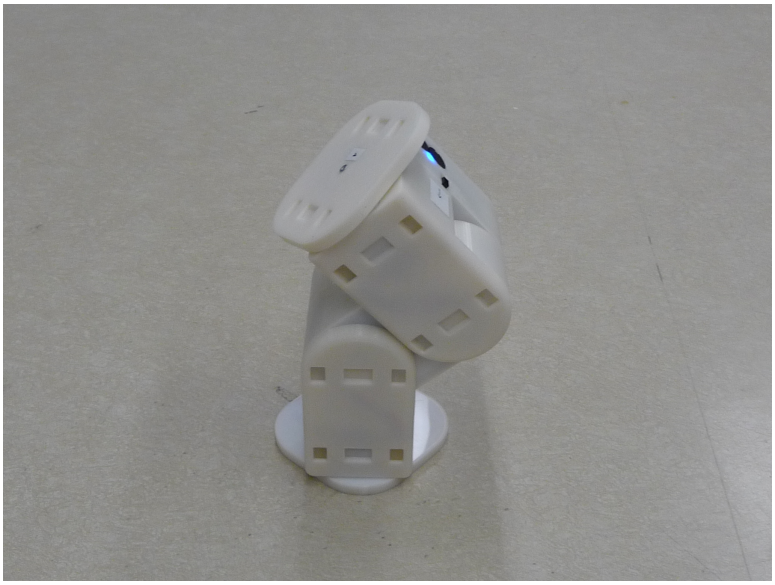
Barobo™

MoBot User's Guide

Version 1.3



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Contents

1 The `CMobot` MoBot Remote Control Library

The `CMobot` library is a collection of functions geared towards controlling the motors and reading sensor values of a MoBot 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++ classes called `CMobot` and `CMobotGroup` to facilitate control of single and multiple MoBots.

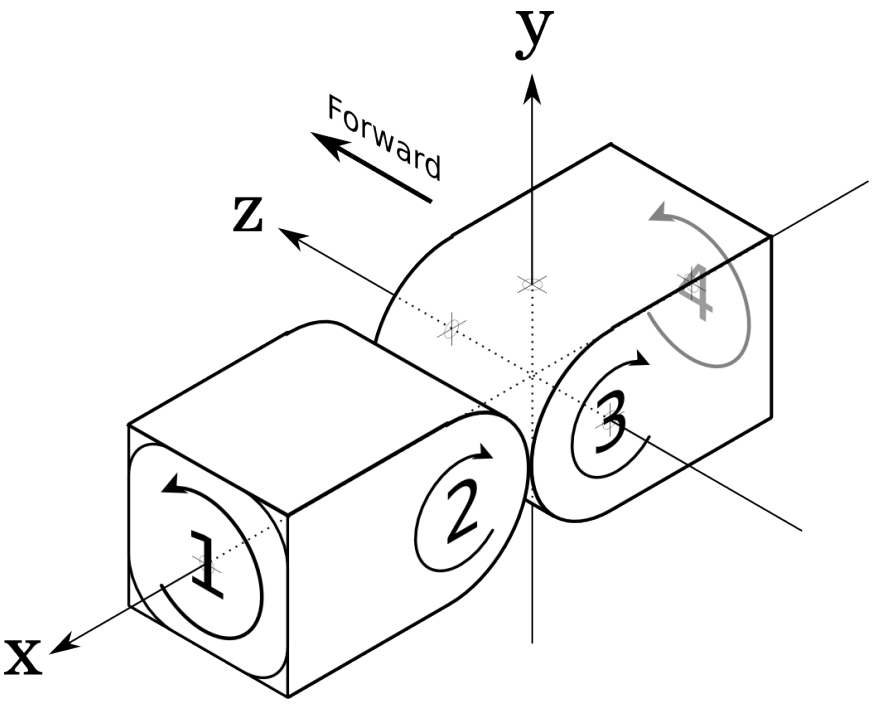

Figure 1: A schematic diagram of a MoBot module.

Figure 1 shows a schematic diagram displaying the locations and positive directions of the four joints of a MoBot module. The joints 1 and 4 shown in the figure are fully rotational and have no joint limits. Joints 2 and 3, however, can only move in the range -90 to +90 degrees.

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

2 Configuring MoBots for Remote Control

MoBot modules should be configured the first time they are used with a new computer. The process informs the computer which MoBots it is allowed to connect to. The is also necessary for certain functions in the `CMobot` API, such as `connect()`, to determine which robots to connect to.

The configuration is performed through the Barobo RobotController program. The remainder of the section contains step-by-step instructions and screenshots showing how to configure your MoBots.

To start the provided Barobo Robot Control Program click on the icon labeled “RobotController” on your desktop, as shown in 2. The control dialog as shown in Figure 3 should pop up.

Figure 2: The icon for the Barobo RobotController.

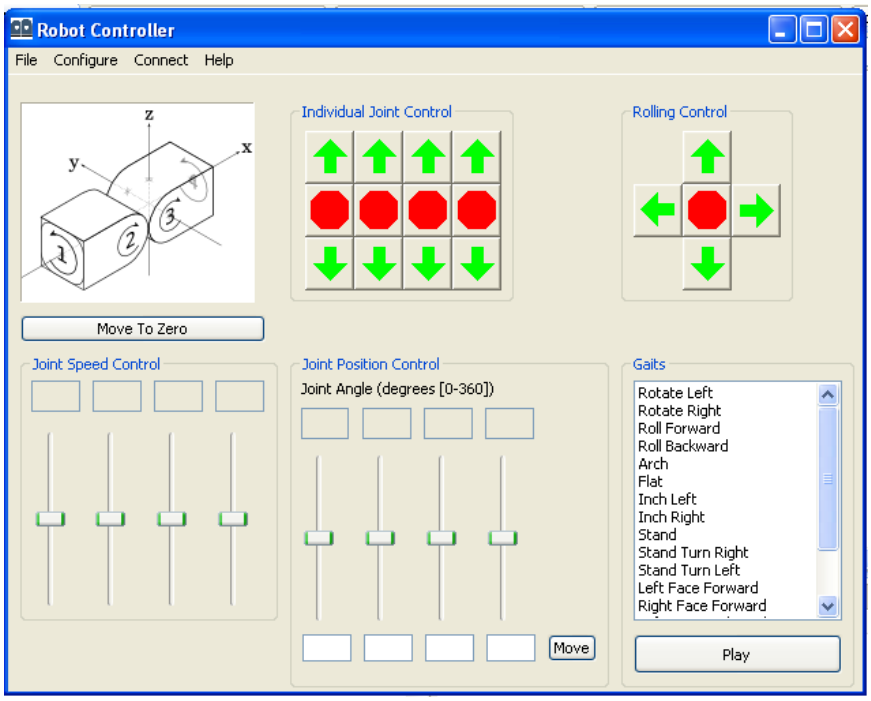

Figure 3: The graphical user interface of the RobotController.

2.1 Adding Bluetooth Addresses of Robots in RobotController.

Click on the menu item "Configure → Configure Robot Bluetooth", as shown in Figure 4.

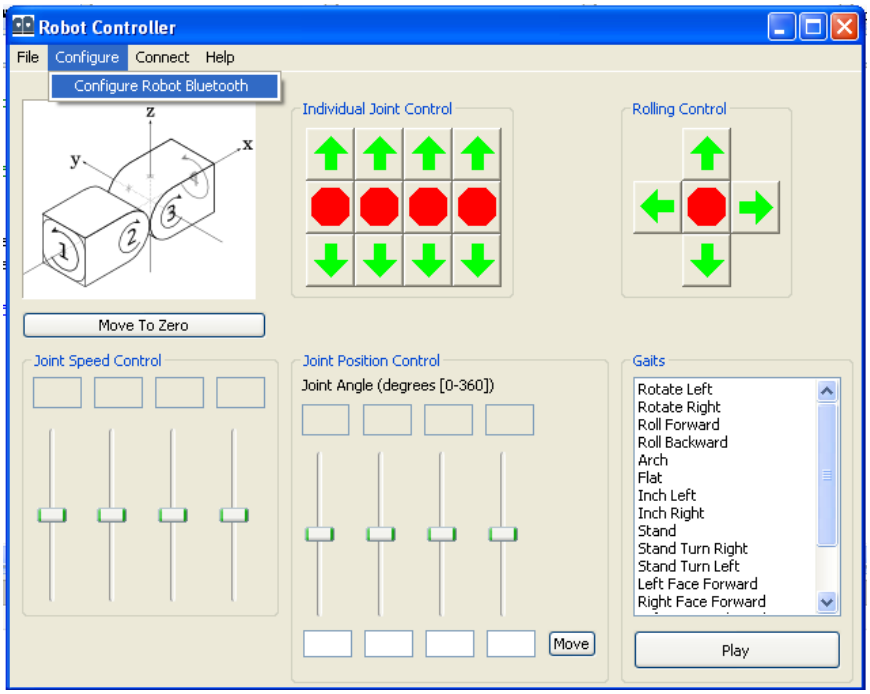

Figure 4: Configuring robot bluetooth connection.

This should bring up a second dialog, titled "Configure Robot Bluetooth", as shown in Figure 5.

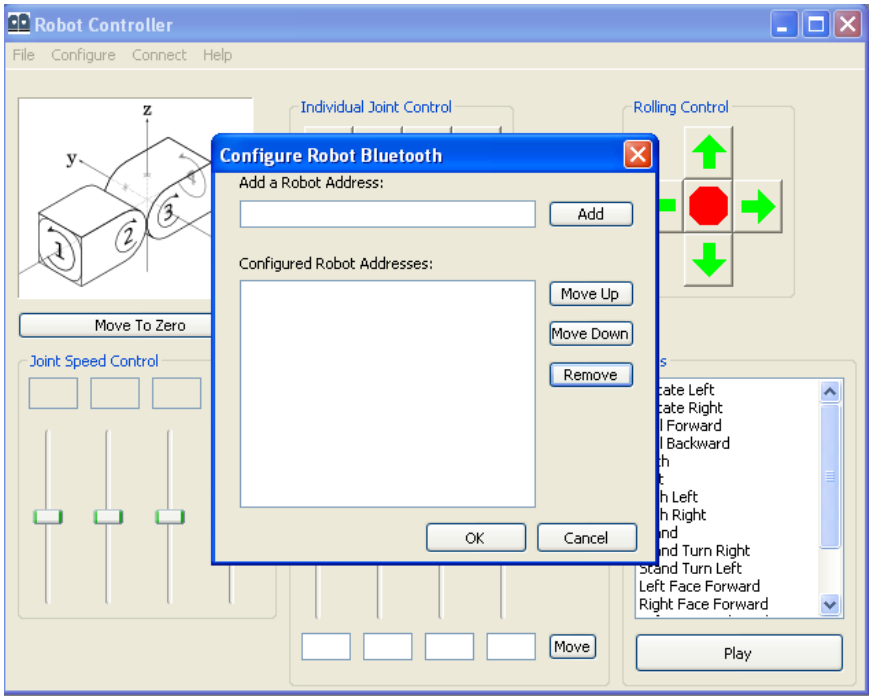

Figure 5: The dialog window for bluetooth connection.

