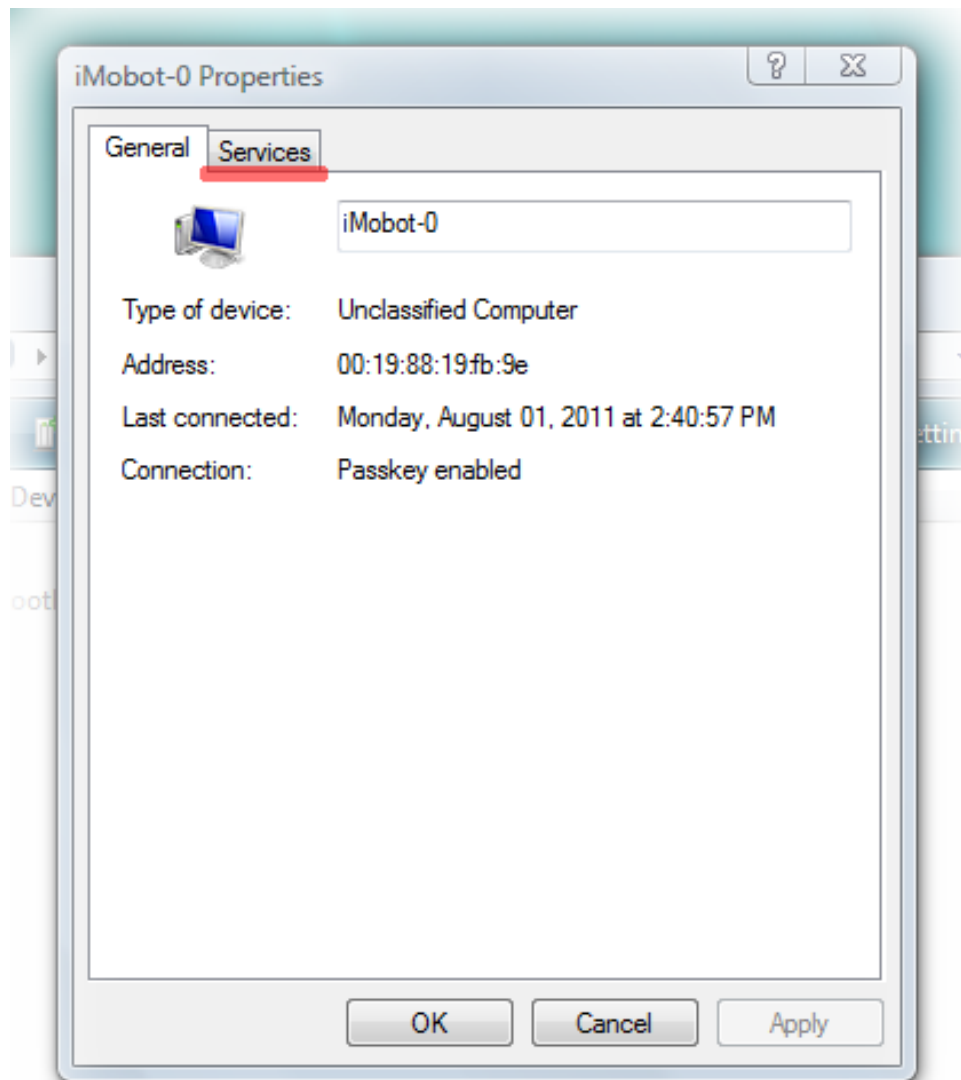


If the previously illustrated dialog box appears, just click the “cancel” button at the bottom right. No extra drivers are necessary for controlling the iMobot module.