This dialog allows us to add robot bluetooth addresses to the list of currently known robot bluetooth addresses. To add an address, first type in the address in the text box on the top of the dialog, as shown in Figure 6. You can find the bluetooth address of each robot inside the battery compartment of the robot on the same side as the power switch.

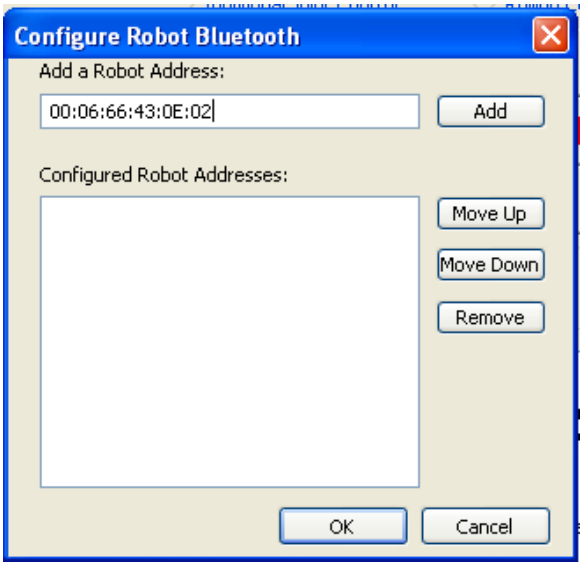

Figure 6: Adding the robot bluetooth address in the dialog window.

Next, click the "Add" button. The newly added address should appear in the list of known addresses, as shown in Figure 7. In our case, we have added the address of one of our robots, which is `"00:06:66:43:0E:02"`.

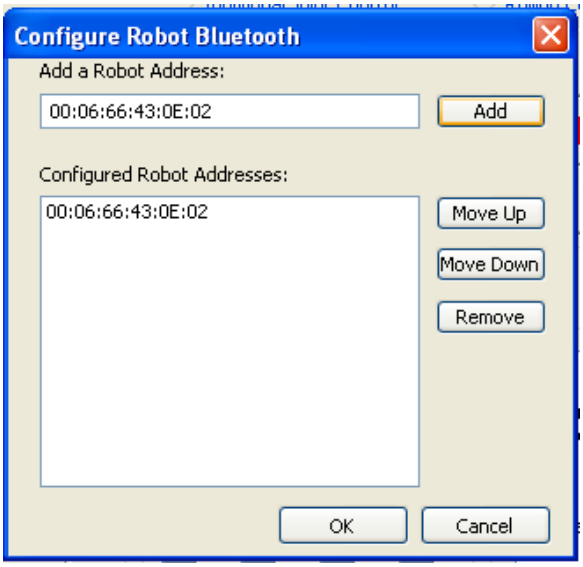

Figure 7: Displaying the added bluetooth address.

We use the same process to add our remaining two robots to the list, with addresses `"00:06:66:43:0D:F2"` and `"00:06:66:47:23:9C"`. The dialog now appears as shown in Figure 8.

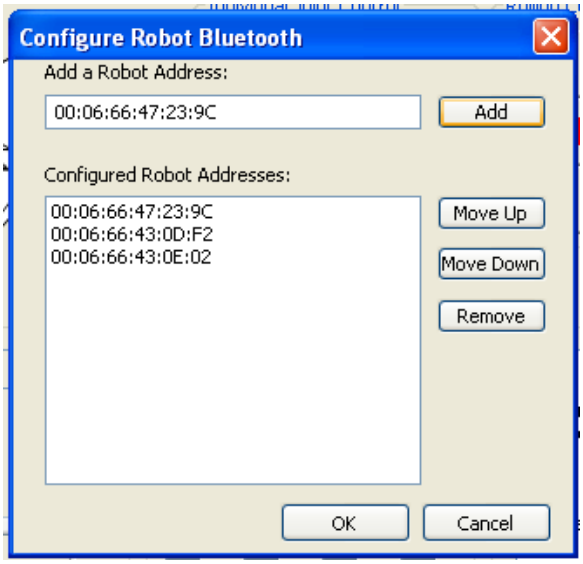

Figure 8: Displaying bluetooth addresses for three robots.

The dialog also allows users to reorder the addresses listed. The order the addresses are listed in affects the order in which the robots are connected to using the `connect()` member function. The remote control dialog

connects to the primary address located at the top of the list by default. To reorder the list of addresses, simply select the address to move and click on the "Move Up" or "Move Down" button to either move the address higher in the list or lower. For instance, the result of clicking on the address `"00:06:66:43:0D:F2"` and clicking the "Move Up" button is shown in Figure 9.

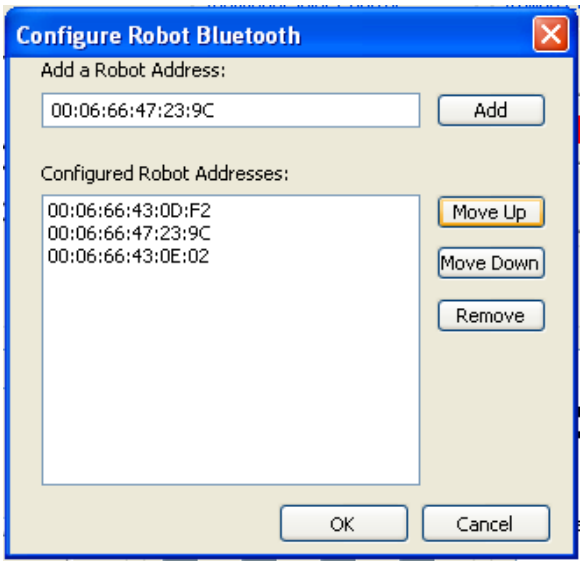

Figure 9: Modifying the order of bluetooth addresses with the "Configure Robot Bluetooth" dialog.

2.2 Connecting and Disconnecting to Robots from the RobotController

Once bluetooth addresses are added to the RobotController, you may connect to the first address by clicking on the "Connect → Connect to Robot" menu item. The connected robot may be disconnected by clicking on the "Connect → Disconnect from Robot" menu item. Any connected robots are automatically disconnected upon exiting the program. Note that in order to run a Ch program that controls a robot, the robot should not currently be connected to any other application, including the RobotController, other Ch programs, and other programs on other computers.

3 The Robot Remote Control Program

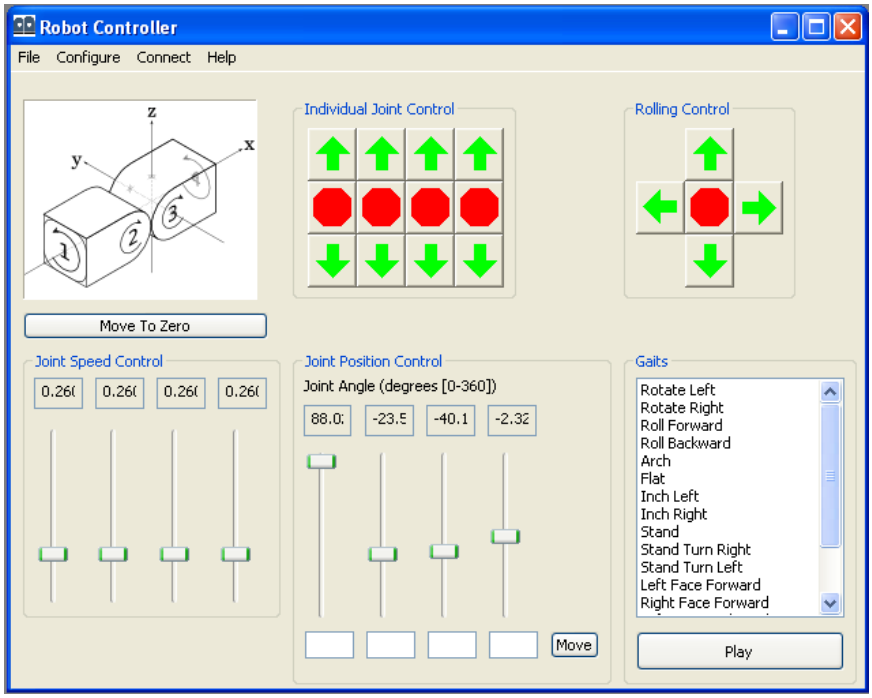

Figure 10: The graphical display of the RobotController while connected to a robot.

Once a robot is connected to the RobotController, the joint angles and speeds of the robot are displayed as shown in Figure 10. The RobotController can then be used to display information about the MoBot's joint positions, and also control the speeds and positions of the MoBot's joints. The interface is divided up into six sections; three on the top half of the interface, and three on the bottom half.

3.1 The MoBot Diagram and "Move To Zero" Button

The first section of the GUI located on the top left of the interface displays a schematic diagram of the MoBot, displaying motor positions. Underneath the diagram, there is a large button with the text "Move To Zero". When clicked, this button will command the connected MoBot to rotate all of its joints to a flat "Zero" position.

3.2 Individual Joint Control

The second section, located at the top-middle section of the interface, is the "Individual Joint Control" section. These buttons command the MoBot to move individual joints. When the up or down arrows are clicked, the MoBot begins to move the corresponding joint in either the positive, or negative direction. The joint will continue to move until the stop button, located between the up and down arrows, is clicked.

If the joint encounters any obstacle that prevents it from moving, the joint will automatically disengage power to the joint. This may happen, example, if a body joint attempts to rotate beyond its limits, or if it collides with the other corresponding body joint.

3.3 Rolling Control

This section contains buttons for controlling the MoBot as a two wheeled mobile robot. The up and down buttons cause the MoBot to roll forward or backward. The left and right buttons cause the MoBot to rotate towards the left, or towards the right. The stop button in the middle causes the MoBot to stop where it is.

3.4 Joint Speeds

The "Joint Speeds" section, located at the bottom left of the interface, displays and controls the current joint speeds of the MoBot. The joint speeds are in units of degrees per second. To set a specific desired joint speed for a particular joint, the joint speed may be typed directly into the edit boxes below the sliders, and the "Set" button should be clicked.

3.5 Joint Positions

This section, located in the bottom-middle of the interface, is used to display and control the positions of each of the four joints of a MoBot. The joint positions are displayed in the numerical text located above each vertical slider. The displayed joint positions are in units of degrees.

The method of controlling the joints is by using the vertical sliders. Each vertical slider's position represents a joint's angle. The sliders for the two end joints vary from -180 degrees to 180 degrees, representing one complete rotation. The angles for the two body joints vary from -90 to 90 degrees. When the position of the slider is moved, the MoBot will move its joints to match the sliders.

Underneath the sliders, there are four text entry boxes. The text boxes accept specific angles for each joint which the user may type in. When the "Move" button is clicked, each joint will move to their respective desired positions. If any text entry is left blank, the corresponding joint will not move.

3.5.1 Joint Limits

Joints 1 and 4 are fully rotational and have no joint limits. Joints 2 and 3, however, are limited to a range of -90 to +90 degrees.

3.6 Motions

This section, located on the bottom right of the interface, contains a set of preprogrammed motions for the MoBot. To execute a preprogrammed motion, simply click on the name of the motion you wish to execute, and then click the button labeled "Play".