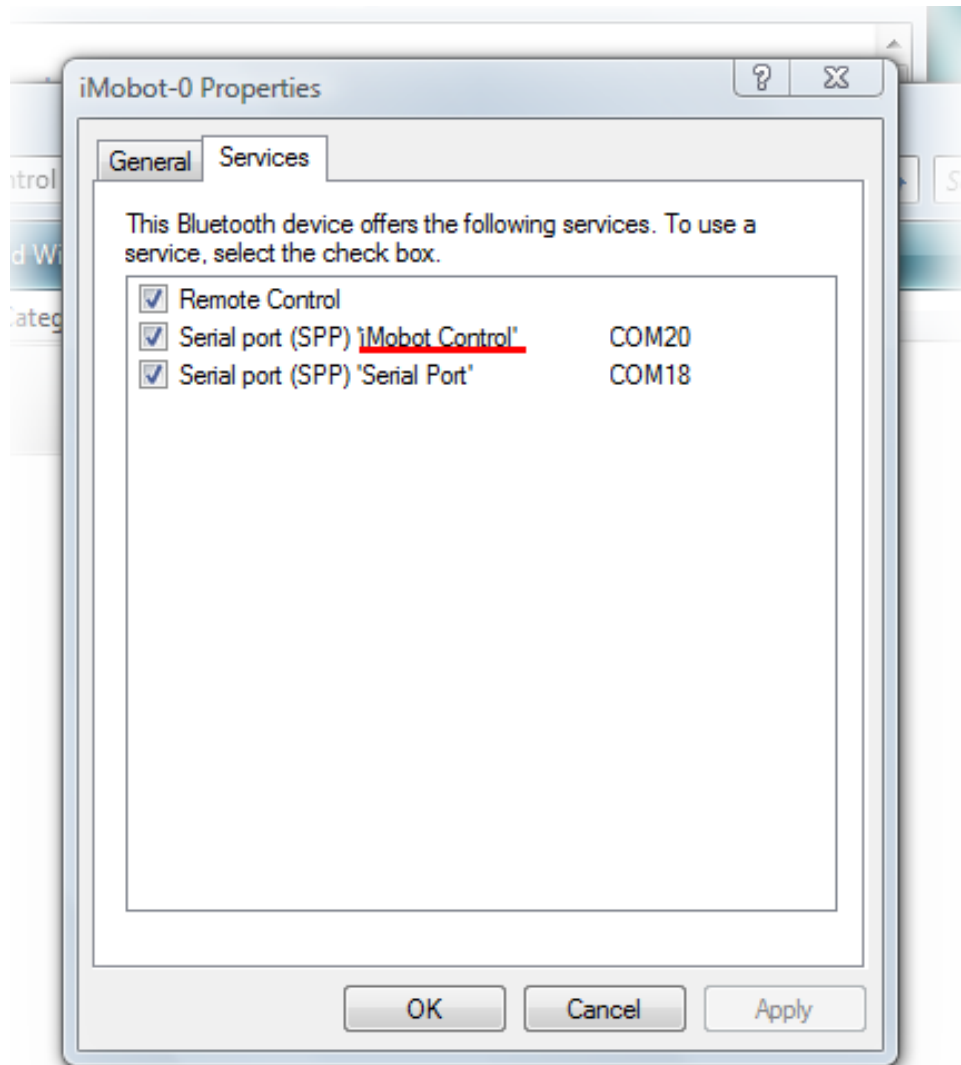
At this point, the following dialog should be shown.



The next step is to enable the iRobot control service. Double-click on the icon denoting the iRobot module to bring up the following dialog:



Click on the tab labeled "Services"



Ensure that the service titled “iMobot Control” is enabled. If it is not enabled, click on the check-box to enable it. Click on the “Ok” button to accept the changes and close the dialogs. The iMobot is now ready to be controlled with the iMobotComms library.

3 Basics of a Ch iMobot Program

To help the user become acquainted with the iMobot control programs, one sample program will be presented to illustrate the basics and minimum requirements

of an iMobot control program.

3.1 getting_started.ch Source Code

```
/* Filename: getting_started.ch */

#include <mobot.h>

CMobot robot;

/* Set the robot to "home" position, where all joint angles are 0 degrees. */
robot.moveToZero();
robot.moveWait();

/* Rotate each of the faceplates by 90 degrees */
robot.moveJointTo(MOBOT_JOINT1, 90);
robot.moveJointTo(MOBOT_JOINT4, 90);

/* Wait for the movement to complete */
robot.moveJointWait(MOBOT_JOINT1);
robot.moveJointWait(MOBOT_JOINT4);
```

3.2 Demo Code for getting_started.ch Explained

The beginning of every iMobot control program will include header files. Each header file imports functions used for a number of tasks, such as printing data onto the screen or controlling the iMobot.

```
#include <stdio.h>          // Required for printf()
#include <mobot.h> // Required for iMobot control functions
```

Next, we must initialize the C++ class used to control the iMobot. This line initializes a new variable named `robot` which represents the remote iMobot module which we wish to control. This special variable is actually an instance of the `CMobot` class, which contains its own set of functions called “methods” or “member functions”.

```
CMobot robot;
```

Note that there is an alternative way to create the `robot` variable. The alternate method takes the following syntax:

```
CMobot robot("12:34:56:78:90:12", 20);
```

The alternate syntax instructs the new `CMobot` variable named `robot` to explicitly connect to the robot with address “12:34:56:78:90:12” and channel 20. This method allows the iMobot program to connect to an iMobot even if it

has not been paired, as described in Section 2. However, it requires the user to know the Bluetooth address of the iMobot in advance.

The next line will use the `moveToZero` member function. The `moveToZero` function causes the iMobot to move all of its motors to the zero position.

```
robot.moveToZero();
```

The majority of iMobot control functions do not wait for the robotic motions to complete before continuing. As such, if we want to wait for the robot to fully complete the requested motion before continuing with the rest of the program, we must use the `moveWait` function, as such.

```
robot.moveWait();
```

The next four lines of code command joints 1 and 4 to rotate 90 degrees, and then waits for the motors to stop moving. Joints 1 and 4 are the faceplates of the iMobot which are sometimes used to act as "wheels".

```
robot.moveJointTo(IMOBOT_JOINT1, 90);  
robot.moveJointTo(IMOBOT_JOINT4, 90);  
robot.moveJointWait(IMOBOT_JOINT1);  
robot.moveJointWait(IMOBOT_JOINT4);
```

A iMobotComms API

The header file **mobot.h** defines all the data types, macros and function prototypes for the iMobot API library. The header file declares a class called **CMobot** which contains member functions which may be used to control the robot.

Table 1: CMobot Member Functions.

Function	Description
CMobot()	The CMobot constructor function. This function is called automatically and should not be called explicitly. This constructor will automatically try to connect with a paired iMobot using the <code>connect()</code> member function. To specify an address to connect to, please use the <code>CMobot(const char address[], int channel);</code> constructor.
CMobot(const char address[], int channel);	An alternate constructor which may be used to explicitly specify the address of an iMobot to connect to.
~CMobot()	The CMobot destructor function. This function is called automatically and should not be called explicitly.
connect()	Connect to a remote iMobot module. This function connects to an already-paired iMobot module in Microsoft Windows. This function does not currently work for non-Windows operating systems, such as Mac or Linux. For those operating systems, please use the <code>connectAddress()</code> function instead.
connectAddress()	Connect to an iMobot module by specifying its Bluetooth address.
disconnect()	Disconnect from an iMobot module.
getJointAngle()	Gets a joint's angle.
getJointSpeed()	Gets a motor's speed.
getJointState()	Gets a motor's current status.
isConnected()	This function is used to check the connection to an iMobot.
move()	Move all four joints of the iMobot by specified angles.
moveContinuous()	Move joints continuously. Joints will move until stopped.
moveContinuousTime()	Move joints continuously for a certain amount of time.
moveTo()	Move all four joints of the iMobot to specified absolute angles.
moveJointTo()	Set the desired motor position.
moveJointWait()	Wait until the specified motor has stopped moving.
moveWait()	Wait until all motors have stopped moving.
moveToZero()	Instructs all motors to go to their zero positions.
to "0" for automatic direction, "1" for forward, and "2" for reverse.	
setJointSpeed()	Sets a motor's speed.
stop()	Stop all currently executing motions of the iMobot.

Table 2: CMobot Member Functions for Compound Motions.

Compound Motions	These are convenience functions of commonly used compound motions.
<code>motionInchwormLeft()</code>	Inchworm gait towards the left.
<code>motionInchwormRight()</code>	Inchworm gait towards the right.
<code>motionRollBackward()</code>	Roll on the faceplates toward the backward direction.
<code>motionRollForward()</code>	Roll on the faceplates forwards.
<code>motionStand()</code>	Stand the iMobot up on its end.
<code>motionTurnLeft()</code> . . .	Rotate the iMobot counterclockwise.
<code>motionTurnRight()</code> . . .	Rotate the iMobot clockwise.

CMobot::connect()

Synopsis

```
#include <mobot.h>
int CMobot::connect();
```

Purpose

Connect to a remote iMobot via Bluetooth.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

None.

Description

This function is used to connect to an iMobot. The iMobot must first be paired with the computer. This function currently only works in Microsoft Windows operating systems. For other operating systems, please use the `connectAddress()` function.