4 Getting Started with Programming the MoBot

Before the Ch program is executed, the Bluetooth addresses of the robots need to be added using the RobotController as described in Section 2. If a robot is already connected to the RobotController, disconnect from the robot before running the Ch program, or close the RobotController application.

The first demo presents a minimal program which connects to a MoBot and moves some joints.

4.1 `start.ch`, A Basic Ch Mobot Program

4.1.1 `start.ch` Source Code

```
/* Filename: start.ch
 * Move the robot endplates. */

#include <mobot.h>
```

```
CMobot robot;
double angle1, angle4; // Angles for joints 1 and 4

/* Connect to the paired MoBot */
robot.connect();

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

/* Rotate each of the faceplates by 360 degrees */
angle1 = 360;
angle4 = 360;
robot.move(angle1, 0, 0, angle4);
robot.moveWait();
```

4.1.2 Demo Code for `start.ch` Explained

The beginning of every MoBot 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 MoBot. The `mobot.h` header file must be included in order to use the `CMobot` class and related robotic control functions.

```
#include <mobot.h> // Required for MoBot control functions
```

Next, we must initialize the C++ class used to control the MoBot.

```
CMobot robot;
```

This line initializes a new variable named `robot` which represents the remote MoBot 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".

Next, we initialize two `double` type variables called "angle1" and "angle4", which we will use to store joint angles by the statement below.

```
double angle1, angle4;
```

The next line,

```
robot.connect();
```

will connect our new variable, `robot`, to a MoBot that has been previously configured with the computer in the process described in Section 2.

Note that there are two common methods to connect to a remote MoBot. The most common method, demonstrated in the previous line of code, is used to connect to a MoBot that is already paired to the computer. It is also possible to connect to MoBots which are not paired with the computer. This method is necessary for connecting to multiple MoBots simultaneously, as only a single MoBot may be paired with the computer at a time. The second method uses the function `connectWithAddress()`, and its default usage is as such:

```
string_t address = "11:22:33:44:55:66";
int defaultChannel = 1;
robot.connectWithAddress(address, defaultChannel);
```

The string `"11:22:33:44:55:66"` represents the Bluetooth address of the MoBot, which must be known in advance. The channel number `1` represents the Bluetooth channel to connect to. Channel `1` is the default channel MoBots listen on for incoming connections, but may be set to other values depending on the type of robot. Detailed documentation for each of the MoBot functions, such as `connect()` and `connectAddress()`, are presented in Appendix B.

The next line,

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

uses the `moveToZero()` member function. The `moveToZero` function causes the MoBot to move all of its motors to the zero position.

The next lines of code command joints 1 and 4 to rotate 360 degrees.

```
angle1 = 360;
angle4 = 360;
robot.move(angle1, 0, 0, angle4);
```

Note that the member function `move()` expects input angles in degrees, so the angles in radians must be first be converted to degrees using the `rad2deg()` function. The `rad2deg()` function takes an angle in radians as its argument and returns the angle in degrees. The function is implemented in Ch with the code

```
#include<math.h>
double rad2deg(double radians)
{
    double degrees;
    radians = radians * 180.0 / M_PI;
    return degrees;
}
```

If desired, values in radians may also be converted to degrees using the counterpart function, `deg2rad()`. Joints 1 and 4 are the faceplates of the MoBot which are sometimes used to act as "wheels".

4.2 `returnval.ch`, A Basic Ch Mobot Program Which Checks Return Values

```
/* Filename: returnval.ch
 * Rotate the faceplates by 90 degrees */

#include <mobot.h>

CMobot robot;

/* Connect to the paired MoBot */
if(robot.connect())
{
    printf("Failed to connect to the robot.\n");
    exit(0);
}
/* Set the robot to "home" position, where all joint angles are 0 degrees. */
robot.moveToZero();

/* Rotate each of the faceplates by 360 degrees */
robot.move(360, 0, 0, 360);
/* Move the motors back to where they were */
robot.move(-360, 0, 0, -360);
```

5 Controlling the Speed of Mobot Joints

```
/* Filename: setspeed.ch
  Move the two wheeled robot with different speed. */

#include <mobot.h>
#include <math.h>

CMobot robot;

/* Connect to the paired MoBot */
robot.connect();

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

double speed, radius;
robot.getJointMaxSpeed(ROBOT_JOINT1, speed);
printf("The maximum speed is %lf degrees/s\n", rad2deg(speed));

robot.setJointSpeed(ROBOT_JOINT1, 90);
robot.setJointSpeed(ROBOT_JOINT4, 90);

//robot.setJointSpeedRatio(ROBOT_JOINT1, 0.5);
//robot.setJointSpeedRatio(ROBOT_JOINT4, 0.5);

//robot.setJointSpeeds(90, 0, 0, 90);

printf("Roll forward 360 degrees.\n");
robot.motionRollForward(360);

speed = (3.5/2) * M_PI / 2;      // 2.75 inch/s
radius = 3.5/2;     // radius is 1.75
robot.setTwoWheelRobotSpeed(speed, radius);

printf("Move 360 degrees.\n");
robot.move(360, 0, 0, 360);

/* move at 2.75inch/sec with the radius 3.5 inches for 3 seconds */
printf("Move continuously for 3 seconds.\n");
robot.moveContinuousTime(ROBOT_FORWARD, ROBOT_HOLD,
                         ROBOT_HOLD, ROBOT_FORWARD, 3000);
```

6 Preprogrammed Motions

The robot API contains functions for executing preprogrammed motions. The preprogrammed motions are motions which are commonly used for robot locomotion. Following is a list of available functions and a brief description about their effect on the robot.

- `motionArch()`: This function causes the robot to arch up for better clearance.

- `motionInchwormLeft()`: This function causes the robot to perform the inchworm gait once, moving the robot towards its left.
- `motionInchwormRight()`: This function causes the robot to perform the inchworm gait once, moving the robot towards its right.
- `motionRollBackward()`: This function causes the robot to rotate its faceplates, using them as wheels to roll backward.
- `motionRollForward()`: This function causes the robot to rotate its faceplates, using them as wheels to roll forward.
- `motionSkinny()`: This function makes the robot assume a skinnier rolling profile.
- `motionStand()`: This function causes the robot to stand up onto a faceplate, assuming the camera platform position.
- `motionTumble()`: This function causes the robot to perform the tumbling motion, flipping end over end.
- `motionTurnLeft()`: This function uses the robot's faceplates as wheels, turning them in opposite directions in order to rotate the robot towards its left.
- `motionTurnRight()`: This function uses the robot's faceplates as wheels, turning them in opposite directions in order to rotate the robot towards its right.
- `motionUnstand()`: This function causes the robot to drop down from a standing position.

Note that all of the functions listed above are "blocking" functions, meaning they will not return until the motion has completed. These functions also have non-blocking equivalents which are discussed in Section 8.

6.1 `inchworm.ch`: A Demo using the `motionInchwormLeft()` Preprogrammed Motion

6.1.1 `inchworm.ch` Source Code

```
/* File: inchworm.ch
 * Perform the "inchworm" motion four times */

#include <mobot.h>

CMobot robot;

/* Connect to the paired MoBot */
robot.connect();

/* Set robot motors to speed of 0.50 */
robot.setJointSpeedRatio(ROBOT_JOINT2, 0.50);
robot.setJointSpeedRatio(ROBOT_JOINT3, 0.50);

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

/* Do the inchworm motion four times */
robot.motionInchwormLeft(4);
```

6.1.2 `inchworm.ch` Explained

First, the header file `mobot.h` is included. This header file is required before usage of the `CMobot` class and its associated member functions can be used. Next, we create a variable to reperesent our robot and connect to the robot with the following lines.

```
CMobot robot;

/* Connect to the paired MoBot */
robot.connect();
```

Next, we set the motor speeds to 50% speed with the following lines.

```
robot.setJointSpeedRatio(ROBOT_JOINT2, 0.50);
robot.setJointSpeedRatio(ROBOT_JOINT3, 0.50);
```

`ROBOT_JOINT2` and `ROBOT_JOINT3` are enumerated values defined in the header file `mobot.h`. Detailed information for all enumerated values defined in `mobot.h` can be found in Appendix A.

We then move the robot to its zero position in preparation for the inchworm gait.

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

Finally, we perform the inchworm gait four times. The argument for the function `motionInchwormLeft()` reperesents the number of times the gait should be performed.

```
robot.motionInchwormLeft(4);
```

6.2 `stand.ch`: A Demo Using the `motionStand()` Preprogrammed Motion

This demo is a simple demonstration of the `motionStand()` member function.

6.2.1 `stand.ch` Source Code

```
/* Filename: stand.ch
 * Make a MoBot stand up on a faceplate */
#include <mobot.h>

CMobot robot;
/* Connect to the paired MoBot */
robot.connect();
/* Run the built-in motionStand function */
robot.motionStand();
sleep(3); // Stand still for three seconds
/* Spin the robot around two revolutions while spinning the top faceplate*/
robot.move(2*360, 0, 0, 2*360);
/* Lay the robot back down */
robot.motionUnstand();
```

6.2.2 `stand.ch` Explained

After the initialization and connection as seen in the previous demo, it executes the following line of code:

```
robot.motionStand();
```

This line of code causes the MoBot to perform a sequence of motions causing it to stand up on a faceplate. After the robot has stood up, the next line of code,

```
sleep(3); // Stand still for three seconds
```

pauses the program for three seconds, causing the robot to remain still for three seconds. After the pause is over, the line

```
robot.move(2*360, 0, 0, 2*360);
```

turns both faceplates of the robot two full rotations, making the robot spin in place while standing. Finally, the line

```
robot.motionUnstand();
```

causes the robot to drop back down into a flat position.

6.3 `tumble.ch`: A Demo Using the `motionTumble()` Preprogrammed Motion

```
/* Filename: tumble.ch
 * Tumbling robot */

#include <mobot.h>

CMobot robot;

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

/* Tumble five times */
robot.motionTumble(5);
```

6.4 `motion.ch`: A Demo Using Multiple Preprogrammed Motions

```
/* Filename: motion.ch
 * Move the two wheeled robot. */

#include <mobot.h>

CMobot robot;

/* Connect to the paired MoBot */
robot.connect();

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

/* test all pre-programmed motions */
robot.motionArch(90);
robot.motionInchwormLeft(4);
robot.motionInchwormRight(4);
robot.motionRollBackward(360);
robot.motionRollForward(360);
robot.motionTurnLeft(360);
```

```
robot.motionTurnRight(360);
robot.motionStand();
robot.motionUnstand();
robot.motionTumble(5);
```

7 Detailed Examples of Preprogrammed Motions and Writing Customized Motions

To help the user become acquainted with the MoBot control programs, sample programs will be presented in this section to illustrate the basics and minimum requirements of a MoBot control program. The sample programs are located at `CHHOME/package/chmobot/demos`, where `CHHOME` is the Ch home directory, such as `C:\Ch` for Windows. For Windows, it is located at `C:\Ch\package\chmobot\demos` by default.

7.1 Inchworm Gait Demo

The next demo will illustrate how a simple gait known as the "Inchworm" gait can be implemented.

7.1.1 `inchworm2.ch` Source Code

```
/* File: inchworm2.ch
 * Perform the "inchworm" motion four times */

#include <mobot.h>

CMobot robot;

/* Connect to the paired MoBot */
robot.connect();

/* Set robot motors to speed of 0.50 */
robot.setJointSpeedRatio(ROBOT_JOINT2, 0.50);
robot.setJointSpeedRatio(ROBOT_JOINT3, 0.50);

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

/* Do the inchworm motion four times */
int i, num = 4;
double angle2 = -45;
double angle3 = 45;
for(i = 0; i < num; i++) {
  robot.moveJointTo(ROBOT_JOINT2, angle2);
  robot.moveJointTo(ROBOT_JOINT3, angle3);
  robot.moveJointTo(ROBOT_JOINT2, 0);
  robot.moveJointTo(ROBOT_JOINT3, 0);
}
```

7.1.2 Demo Code for `inchworm2.ch` Explained

The first portion of the code is identical to the previous demo, and performs the same function of declaring a MoBot variable and connecting to a paired MoBot.

```
#include <mobot.h>

CMobot robot;

/* Connect to the paired MoBot */
robot.connect();
```

The next lines of code set the joint speeds for the two body joints, joints two and three, to 50% speed. They are set to fifty percent speed in order to slow the motion down in order to minimize slippage.

```
/* Set robot motors to speed of 0.50 */
robot.setJointSpeedRatio(ROBOT_JOINT2, 0.50);
robot.setJointSpeedRatio(ROBOT_JOINT3, 0.50);
```

Next, we move the robot into a flat "zero" position.

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

Finally, we perform the actual inchworm motion. The inchworm motion is a gait defined by a sequence of motions performed by the body joints. The motions are as such:

1. The first body joint, referred to as joint A, rotates towards the ground. This drags the MoBot towards the direction of joint A.
2. The other body joint, joint B, rotates towards the ground. Since the center of gravity is currently positioned over joint A, this causes the trailing body joint to slide toward joint A.
3. Joint A moves back to a flat position.
4. Joint B moves back to a flat position.
5. Repeat, if desired.

The direction of travel depends on the selection of the initial body joint. In the following code example, joint 2 is chosen as the initial body joint to move. In this case, the MoBot will traverse towards joint 2. The entire motion is encapsulated in a "for" loop which executes the entire motion four times.

```
/* Do the inchworm gait four times */
int i, num = 4;
double angle2 = -45;
double angle3 = 45;
for(i = 0; i < num; i++) {
    robot.moveJointTo(ROBOT_JOINT2, angle2);
    robot.moveJointTo(ROBOT_JOINT3, angle3);
    robot.moveJointTo(ROBOT_JOINT2, 0);
    robot.moveJointTo(ROBOT_JOINT3, 0);
}
```

The values of the variables `angle2` and `angle3` may also be modified to produce different variations of the inchworm gait to accomodate different terrain textures and ground surfaces.

7.2 Standing Demo

7.2.1 `stand2.ch` Source Code

```
/* Filename: stand2.ch
 * Make a MoBot stand up on a faceplate */

#include <mobot.h>

CMobot robot;

/* Connect to the paired MoBot */
robot.connect();

/* Set robot motors to speed of 90 degrees per second */
robot.setJointSpeed(ROBOT_JOINT2, 90);
robot.setJointSpeed(ROBOT_JOINT3, 90);
/* Set the robot to "home" position, where all joint angles are 0 degrees. */
robot.moveToZero();

/* Move the robot into a fetal position */
robot.moveJointTo(ROBOT_JOINT2, -85);
robot.moveJointTo(ROBOT_JOINT3, 70);

/* Wait a second for the robot to settle down */
sleep(1);

/* Rotate the bottom faceplate by 45 degrees */
robot.moveJointTo(ROBOT_JOINT1, 45);

/* Lift the body up */
robot.moveJointTo(ROBOT_JOINT2, 20);

/* Pan the robot around for 3 seconds at 45 degrees per second*/
robot.setJointSpeed(ROBOT_JOINT1, 45);
robot.moveContinuousTime(ROBOT_FORWARD, ROBOT_HOLD, ROBOT_HOLD, ROBOT_HOLD, 3000);
```

7.2.2 `stand2.ch` Explained

The first portion of the program performs the necessary setup and connecting, similar to the previous demos. Similar to the previous inchworm demo, the motor speeds are set to a speed of 90 degrees per second, and the function `moveToZero()` is called to put the robot into a flat position. Next, the following lines are executed:

```
robot.moveJointTo(ROBOT_JOINT2, -85);
robot.moveJointTo(ROBOT_JOINT3, 70);
```

These movement commands cause the MoBot to curl up into a fetal position with both of its endplates facing toward the ground. The next line,

```
sleep(1);
```

causes the program to pause for one second before continuing. This allows the robot to settle down, in case it was still in motion from the last movement.

Next, the MoBot rotates one of the endplates by 45 degrees.

```
robot.moveJointTo(ROBOT_JOINT1, 45);
```

This endplate will eventually become the "foot" of the standing MoBot. Next, the MoBot lifts itself into a standing position, balancing on its endplate.

```
robot.moveJointTo(ROBOT_JOINT2, 20);
```

Note that the previous joint angle for Joint 2, a body joint, was -85 degrees. This motion causes joint 2 to rotate all the way to a 20 degree position, which lift up the body of the MoBot such that the MoBot is balancing on faceplate joint 1.

Finally, we rotate joint 1, the foot joint, for three seconds which causes the entire MoBot to rotate in place. The speed is first set to 45 degrees per second to make the rotation a slow rotation. Next, the `moveContinuousTime` member function is used to continuously rotate a joint for a desired amount of time.

```
robot.setJointSpeed(ROBOT_JOINT1, 45);
robot.moveContinuousTime(ROBOT_FORWARD, ROBOT_HOLD, ROBOT_HOLD, ROBOT_HOLD, 3000);
```

The macros `ROBOT_FORWARD` and `ROBOT_BACKWARD` indicate the directions for each motor to turn. The macro `ROBOT_NEUTRAL` indicates that the motor should not turn, but should remain flexible and backdrivable. The macro `ROBOT_HOLD` indicates that the joint will not turn, and that the joint will be forcefully held in place at its current position. More information regarding these macros may be found in Section A.2.

7.3 Tumbling Demo

```
/* Filename: tumble2.ch
 * Tumbling robot */

#include <mobot.h>

CMobot robot;

/* Connect to the paired MoBot */
robot.connect();

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

/* Move the robot into a fetal position */
robot.moveJointTo(ROBOT_JOINT2, -85);
robot.moveJointTo(ROBOT_JOINT3, 80);

/* Begin tumbling for n times */
int n = 5;
int i;
for(i = 0; i < n; i++) {
    if((i%2) == 0) { /* If i is an even number... */
        robot.moveJointTo(ROBOT_JOINT2, 0);
        robot.moveJointTo(ROBOT_JOINT3, 0);
        robot.moveJointTo(ROBOT_JOINT2, 70);
        robot.moveJointTo(ROBOT_JOINT3, -85);
        robot.moveJointTo(ROBOT_JOINT2, 80);
    } else { /* If i is an odd number, */
```

```
        robot.moveJointTo(ROBOT_JOINT3, 0);
        robot.moveJointTo(ROBOT_JOINT2, 0);
        robot.moveJointTo(ROBOT_JOINT3, 70);
        robot.moveJointTo(ROBOT_JOINT2, -85);
        robot.moveJointTo(ROBOT_JOINT3, 80);
    }
}
```

8 Blocking and Non-Blocking Functions

All of the MoBot movement functions may be designated as either "blocking" functions or "non-blocking" functions. A blocking function is a function which does not return while operations are being performed. All standard C functions, such as `printf()`, are blocking functions. The `moveWait()` function is a blocking function. When called, the function will hang, or "block", until all the joints have stopped moving. After all joints have stopped moving, the `moveWait()` function will return, and the rest of the program will execute.

Furthermore, some functions have both a blocking version and a non-blocking version. For these functions, the suffix `NB` denotes that the function is non-blocking. For instance, the function `motionStand()` is blocking, meaning the function will not return until the motion is completed, whereas the function `motionStandNB()` is non-blocking, meaning the function returns immediately and the robot performs the "standing" motion asynchronously.

The function `moveNB()` is an example of a non-blocking function. When the `moveNB()` function is called, the function immediately returns as the joints begin moving. Any lines of code following the call to `moveNB()` will be executed even if the current motion is still in progress.

Demos for the non-blocking functions are located in the next section of this document.

8.1 List of Blocking Movement Functions

- `move()`
- `moveContinuousTime()`
- `moveJoint()`
- `moveJointTo()`
- `moveTo()`
- `moveToZero()`
- `moveJointWait()`
- `moveWait()`
- `motionArch()`
- `motionInchwormLeft()`
- `motionInchwormRight()`
- `motionRollBackward()`
- `motionRollForward()`
- `motionSkinny()`

- motionStand()
- motionTumble()
- motionTurnLeft()
- motionTurnRight()
- motionUnstand()

8.2 List of Non-Blocking Movement Functions

- moveNB()
- moveContinuousNB()
- moveJointNB()
- moveJointToNB()
- moveToNB()
- moveToZeroNB()
- motionArchNB()
- motionInchwormLeftNB()
- motionInchwormRightNB()
- motionRollBackwardNB()
- motionRollForwardNB()
- motionSkinnyNB()
- motionStandNB()
- motionTumbleNB()
- motionTurnLeftNB()
- motionTurnRightNB()
- motionUnstandNB()

8.3 Blocking and Non-Blocking Demo Programs

```
/* File: nonblock.ch
   use the non-blocking functoin move() . */
#include <mobot.h>

CMobot robot;

/* Connect to the paired MoBot */
robot.connect();

robot.moveToZero();
```

```
/* Rotate each of the faceplates by 720 degrees */
//robot.move(720, 0, 0, 720); // Blocking version
robot.moveNB(720, 0, 0, 720); // Non-Blocking version
while(robot.isMoving()) {
    printf("robot is moving ...\n");
}
printf("move finished!\n");
```

```
/* File: nonblock2.ch
   use the non-blocking functoin move() . */
#include <mobot.h>

CMobot robot;

/* Connect to the paired MoBot */
robot.connect();

robot.moveToZero();

/* Rotate each of the faceplates by 360 degrees */
//robot.moveJoint(ROBOT_JOINT1, 360); // Blocking version
robot.moveJointNB(ROBOT_JOINT1, 360); // Non-Blocking version
robot.moveJoint(ROBOT_JOINT4, 360);
```

```
/* File: nonblock3.ch
   Roll and arch simultaneously. */
#include <mobot.h>

CMobot robot;

/* Connect to the paired MoBot */
robot.connect();

robot.moveToZero();

printf("Rolling 360 degrees.\n");
robot.motionRollForward(360);
printf("Rolling 360 degrees while arching.\n");
robot.motionArchNB(90);
robot.motionRollForwardNB(360);
robot.motionWait();
```

9 Controlling Multiple Modules

The MoBot control software is designed to be able to control multiple modules simultaneously. There are some important differences in the program which enable the control of multiple modules. A small demo program which controls two modules simultaneously will first be presented, followed by a detailed explanation of the program elements.