Example

Please see the example in Section 3.2 on page 9.

See Also

`connectAddress()`

CMobot::connectAddress()

Synopsis

```
#include <mobot.h>
int CMobot::connectAddress(const char* address, int channel);
```

Purpose

Connect to a remote iMobot via Bluetooth by specifying the specific Bluetooth address of the device.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

address The Bluetooth address of the iMobot.

channel The Bluetooth channel that the listening program is listening on. The default channel is channel 20.

Description

This function is used to connect to an iMobot.

Example

See Also

`connect()`

CMobot::disconnect()

Synopsis

```
#include <mobot.h>
int CMobot::disconnect();
```

Purpose

Disconnect from a remote iMobot.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

None.

Description

This function is used from disconnect to an iMobot. A call to this function is not necessary before the termination of a program. It is only necessary if another connection will be established within the same program at a later time.

Example

See Also

CMobot::getJointAngle()

Synopsis

```
#include <mobot.h>
int CMobot::getJointAngle(int id, double &position);
```

Purpose

Connect to a remote iMobot via Bluetooth.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

id The joint number to wait for.
positionA variable to store the current position of the iMobot motor. The contents of this variable will be overwritten with a value that represents the motor's angle in degrees.

Description

This function gets the current motor position of an iMobot's motor. The position returned is in units of degrees and is accurate to roughly ± 0.1 degrees.

Example

See Also

connectAddress()

CMobot::getJointSpeed()

Synopsis

```
#include <mobot.h>
int CMobot::getJointSpeed(int id, double &speed);
```

Purpose

Get the speed of a joint on the iMobot.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

- | | |
|--------------|--|
| id | The joint number to pose. |
| speed | A variable of type double . The value of this variable will be overwritten with the current speed setting of the joint, which is a value between 0 and 1. |

Description

This function is used to find the speed of a joint. This is the speed at which the joint will move when given motion commands. The values should be between 0 and 1.

Example

See Also

CMobot::getJointState()

Synopsis

```
#include <mobot.h>
enum iMobot_joint_state_e
{
    IMOBOT_JOINT_IDLE = 0,
    IMOBOT_JOINT_MOVING,
    IMOBOT_JOINT_GOALSEEK,
};
int CMobot::getJointState(int id, int &state);
```

Purpose

Determine whether a motor is moving or not.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

- `id` The joint number to pose.
- `state` An integer variable which will be overwritten with the current state of the motor.

Description

This function is used to determine the current state of a motor. Valid states are:

- IMOBOT_JOINT_IDLE : 0: The motor is idle.
- IMOBOT_JOINT_MOVING : 1: The motor is moving.
- IMOBOT_JOINT_GOALSEEK : 2: The motor is heading towards a specified position.

Example

See Also

CMobot::isConnected()

Synopsis

```
#include <mobot.h>
int CMobot::isConnected();
```

Purpose

Check to see if currently connected to a remote iMobot via Bluetooth.

Return Value

The function returns zero if it is not currently connected to an iMobot, or non-zero otherwise.

Parameters

None.

Description

This function is used to check if the software is currently connected to an iMobot.

Example

See Also

CMobot::motionInchwormLeft()

Synopsis

```
#include <mobot.h>
int CMobot::motionInchwormLeft();
```

Purpose

Perform the inch-worm gait to the left.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

None.

Description

This function causes the iMobot to perform a single cycle of the inchworm gait to the left.

See Also

`motionInchwormRight()`

CMobot::motionInchwormRight()

Synopsis

```
#include <mobot.h>
int CMobot::motionInchwormRight();
```

Purpose

Perform the inch-worm gait to the right.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

None.

Description

This function causes the iMobot to perform a single cycle of the inchworm gait to the right.

See Also

`motionInchwormLeft()`

CMobot::motionRollBackward()

Synopsis

```
#include <mobot.h>
int CMobot::motionRollBackward();
```

Purpose

Use the faceplates as wheels to roll backward.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

None.

Description

This function causes each of the faceplates to rotate 90 degrees to roll the robot backward.

See Also

`motionRollBackward()`

CMobot::motionRollForward()

Synopsis

```
#include <mobot.h>
int CMobot::motionRollForward();
```

Purpose

Use the faceplates as wheels to roll forward.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

None.