9.1 `twoModules.ch` Source Code

```
/* Filename: twoModules.ch
 * Control two modules and make them stand simultaneously. */

#include <mobot.h>

CMobot robot1;
CMobot robot2;

/* Connect robot variables to the robot modules. The */
robot1.connect();
robot2.connect();

/* Set the robot to "home" position, where all joint angles are 0 degrees. */
robot1.moveToZeroNB();
robot2.moveToZeroNB();

robot1.moveWait();
robot2.moveWait();

/* Instruct the first robot to stand and the second robot to inchworm left four
 * times simultaneously. */
robot1.motionStandNB();
robot2.motionInchwormLeftNB();
robot1.motionWait();
robot2.motionWait();
/* Make the first robot unstand and the second robot inchworm right four times
 * simultaneously. */
robot1.motionUnstandNB();
robot2.motionInchwormRightNB(4);
robot1.motionWait();
robot2.motionWait();
```

9.2 Demo Explanation

The first two lines of interest appear as such:

```
CMobot robot1;
CMobot robot2;
```

These two lines declare two separate variables which will represent the two separate MoBot modules. Next, we need to connect each variable to a physically separate MoBot. This is done with the following lines.

```
robot1.connect();
robot2.connect();
```

These two lines connect the robots to the first two addresses of the known robot addresses. The list of the computer's known robot addresses may be configured in the process detailed in Section 2 on page 8. For each separate control program, the first call to the `connect()` member function will connect to the first robot listed in the configuration file. Each successive call to the `connect()` function will connect to successive robots listed in the configuration file. The order in which they are connected may be modified using the "Configure Robot Bluetooth" dialog, as discussed in Section 2.

```
robot1.moveToZeroNB();
robot2.moveToZeroNB();
```

These two lines command the two robots to move to their zero positions. Note that these functions are non-blocking. This means that the `moveToZeroNB()` function will return immediately, and will not wait for the first robot to finish completing the motion before commanding the second robot to begin. In a normal program, this effectively causes both robots to move to their zero positions simultaneously.

```
robot1.moveWait();
robot2.moveWait();
```

Since the `moveToZeroNB()` functions are non-blocking, we would like the program to wait until the motions are complete before continuing. By calling `moveWait()` on both of the robots, we can be assured that the robots have finished moving before the program continues.

```
robot1.motionStandNB();
robot2.motionInchwormLeftNB();
robot1.motionWait();
robot2.motionWait();
```

Similar to the calls to `moveToZeroNB()`, this block of code instructs the first MoBot to stand and the second MoBot to perform the inchworm gait. Note that we call the non-blocking versions of the functions, `motionStandNB()` and `motionInchwormLeftNB`. Since these functions are non-blocking, both robots will effectively perform the motions simultaneously. Next, we call the member function `motionWait()` to wait for the motions to finish.

Finally, the following lines,

```
robot1.motionUnstandNB();
robot2.motionInchwormRightNB(4);
robot1.motionWait();
robot2.motionWait();
```

make the first robot come back down from its standing position and the second robot inchworm to the right four times simultaneously. Note that the function `motionWait()` is used to wait for motions, which are compound movements, to finish. This is similar to how the function `moveWait()` is used to wait for individual movements to finish.

9.3 Controlling Multiple Connected Modules

9.3.1 `lift.ch`, Lifting Demo

```
/* Filename: lift.ch
   Control two modules and make them stand simultaneously.
   The joint4 of the first robot should be connected to the joint1 of the second robot. */

#include <mobot.h>

CMobot robot1;
CMobot robot2;

/* Connect robot variables to the robot modules. */
robot1.connect();
robot2.connect();
```

```
/* Set the robot to "home" position, where all joint angles are 0 degrees. */
robot1.moveToZeroNB();
robot2.moveToZeroNB();

robot1.moveWait();
robot2.moveWait();

/* First lift */
robot1.moveNB(0, -90,  0, 0);
robot2.moveNB(0, 0, 90, 0);
robot1.moveWait();
robot2.moveWait();
/* Second lift */
robot1.moveToNB(0, 0, 90,  0);
robot2.moveToNB(0,  -90, 0, 0);
robot1.moveWait();
robot2.moveWait();
robot1.moveToZeroNB();
robot2.moveToZeroNB();
robot1.moveWait();
robot2.moveWait();
```

10 Commanding Multiple Robots to Perform Identical Tasks

There is a specialized class called `CMobotGroup` which may be used to control multiple modules simultaneously. The `CMobotGroup` represents a group of robots. Any command that is given to the group of modules is duplicated to each member of the group.

The majority of the movement functions available in the `CMobot` class are also available in the `CMobotGroup` class. The detailed information for each member function are presented in Appendix B. Following is a complete listing of the available member functions in the `CMobotGroup` class.

Function Name	Description
`addRobot()`	Add a robot to the group.
`move()`	Move joints on robots from their current positions for all robots in the group.
`moveContinuousNB()`	Move joints continuously for all robots in the group.
`moveContinunousTime()`	Move joints continuously for a specific amount of time for all robots in the group.
`moveJointContinuousNB()`	Move a single joint continuously for all robots in the group.
`moveJointContinuousTime()`	Move a single joint continuously for a specific amount of time for all robots in the group.
`moveJointTo()`	Move a joint to an absolute angle for all robots in the group.
`moveJointWait()`	Wait for a joint to finish moving for all robots in the group.
`moveTo()`	Move joints to a set of specific angles for all robots in the group.
`moveWait()`	Wait for all joints to finish moving.
`moveToZero()`	Move all joints to their zero positions.
`setJointSpeed()`	Set the speed of a joint, in radians per second.
`setJointSpeedRatio()`	Set the speed of a joint as a ratio of the maximum speed.
`setTwoWheelRobotSpeed()`	Move the robot at a linear speed, given the wheel size and desired speed.
`stop()`	Stop all the joints of all robots in the group.
`motionArch()`	Cause all robots in the group to arch for higher rolling clearance.
`motionArchNB()`	Cause all robots in the group to arch for higher rolling clearance.
`motionInchwormLeft()`	Cause all robots in the group to inchworm.
`motionInchwormLeftNB()`	Cause all robots in the group to inchworm.
`motionInchwormRight()`	Cause all robots in the group to inchworm.
`motionInchwormRightNB()`	Cause all robots in the group to inchworm.
`motionRollBackward()`	Makes all robots in the group roll backward.
`motionRollForwardNB()`	Makes all robots in the group roll forward.
`motionSkinny()`	Make all robots in the group assume a skinny rolling profile.
`motionSkinnyNB()`	Make all robots in the group assume a skinny rolling profile.
`motionStand()`	Make all robots in the group stand.
`motionStandNB()`	Make all robots in the group stand.
`motionTumble()`	Make all the robots in the group perform the tumbling motion.
`motionTumbleNB()`	Make all the robots in the group perform the tumbling motion.
`motionTurnLeft()`	Make all robots in the group turn left.
`motionTurnLeftNB()`	Make all robots in the group turn left.
`motionTurnRight()`	Make all robots in the group turn right.
`motionTurnRightNB()`	Make all robots in the group turn right.
`motionUnstand()`	Make all robots in the group drop down from a standing position.
`motionUnstandNB()`	Make all robots in the group drop down from a standing position.
`motionWait()`	Wait for the robots to complete all currently executing compound motions.

10.1 Demo program `group.ch`

10.1.1 Source Code

```
/* Filename: group.ch
 * Control multiple MoBot modules simultaneously using the CMobotGroup class */

#include <mobot.h>

CMobot robot1;
CMobot robot2;

CMobotGroup group;

/* Connect to the robots listed in the configuration file. */
robot1.connect();
robot2.connect();

/* Add the two modules to be members of our group */
group.addRobot(robot1);
group.addRobot(robot2);

/* Now, any commands given to "group" will cause both robot1 and robot2 to
 * execute the command. */
group.motionInchwormLeft(4); /* Cause both robots to inchworm left 4 times */
group.motionStand(); /* Cause both robots to stand */
sleep(3); /* Make the robots stand still for 3 seconds */
group.motionUnstand(); /* Make the robots get back down from standing */
```

10.1.2 Demo Explanation

The first lines of interest appear as such:

```
CMobot robot1;
CMobot robot2;

CMobotGroup group;
```

These lines declare two robot variables, and one variable which will represent a group of robots. Next, we connect the robot variables to their physical counterparts.

```
robot1.connect();
robot2.connect();
```

Once they are connected, we wish to add both of these robots to our robot group, which we have named `group`.

```
group.addRobot(robot1);
group.addRobot(robot2);
```

Finally, we wish for all of the robots in our robot group, namely `robot1` and `robot2`, to peform an inchworm motion four times, followed by a standing motion. This is done with the following lines:

```
group.motionInchwormLeft(4); /* Cause both robots to inchworm left 4 times */
group.motionStand(); /* Cause both robots to stand */
```

After the robots stand, the next line,

```
sleep(3); /* Make the robots stand still for 3 seconds */
```

makes the robots stand still for three seconds. After standing still for three seconds, the line

```
group.motionUnstand(); /* Make the robots get back down from standing */
```

makes both robots move back down from a standing position into a prone position.

A Data Types

The data types defined in the header file `mobot.h` are described in this appendix. These data types are used by the MoBot library to represent certain values, such as joint id's and motor directions.

Data Type	Description
`robotJointId_t`	An enumerated value that indicates a MoBot joint.
`robotJointState_t`	The current state of a MoBot joint.

A.1 `robotJointId_t`

This datatype is an enumerated type used to identify a joint on the MoBot. Valid values for this type are:

```
typedef enum mobot_joints_e {
  ROBOT_JOINT1 = 1,
  ROBOT_JOINT2 = 2,
  ROBOT_JOINT3 = 3,
  ROBOT_JOINT4 = 4
} robotJointId_t;
```

Value	Description
`ROBOT_JOINT1`	Joint number 1 on the MoBot, which is a faceplate joint.
`ROBOT_JOINT2`	Joint number 2 on the MoBot, which is a body joint.
`ROBOT_JOINT3`	Joint number 3 on the MoBot, which is a body joint.
`ROBOT_JOINT4`	Joint number 4 on the MoBot, which is a faceplate joint.

A.2 `robotJointState_t`

This datatype is an enumerated type used to designate the current movement state of a joint. The values may be retrieved from the robot with the `getJointState()` function and may be set with the `moveContinuous()` family of functions. Valid values are:

```
typedef enum mobot_joint_state_e {
  ROBOT_NEUTRAL   = 0,
  ROBOT_FORWARD   = 1,
  ROBOT_BACKWARD  = 2,
  ROBOT_HOLD      = 3
} robotJointState_t;
```

Value	Description
`ROBOT_NEUTRAL`	This value indicates that the joint is not moving and is not actuated. The joint is freely backdrivable.
`ROBOT_FORWARD`	This value indicates that the joint is currently moving forward.
`ROBOT_BACKWARD`	This value indicates that the joint is currently moving backward.
`ROBOT_HOLD`	This value indicates that the joint is currently not moving and is holding its current position. The joint is not currently backdrivable.

B CMobot API

The header file **mobot.h** defines all the data types, macros and function prototypes for the robot 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.
`~CMobot()`	The CMobot destructor function. This function is called automatically and should not be called explicitly.
`connect()`	Connect to a remote robot module. This function connects to the first robot listed in the Barobo configuration file. To edit the configuration file, use the robot control graphical user interface, and select the menu item "Robot → Configure Robot Bluetooth".
`connectWithAddress()`	Connect to a robot module by specifying its Bluetooth address.
`disconnect()`	Disconnect from a robot module.
`getJointAngle()`	Get a joint's angle.
`getJointMaxSpeed()`	Get a joint's maximum speed in radians per second.
`getJointSpeed()`	Get a motor's current speed setting in radians per second.
`getJointSpeeds()`	Get all motor's current speed settings in radians per second.
`getJointSpeedRatio()`	Get a motor's speed as a ratio of the motor's maximum speed.
`getJointSpeedRatios()`	Get all motor speeds as ratios of the motor's maximum speed.
`getJointState()`	Get a motor's current status.
`isConnected()`	This function is used to check the connection to a robot.
`isMoving()`	This function is used to check if any joints are currently in motion.
`move()`	Move all four joints of the robot by specified angles.
`moveNB()`	Identical to `move()` but non-blocking.
`moveContinuousNB()`	Move joints continuously. Joints will move untill stopped.
`moveContinuousTime()`	Move joints continuously for a certain amount of time.
`moveTo()`	Move all four joints of the robot to specified absolute angles.
`moveToNB()`	Identical to `moveTo()` but non-blocking.
`moveJoint()`	Move a joint.
`moveJointNB()`	Move a joint.
`moveJointTo()`	Set the desired motor position for a joint.
`moveJointToNB()`	Identical to `moveJointTo()` but non-blocking.
`moveJointWait()`	Wait until the specified motor has stopped moving.
`moveWait()`	Wait until all motors have stopped moving.
`moveToZero()`	Instruct all motors to go to their zero positions.
`moveToZeroNB()`	Identical to `moveToZero()` but non-blocking.
`setJointSpeed()`	Set a motor's speed setting in radians per second.
`setJointSpeeds()`	Set all motor speeds in radians per second.
`setJointSpeedRatio()`	Set a joints speed setting to a fraction of its maximum speed, a value between 0 and 1.
`setJointSpeedRatios()`	Set all joint speed settings to a fraction of its maximum speed, expressed as a value from 0 to 1.
`stop()`	Stop all currently executing motions of the robot.

Table 2: CMobot Member Functions for Compound Motions.

Compound Motions	These are convenience functions of commonly used compound motions.
`motionArch()`	Arch the robot for better ground clearance.
`motionArchNB()`	Identical to `motionArch` but non-blocking.
`motionInchwormLeft()`	Inchworm motion towards the left.
`motionInchwormLeftNB()`	Identical to `motionInchwormLeft` but non-blocking.
`motionInchwormRight()`	Inchworm motion towards the right.
`motionInchwormRightNB()`	Identical to `motionInchwormRight` but non-blocking.
`motionRollBackward()`	Roll on the faceplates toward the backward direction.
`motionRollBackwardNB()`	Identical to `motionRollBackward()` but non-blocking.
`motionRollForward()` .	Roll on the faceplates forwards.
`motionRollForwardNB()`	Identical to `motionRollForward()` but non-blocking.
`motionSkinny()`	Move the robot into a skinny profile.
`motionSkinnyNB()`	Identical to `motionSkinny()` but non-blocking.
`motionStand()`	Stand the robot up on its end.
`motionStandNB()`	Identical to `motionStand()` but non-blocking.
`motionTumble()`	Perform the tumbling motion.
`motionTumbleNB()`	Identical to `motionTumble()` but non-blocking.
`motionTurnLeft()`	Rotate the robot counterclockwise.
`motionTurnLeftNB()` ..	Identical to `motionTurnLeft()` but non-blocking.
`motionTurnRight()` ...	Rotate the robot clockwise.
`motionTurnRightNB()` .	Identical to `motionTurnRight()` but non-blocking.
`motionWait()`	Wait for a motion to finish.

CMobot::connect()

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

Purpose
Connect to a remote robot via Bluetooth.

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

Parameters
None.

Description
This function is used to connect to a robot. The function looks inside of a Barobo configuration file and connects to the first robot listed in the file. The configuration file may be created and/or modified using the Robot Controller Interface, and selecting the "Robot → Configure Robot Bluetooth" menu item.
Example
Please see the example in Section 4.1.2 on page 16.

See Also
`connectWithAddress(), disconnect()`

CMobot::connectWithAddress()

Synopsis
```
#include <mobot.h>
int CMobot::connectWithAddress(char address[], int channel);
```

Purpose
Connect to a remote robot 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 robot.
`channel` The Bluetooth channel that the listening program is listening on. The default channel is channel 1.

Description
This function is used to connect to a robot.
Example

See Also
`connect(), disconnect()`

CMobot::disconnect()

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

Purpose
Disconnect from a remote robot.

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

Parameters
None.

Description
This function is used to disconnect from a robot. 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
`connect()`, `connectWithAddress()`

CMobot::getJointAngle()

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

Purpose
Retrieve a robot joint's current angle.

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

Parameters

`id`	The joint number. This is an enumerated type discussed in Section A.1 on page 35.
`angle`	A variable to store the current angle of the robot motor. The contents of this variable will be overwritten with a value that represents the motor's angle in radians.

Description
This function gets the current motor angle of a robot's motor. The angle returned is in units of degrees and is accurate to roughly ± 0.17 degrees.

Example

See Also

CMobot::getJointMaxSpeed()

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

Purpose
Get the maximum speed of a joint on the robot.

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

Parameters

`id`	The joint number. This is an enumerated type discussed in Section A.1 on page 35.
`speed`	A variable of type `double`. The value of this variable will be overwritten with the maximum speed setting of the joint, which is in units of degrees per second.

Description
This function is used to find the maximum speed setting of a joint. This is the maximum speed at which the joint will accept speed setting from the function `setJointSpeed()`. The values are in units of degrees per second.
Example

See Also
`getJointSpeed()`, `getJointMaxSpeedRatio()`, `setJointSpeed()`, `setJointSpeedRatio()`

CMobot::getJointSpeed()

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

Purpose
Get the speed of a joint on the robot.

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

Parameters

`id`	The joint number to pose. This is an enumerated type discussed in Section A.1 on page 35.
`speed`	A variable of type `double`. The value of this variable will be overwritten with the current speed setting of the joint, which is in units of degrees per second.

Description
This function is used to find the current speed setting of a joint. This is the speed at which the joint will move when given motion commands. The values are in units of degrees per second.
Example

See Also
`getJointMaxSpeed()`, `getJointSpeedRatio()`, `setJointSpeed()`, `setJointSpeedRatio()`

CMobot::getJointSpeedRatio()

Synopsis

```
#include <mobot.h>
int CMobot::getJointSpeedRatio(robotJointId_t id, double &ratio);
```

Purpose
Get the speed ratio settings of a joint on the robot.

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

Parameters

`id`	Retrieve the speed ratio setting of this joint. This is an enumerated type discussed in Section A.1 on page 35.
`ratio`	A variable of type double. The value of this variable will be overwritten with the current speed ratio setting of the joint.

Description
This function is used to find the speed ratio setting of a joint. The speed ratio setting of a joint is the percentage of the maximum joint speed, and the value ranges from 0 to 1. In other words, if the ratio is set to 0.5, the joint will turn at 50% of its maximum angular velocity while moving continuously or moving to a new goal position.

Example

See Also
`setJointSpeeds()`, `getJointSpeedRatio()`, `getJointSpeed()`

CMobot::getJointSpeedRatios()

Synopsis
```
#include <mobot.h>
int CMobot::getJointSpeedRatios(double &ratio1, double &ratio2, double &ratio3, double &ratio4);
```

Purpose
Get the speed ratio settings of all joints on the robot.

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

Parameters

`ratio1`	A variable to store the speed ratio of joint 1.
`ratio2`	A variable to store the speed ratio of joint 2.
`ratio3`	A variable to store the speed ratio of joint 3.
`ratio4`	A variable to store the speed ratio of joint 4.

Description
This function is used to retrieve all four joint speed ratio settings of a robot simultaneously. The speed ratios are as a value from 0 to 1.

Example

See Also
`setJointSpeeds()`, `getJointSpeedRatios()`, `getJointSpeed()`

CMobot::getJointSpeeds()

Synopsis
```
#include <mobot.h>
int CMobot::getJointSpeeds(double &speed1, double &speed2, double &speed3, double &speed4);
```

Purpose
Get the speed settings of all joints on the robot.

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

Parameters
- `speed1` The joint speed setting for joint 1.
- `speed2` The joint speed setting for joint 2.
- `speed3` The joint speed setting for joint 3.
- `speed4` The joint speed setting for joint 4.

Description
This function is used to retrieve all four joint speed settings of a robot simultaneously. The speeds are in degrees per second.

Example

See Also
`setJointSpeeds()`, `getJointSpeedRatios()`, `getJointSpeed()`

CMobot::getJointState()