Description

This function causes each of the faceplates to rotate 90 degrees to roll the robot forward.

See Also

`motionRollBackward()`

CMobot::motionStand()

Synopsis

```
#include <mobot.h>
int CMobot::motionStand();
```

Purpose

Stand the robot up on a faceplate.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

None.

Description

This function causes the robot to motionStand up into the camera platform.

See Also

CMobot::motionTurnLeft()

Synopsis

```
#include <mobot.h>
int CMobot::motionTurnLeft();
```

Purpose

Rotate the iMobot using the faceplates as wheels.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

None.

Description

This function causes the iMobot to rotate the faceplates in opposite directions to cause the robot to rotate counter-clockwise.

See Also

`motionTurnRight()`

CMobot::motionTurnRight()

Synopsis

```
#include <mobot.h>
int CMobot::motionTurnRight();
```

Purpose

Rotate the iMobot using the faceplates as wheels.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

None.

Description

This function causes the iMobot to rotate the faceplates in opposite directions to cause the robot to rotate clockwise.

See Also

`motionTurnLeft()`

CMobot::move()

Synopsis

```
#include <mobot.h>
int CMobot::move(double angle1, double angle2, double angle3, double angle4);
```

Purpose

Move all of the joints of an iMobot by specified angles.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

None.

Description

This function moves all of the joints of an iMobot by the specified number of degrees from their current positions.

Example

Please see the demo at Section 3.2 on page 9.

See Also

CMobot::moveContinuous()

Synopsis

```
#include <mobot.h>
int CMobot::moveContinuous(int dir1, int dir2, int dir3, int dir4);
```

Purpose

Move the joints of an iMobot continuously in the specified directions.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

Each integer parameter specifies the direction the joint should move. The types are enumerated in `mobot.h` and have the following values:

- `MOBOT_NEUTRAL` : The joint should not move.
- `MOBOT_FORWARD` : The joint will begin moving in the positive direction.
- `MOBOT_BACKWARD`: The joint will begin moving in the negative direction.

Description

This function causes joints of an iMobot to begin moving at the previously set speed. The joints will continue moving until the joint hits a joint limit, or the joint is stopped by setting the speed to zero.

Example

See Also

CMobot::moveContinuousTime()

Synopsis

```
#include <mobot.h>
int CMobot::moveContinuousTime(int dir1, int dir2, int dir3, int dir4, int msec);
```

Purpose

Move the joints of an iMobot continuously in the specified directions.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

Each integer direction parameter specifies the direction the joint should move. The types are enumerated in `mobot.h` and have the following values:

- `MOBOT_NEUTRAL` : The joint should not move.
- `MOBOT_FORWARD` : The joint will begin moving in the positive direction.
- `MOBOT_BACKWARD`: The joint will begin moving in the negative direction.

The `msec` parameter is the time to perform the movement, in milliseconds.

Description

This function causes joints of an iMobot to begin moving. The joints will continue moving until the joint hits a joint limit, or the time specified in the `msec` parameter is reached. This function will block until the motion is completed.

Example

See Also

CMobot::moveTo()

Synopsis

```
#include <mobot.h>
int CMobot::moveTo(double angle1, double angle2, double angle3, double angle4);
```

Purpose

Move all of the joints of an iMobot to the specified positions.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

None.

Description

This function moves all of the joints of an iMobot to the specified absolute positions.

Example

Please see the demo at Section 3.2 on page 9.

See Also

CMobot::moveJointTo()

Synopsis

```
#include <mobot.h>
int CMobot::moveJointTo(int id, double position);
```

Purpose

Connect to a remote iMobot via Bluetooth.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

`id` The joint number to wait for.
`position` The absolute angle to move the motor to.

Description

This function commands the motor to move to a position specified in degrees at the current motor's speed. The current motor speed may be set with the `setJointSpeed()` member function. Please note that if the motor speed is set to zero, the motor will not move after calling the `moveJointTo()` function.

Example

Please see the example in Section 3.2 on page 9.

See Also

`connectAddress()`

CMobot::moveJointWait()

Synopsis

```
#include <mobot.h>
int CMobot::moveJointWait(int id);
```

Purpose

Wait for a joint to stop moving.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

`id` The joint number to wait for.