Synopsis
```
#include <mobot.h>
int CMobot::getJointState(robotJointId_t id, robotJointState_t &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. This is an enumerated type discussed in Section A.1 on page 35.
- `state` An integer variable which will be overwritten with the current state of the motor. This is an enumerated type discussed in Section A.2 on page 35.

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

Value	Description
`ROBOT_NEUTRAL`	This value indicates that the joint is not moving and is not actuated. The joint is freely backdrivable.
`ROBOT_FORWARD`	This value indicates that the joint is currently moving forward.
`ROBOT_BACKWARD`	This value indicates that the joint is currently moving backward.
`ROBOT_HOLD`	This value indicates that the joint is currently not moving and is holding its current position. The joint is not currently backdrivable.

Example

See Also
`isMoving()`

CMobot::isConnected()

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

Purpose
Check to see if currently connected to a remote robot via Bluetooth.

Return Value
The function returns zero if it is not currently connected to a robot or if an error has occured, or 1 if the robot is connected.

Parameters
None.

Description
This function is used to check if the software is currently connected to a robot.

Example

See Also
`connect()`, `disconnect()`

CMobot::isMoving()

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

Purpose
Check to see if a robot is currently moving any of its joints.

Return Value
This function returns 0 if none of the joints are being driven or if an error has occured, or 1 if any joint is being driven. A value of 1 is equivalent to either a joint state of `ROBOT_FORWARD` or `ROBOT_BACKWARD` from `getJointState()`

Parameters
None.

Description
This function is used to determine if a robot is currently moving any of its joints.

Example

See Also
`getJointState()`

CMobot::motionArch()
CMobot::motionArchNB()

Synopsis
```
#include <mobot.h>
int CMobot::motionArch(double angle);
int CMobot::motionArchNB(double angle);
```

Purpose
Arch the robot for more ground clearance.

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

Parameters

`angle`	The angle in degrees to arch. This number can range from 0 degrees, which is no arch, to 180 degrees, which is a fully curled up position.

Description

CMobot::motionArch()
This function causes the robot to Arch up for better ground clearance while rolling.

CMobot::motionArchNB()
This function causes the robot to Arch up for better ground clearance while rolling.

The non-blocking function, `motionArchNB()`, will return immediately, and the motion will be performed asynchronously.

See Also

CMobot::motionInchwormLeft()
CMobot::motionInchwormLeftNB()

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

Purpose
Perform the inch-worm gait to the left.

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

Parameters

`num`	The number of times to perform the inchworm gait.

Description

CMobot::motionInchwormLeft()
This function causes the robot to perform a single cycle of the inchworm gait to the left.

CMobot::motionInchwormLeftNB()
This function causes the robot to perform a single cycle of the inchworm gait to the left.

This is the non-blocking version of the function `CMobot::motionInchwormLeft()`, meaning that the function will return immediately while the motion is performed asynchronously.

See Also
`motionInchwormRight()`

CMobot::motionInchwormRight()
CMobot::motionInchwormRightNB()

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

Purpose
Perform the inch-worm gait to the right.

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

Parameters

`num`	The number of times to perform the inchworm gait.

Description

CMobot::motionInchwormRight()
This function causes the robot to perform a single cycle of the inchworm gait to the right.

CMobot::motionInchwormRightNB()
This function causes the robot to perform a single cycle of the inchworm gait to the right.

This function has both a blocking and non-blocking version. The blocking version, `motionInchwormRight()`, will block until the robot motion has completed. The non-blocking version, `motionInchwormRightNB()`, will return immediately, and the motion will be performed asynchronously.

See Also
`motionInchwormLeft()`

CMobot::motionRollBackward()
CMobot::motionRollBackwardNB()

Synopsis
```
#include <mobot.h>
int CMobot::motionRollBackward(double angle);
int CMobot::motionRollBackwardNB(double angle);
```

Purpose
Use the faceplates as wheels to roll backward.

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

Parameters

`angle`	The angle to turn the wheels, specified in degrees.

Description

CMobot::motionRollBackward()
This function causes each of the faceplates to rotate to roll the robot backward. The amount to roll the wheels is specified by the argument, `angle`.

CMobot::motionRollBackwardNB()
This function causes each of the faceplates to rotate to roll the robot backward. The amount to roll the wheels is specified by the argument, `angle`.

This function has both a blocking and non-blocking version. The blocking version, `motionRollBackward()`, will block until the robot motion has completed. The non-blocking version, `motionRollBackwardNB()`, will return immediately, and the motion will be performed asynchronously.

See Also
`motionRollForward()`

CMobot::motionRollForward()
CMobot::motionRollForwardNB()

Synopsis
```
#include <mobot.h>
int CMobot::motionRollForward(double angle);
int CMobot::motionRollForwardNB(double angle);
```

Purpose
Use the faceplates as wheels to roll forward.

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

Parameters

`angle`	The angle to turn the wheels, specified in degrees.

Description

CMobot::motionRollForward()
This function causes each of the faceplates to rotate to roll the robot forward. The amount to roll the wheels is specified by the argument, `angle`.

CMobot::motionRollForwardNB()
This function causes each of the faceplates to rotate to roll the robot forward. The amount to roll the wheels is specified by the argument, `angle`.

This function has both a blocking and non-blocking version. The blocking version, `motionRollForward()`, will block until the robot motion has completed. The non-blocking version, `motionRollForwardNB()`, will return immediately, and the motion will be performed asynchronously.

See Also
`motionRollBackward()`

CMobot::motionSkinny()
CMobot::motionSkinnyNB()

Synopsis
```
#include <mobot.h>
int CMobot::motionSkinny(double angle);
int CMobot::motionSkinnyNB(double angle);
```

Purpose
Move the robot into a skinny profile.

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

Parameters

`angle` The angle in degrees to move the joints. A value of zero means a completely flat profile, while a value of 90 degrees means a fully skinny profile.

Description

CMobot::motionSkinny()
This function makes the robot assume a skinny rolling profile.

CMobot::motionSkinnyNB()
This function makes the robot assume a skinny rolling profile.

This function has both a blocking and non-blocking version. The blocking version, `motionSkinny()`, will block until the robot motion has completed. The non-blocking version, `motionSkinnyNB()`, will return immediately, and the motion will be performed asynchronously.

See Also

CMobot::motionStand()
CMobot::motionStandNB()

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

Purpose
Stand the robot up on a faceplate.

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

Parameters
None.

Description

CMobot::motionStand()
This function causes the robot to motionStand up into the camera platform.

CMobot::motionStandNB()
This function causes the robot to motionStand up into the camera platform.

This function has both a blocking and non-blocking version. The blocking version, `motionStand()`, will block until the robot motion has completed. The non-blocking version, `motionStandNB()`, will return immediately, and the motion will be performed asynchronously.

See Also

CMobot::motionTumble()
CMobot::motionTumbleNB()

Synopsis
```
#include <mobot.h>
int CMobot::motionTumble(int num);
int CMobot::motionTumbleNB(int num);
```

Purpose
Make the robot tumble end over end.

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

Parameters

`num`	The number of times to tumble.

Description

CMobot::motionTumble()
This causes the robot to tumble end over end. The argument, `num`, indicates the number of times to tumble.

CMobot::motionTumbleNB()
This causes the robot to tumble end over end. The argument, `num`, indicates the number of times to tumble.

This function has both a blocking and non-blocking version. The blocking version, `motionTumble()`, will block until the robot motion has completed. The non-blocking version, `motionTumbleNB()`, will return immediately, and the motion will be performed asynchronously.

See Also

CMobot::motionTurnLeft()
CMobot::motionTurnLeftNB()

Synopsis
```
#include <mobot.h>
int CMobot::motionTurnLeft(double angle);
int CMobot::motionTurnLeftNB(double angle);
```

Purpose
Rotate the robot using the faceplates as wheels.

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

Parameters

`angle` The angle in degrees to turn the wheels. The wheels will turn in opposite directions by the amount specifid by this argument in order to turn the robot to the left.

Description

CMobot::motionTurnLeft()
This function causes the robot to rotate the faceplates in opposite directions to cause the robot to rotate counter-clockwise.

CMobot::motionTurnLeftNB()
This function causes the robot to rotate the faceplates in opposite directions to cause the robot to rotate counter-clockwise.

This function has both a blocking and non-blocking version. The blocking version, `motionTurnLeft()`, will block until the robot motion has completed. The non-blocking version, `motionTurnLeftNB()`, will return immediately, and the motion will be performed asynchronously.

See Also
`motionTurnRight()`

CMobot::motionTurnRight()
CMobot::motionTurnRightNB()

Synopsis
```
#include <mobot.h>
int CMobot::motionTurnRight(double angle);
int CMobot::motionTurnRightNB(double angle);
```

Purpose
Rotate the robot using the faceplates as wheels.

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

Parameters

`angle` The angle in degrees to turn the wheels. The wheels will turn in opposite directions by the amount specifid by this argument in order to turn the robot to the right.

Description

CMobot::motionTurnRight()
This function causes the robot to rotate the faceplates in opposite directions to cause the robot to rotate clockwise.

CMobot::motionTurnRightNB()
This function causes the robot to rotate the faceplates in opposite directions to cause the robot to rotate clockwise.

This function has both a blocking and non-blocking version. The blocking version, `motionTurnRight()`, will block until the robot motion has completed. The non-blocking version, `motionTurnRightNB()`, will return immediately, and the motion will be performed asynchronously.

See Also
`motionTurnRight()`

CMobot::motionUnstand()
CMobot::motionUnstandNB()

Synopsis
```
#include <mobot.h>
int CMobot::motionUnstand();
int CMobot::motionUnstandNB();
```

Purpose
Move a robot currently standing on a faceplate back down into a prone position.

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

Parameters
None.

Description

CMobot::motionUnstand()
This function causes the robot to move down from the camera platform.

CMobot::motionUnstandNB()
This function causes the robot to move down from the camera platform.

This function has both a blocking and non-blocking version. The blocking version, `motionUnstand()`, will block until the robot motion has completed. The non-blocking version, `motionUnstandNB()`, will return immediately, and the motion will be performed asynchronously.

See Also

CMobot::motionWait()

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

Purpose
Wait for a motion to complete execution.

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

Description
This function is used to wait for a motion function to fully complete its cycle. The `CMobot` motion functions are those member functions which begin with "motion" as part of their name, such as `motionInchwormLeft()`.
Example

See Also

CMobot::move()
CMobot::moveNB()

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

Purpose
Move all of the joints of a robot by specified angles.

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

Parameters

`angle1`	The amount to move joint 1, expressed in degrees, relative to the current position.
`angle2`	The amount to move joint 2, expressed in degrees, relative to the current position.
`angle3`	The amount to move joint 3, expressed in degrees, relative to the current position.
`angle4`	The amount to move joint 4, expressed in degrees, relative to the current position.

Description

CMobot::move()
This function moves all of the joints of a robot by the specified number of degrees from their current positions.

CMobot::moveNB()
This function moves all of the joints of a robot by the specified number of degrees from their current positions.

The function `moveNB()` is the non-blocking version of the `move()` function, which means that the function will return immediately and the physical robot motion will occur asynchronously. For more information on blocking and non-blocking functions, please refer to Section 8 on page 26.

Example
Please see the demo at Section 4.1.2 on page 16.

See Also

CMobot::moveContinuousNB()

Synopsis

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

Purpose
Move the joints of a robot continuously in the specified directions.

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

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

- `ROBOT_NEUTRAL` : The joint should not move.
- `ROBOT_FORWARD` : The joint will begin moving in the positive direction.
- `ROBOT_BACKWARD`: The joint will begin moving in the negative direction.
- `ROBOT_HOLD`: The joint will hold its current position.

More documentation about these types may be found at Section A.2 on page 35.
Description
This function causes joints of a robot 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. This function is a non-blocking function.

Example

See Also

CMobot::moveContinuousTime()

Synopsis

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

Purpose
Move the joints of a robot continuously in the specified directions for some amount of time.

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

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

- `ROBOT_NEUTRAL` : The joint should not move.
- `ROBOT_FORWARD` : The joint will begin moving in the positive direction.
- `ROBOT_BACKWARD`: The joint will begin moving in the negative direction.
- `ROBOT_HOLD`: The joint will actively hold its current position.

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

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

Example

See Also

CMobot::moveTo()
CMobot::moveToNB()

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

Purpose
Move all of the joints of a robot to the specified positions.

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

Parameters

`angle1`	The absolute position to move joint 1, expressed in degrees.
`angle2`	The absolute position to move joint 2, expressed in degrees.
`angle3`	The absolute position to move joint 3, expressed in degrees.
`angle4`	The absolute position to move joint 4, expressed in degrees.

Description

CMobot::moveTo()
This function moves all of the joints of a robot to the specified absolute positions.

CMobot::moveToNB()
This function moves all of the joints of a robot to the specified absolute positions.

The function `moveToNB()` is the non-blocking version of the `moveTo()` function, which means that the function will return immediately and the physical robot motion will occur asynchronously. For more details on blocking and non-blocking functions, please refer to Section 8 on page 26.

Example
Please see the demo at Section 4.1.2 on page 16.

See Also

CMobot::moveJoint()
CMobot::moveJointNB()

Synopsis
```
#include <mobot.h>
int CMobot::moveJoint(robotJointId_t id, double angle);
int CMobot::moveJointNB(robotJointId_t id, double angle);
```

Purpose
Move a joint on the robot by a specified angle with respect to the current position.

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

Parameters

`id`	The joint number to move.
`angle`	The angle in degrees to move the motor relative to its current position.

Description

CMobot::moveJoint()
This function commands the motor to move by an angle relative to the joint's current position at the joints current speed setting. 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 `moveJoint()` function.

CMobot::moveJointNB()
This function commands the motor to move by an angle relative to the joint's current position at the joints current speed setting. 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 `moveJoint()` function.

The function `moveJointNB()` is the non-blocking version of the `moveJoint()` function, which means that the function will return immediately and the physical robot motion will occur asynchronously. For more details on blocking and non-blocking functions, please refer to Section 8 on page 26.

Example
Please see the example in Section 4.1.2 on page 16.

See Also
`connectWithAddress()`

CMobot::moveJointTo()
CMobot::moveJointToNB()

Synopsis
```
#include <mobot.h>
int CMobot::moveJointTo(robotJointId_t id, double angle);
int CMobot::moveJointToNB(robotJointId_t id, double angle);
```

Purpose
Move a joint on the robot to an absolute position.

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

Parameters

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

Description

CMobot::moveJointTo()
This function commands the motor to move to a position specified in radians 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.

CMobot::moveJointToNB()
This function commands the motor to move to a position specified in radians 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.

The function `moveJointToNB()` is the non-blocking version of the `moveJointTo()` function, which means that the function will return immediately and the physical robot motion will occur asynchronously. For more details on blocking and non-blocking functions, please refer to Section 8 on page 26.

Example
Please see the example in Section 4.1.2 on page 16.

See Also
`connectWithAddress()`

CMobot::moveJointWait()

Synopsis
```
#include <mobot.h>
int CMobot::moveJointWait(robotJointId_t 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 `moveNB()` and `moveJointNB()` do not wait for a joint to finish moving before continuing to allow multiple joints to move at the same time. The `moveJointWait()` function is used to wait for a robotic joint motion 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 4.1.2 on page 16.