Description

This function is used to wait for a joint motion to finish. Functions such as `poseJoint()` and `moveJoint()` do not wait for a joint to finish moving before continuing to allow multiple joints to move at the same time. The `moveJointWait()` or `moveJointWait()` functions are used to wait for robotic motions to complete.

Please note that if this function is called after a motor has been commanded to turn indefinitely, this function may never return and your program may hang.

Example

Please see the example in Section 3.2 on page 9.

See Also

`moveWait()`

CMobot::moveWait()

Synopsis

```
#include <mobot.h>
int CMobot::moveWait();
```

Purpose

Wait for all joints to stop moving.

Return Value

The function returns 0 on success and non-zero otherwise.

Description

This function is used to wait for all joint motions to finish. Functions such as `poseJoint()` and `moveJoint()` do not wait for a joint to finish moving before continuing to allow multiple joints to move at the same time. The `moveWait()` or `moveJointWait()` functions are used to wait for robotic motions to complete.

Please note that if this function is called after a motor has been commanded to turn indefinitely, this function may never return and your program may hang.

Example

See the sample program in Section 3.2 on page 9.

See Also

`moveWait()`, `moveJointWait()`

CMobot::moveToZero()

Synopsis

```
#include <mobot.h>
int CMobot::moveToZero();
```

Purpose

Move all of the joints of an iMobot to their zero position.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

None.

Description

This function moves all of the joints of an iMobot to their zero position. Please note that this function is non-blocking and will return immediately. Use this function in conjunction with the `moveWait()` function to block until the movement completes.

Example

Please see the demo at Section 3.2 on page 9.

See Also

CMobot::setJointSpeed()

Synopsis

```
#include <mobot.h>
int CMobot::setJointSpeed(int id, double speed);
```

Purpose

Get the speed of a joint on the iMobot.

Return Value

The function returns 0 on success and non-zero otherwise.

Parameters

id The joint number to pose.
speed An variable of type **double** indicating the requested speed.

Description

This function is used to set the speed of a joint of an iMobot. Valid speed values range from 0 to 1.

Example

See Also

CMobot::stop()

Synopsis

```
#include <mobot.h>
int CMobot::stop();
```

Purpose

Stop all current motions on the iMobot.

Return Value

The function returns 0 on success and non-zero otherwise.

Description

This function stops all currently occurring movements on the iMobot. Internally, this function simply sets all motor speeds to zero. If it is only required to stop a single motor, use the `setJointSpeed()` function to set the motor's speed to zero.

Example

See Also

`setJointSpeed()`

B Macros

B.1 iMobot_joints_t

The data type `iMobot_joints_t` contains the following macro datatypes.

Value	Description
IMOBOT_JOINT1	Joint number 1 on the iMobot, which is a face-plate joint.
IMOBOT_JOINT2	Joint number 1 on the iMobot, which is a body joint.
IMOBOT_JOINT3	Joint number 1 on the iMobot, which is a body joint.
IMOBOT_JOINT3	Joint number 1 on the iMobot, which is a face-plate joint.

B.2 iMobot_joint_direction_t

The data type `iMobot_joint_direction_t` indicates the commanded direction of a joint on the Mobot.

Value	Description
IMOBOT_NEUTRAL	This value indicates automatic direction control for a joint. The Mobot will choose the best direction to attain the commanded joint position.
IMOBOT_FORWARD	Move the joint in the forward direction.
IMOBOT_BACKWARD	Move the joint in the backward direction.

C Index

Index

connect(), 13
connectAddress(), 14

disconnect(), 15

getJointAngle(), 16
getJointSpeed(), 17
getJointState(), 18

IMOBOT_BACKWARD, 36
IMOBOT_FORWARD, 36
IMOBOT_JOINT1, 36
IMOBOT_JOINT2, 36
IMOBOT_JOINT3, 36
IMOBOT_JOINT4, 36
iMobot_joint_direction_t, 36
iMobot_joints_t, 36
IMOBOT_NEUTRAL, 36
isConnected(), 19

motionInchwormLeft(), 20
motionInchwormRight(), 21
motionRollBackward(), 22
motionRollForward(), 23
motionStand(), 24
motionTurnLeft(), 25
motionTurnRight(), 26
move(), 27
moveContinuous(), 28
moveContinuousTime(), 29
moveJointTo(), 31
moveJointWait(), 32
moveTo(), 30
moveToZero(), 34
moveWait(), 33

setJointSpeed(), 35
stop(), 36