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 `move()` and `moveTo()` do not wait for a joint to finish moving before continuing to allow multiple joints to move at the same time. The `moveWait()` function is 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 4.1.2 on page 16.

See Also
`moveWait(), moveJointWait()`

CMobot::moveToZero()
CMobot::moveToZeroNB()

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

Purpose
Move all of the joints of a robot to their zero position.

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

Parameters
None.

Description

CMobot::moveToZero()
This function moves all of the joints of a robot to their zero position.

CMobot::moveToZeroNB()
This function moves all of the joints of a robot to their zero position.

The function `moveToZeroNB()` is the non-blocking version of the `moveToZero()` function, which means that the function will return immediately and the physical robot motion will occur asynchronously. For more details on blocking and non-blocking functions, please refer to Section 8 on page 26.

Example
Please see the demo at Section 4.1.2 on page 16.

See Also

CMobot::setJointSpeed()

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

Purpose
Set the speed of a joint on the robot.

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` for the requested average angular speed in degrees per second.

Description
This function is used to set the angular speed of a joint of a robot. The maximum possible angular speed for a particular joint may be obtained by using the function `getJointMaxSpeed()`.
Example

See Also

CMobot::setJointSpeedRatio()

Synopsis
```
#include <mobot.h>
int CMobot::setJointSpeedRatio(robotJointId_t id, double ratio);
```

Purpose
Set the speed ratio settings of a joint on the robot.

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

Parameters
`id` Set the speed ratio setting of this joint. This is an enumerated type discussed in Section A.1 on page 35.
`ratio` A variable of type double with a value from 0 to 1.

Description
This function is used to set the speed ratio setting of a joint. The speed ratio setting of a joint is the percentage of the maximum joint speed, and the value ranges from 0 to 1. In other words, if the ratio is set to 0.5, the joint will turn at 50% of its maximum angular velocity while moving continuously or moving to a new goal position.

Example

See Also
`setJointSpeeds()`, `setJointSpeedRatio()`, `getJointSpeed()`

CMobot::setJointSpeedRatios()

Synopsis
```
#include <mobot.h>
int CMobot::setJointSpeedRatios(double ratio1, double ratio2, double ratio3, double ratio4);
```

Purpose
Set the speed ratio settings of all joints on the robot.

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

Parameters

`ratio1` The speed ratio setting for the first joint.
`ratio2` The speed ratio setting for the second joint.
`ratio3` The speed ratio setting for the third joint.
`ratio4` The speed ratio setting for the fourth joint.

Description
This function is used to simultaneously set the angular speed ratio settings of all four joints of a robot. The speed ratio is a percentage of the maximum speed of a joint, expressed in a value from 0 to 1.

Example

See Also
`getJointSpeeds()`, `setJointSpeed()`, `getJointSpeed()`

CMobot::setJointSpeeds()

Synopsis
```
#include <mobot.h>
int CMobot::setJointSpeeds(double speed1, double speed2, double speed3, double speed4);
```

Purpose
Set the speed settings of all joints on the robot.

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

Parameters
`speed1` The speed for the first joint, in degrees per second.
`speed2` The speed for the second joint, in degrees per second.
`speed3` The speed for the third joint, in degrees per second.
`speed4` The speed for the fourth joint, in degrees per second.

Description
This function is used to simultaneously set the angular speed settings of all four joints of a robot.

Example

See Also
`getJointSpeeds()`, `setJointSpeed()`, `getJointSpeed()`

CMobot::setTwoWheelRobotSpeed()

Synopsis
```
#include <mobot.h>
int CMobot::setTwoWheelRobotSpeed(double speed, double radius);
```

Purpose
Roll the robot at a certain speed in a straight line.

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

Parameters

`speed` The speed at which to roll the robot. The units used will be the units specified in the `unit` parameter.

`radius` The radius of the wheels attached to the robot. The units of the parameter should match the units provided in the `unit` parameter.

speed	radius
cm/s	cm
m/s	m
inch/s	inch
foot/s	foot

Description
This function is used to make a two wheeled robot roll at a certain speed. The desired speed and radius of the wheels is provided and the function will rotate the wheels at the appropriate rate in order to achieve the desired speed.

Example

See Also

CMobot::stop()

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

Purpose
Stop all current motions on the robot.

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

Description
This function stops all currently occuring movements on the robot. 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(), setJointSpeeds()`

C CMobotGroup API

The `CMobotGroup` class is used to control multiple modules simultaneously. The member functions of the `CMobotGroup` class closely mimic those of the `CMobot` group. The main difference is that the member functions of the `CMobot` class affect a single robot, whereas the member functions of the `CMobotGroup` class move and affect a group of many robots.

Table 3: CMobotGroup Member Functions.

Function	Description
`CMobotGroup()`	The CMobotGroup constructor function. This function is called automatically and should not be called explicitly.
`~CMobotGroup()`	The CMobotGroup destructor function. This function is called automatically and should not be called explicitly.
`addRobot()`	Add a robot to be a member of the robot group.
`move()`	Move all four joints of the robots by specified angles.
`moveNB()`	Identical to `move()` but non-blocking.
`moveContinuousNB()`	Move joints continuously. Joints will move untill stopped.
`moveContinuousTime()`	Move joints continuously for a certain amount of time.
`moveJointContinuousNB()`	Move a single joint on all robots continuously.
`moveJointContinuousTime()`	Move a single joint on all robots continuously for a specific amount of time.
`moveTo()`	Move all four joints of the robots to specified absolute angles.
`moveToNB()`	Identical to `moveTo()` but non-blocking.
`moveJoint()`	Move a motor from its current position by an angle.
`moveJointNB()`	Identical to `moveJoint()` but non-blocking.
`moveJointTo()`	Set the desired motor position for a joint.
`moveJointToNB()`	Identical to `moveJointTo()` but non-blocking.
`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.
`moveToZeroNB()`	Identical to `moveToZero()` but non-blocking.
`setJointSpeed()`	Set a motor's speed setting in radians per second.
`setJointSpeeds()`	Set all motor speeds in radians per second.
`setJointSpeedRatio()`	Set a joints speed setting to a fraction of its maximum speed, a value between 0 and 1.
`setJointSpeedRatios()`	Set all joint speed settings to a fraction of its maximum speed, expressed as a value from 0 to 1.
`setTwoWheelRobotSpeed()`	Move the robot at a constant forward velocity.
`stop()`	Stop all currently executing motions of the robot.

Table 4: CMobot Member Functions for Compound Motions.

Compound Motions	These are convenience functions of commonly used compound motions.
`motionInchwormLeft()`	Inchworm motion towards the left.
`motionInchwormLeftNB()`	Identical to `motionInchwormLeft` but non-blocking.
`motionInchwormRight()`	Inchworm motion towards the right.
`motionInchwormRightNB()`	Identical to `motionInchwormRight` but non-blocking.
`motionRollBackward()`	Roll on the faceplates toward the backward direction.
`motionRollBackwardNB()`	Identical to `motionRollBackward()` but non-blocking.
`motionRollForward()` .	Roll on the faceplates forwards.
`motionRollForwardNB()`	Identical to `motionRollForward()` but non-blocking.
`motionStand()`	Stand the robot up on its end.
`motionStandNB()`	Identical to `motionStandNB()` but non-blocking.
`motionTurnLeft()`	Rotate the robot counterclockwise.
`motionTurnLeftNB()` ..	Identical to `motionTurnLeft()` but non-blocking.
`motionTurnRight()` ...	Rotate the robot clockwise.
`motionTurnRightNB()` .	Identical to `motionTurnRight()` but non-blocking.

CMobotGroup::addRobot()

Synopsis
```
#include <mobot.h>
int CMobotGroup::addRobot(CMobot &robot);
```

Purpose
Add a robot to a robot group.

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

Parameters
A robot handle attached to the robot to add to the group.

Description
This function is used to add a robot to a robot group.
Example

See Also

CMobotGroup::motionArch()
CMobotGroup::motionArchNB()

Synopsis
```
#include <mobot.h>
int CMobotGroup::motionArch(double angle);
int CMobotGroup::motionArchNB(double angle);
```

Purpose
Arch the robots in the group for more ground clearance.

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

Parameters

`angle` The angle which to arch. This number can range from 0 degrees, which is no arch, to 180 degrees, which is a fully curled up position.

Description

CMobot::motionArch()
This function causes the robots to Arch up for better ground clearance while rolling.

CMobot::motionArch()
This function causes the robots to Arch up for better ground clearance while rolling.

This function has both a blocking and non-blocking version. The blocking version, `motionArch()`, will block until the robot motion has completed. The non-blocking version, `motionArchNB()`, will return immediately, and the motion will be performed asynchronously.

See Also

CMobotGroup::motionInchwormLeft()
CMobotGroup::motionInchwormLeftNB()

Synopsis

```
#include <mobot.h>
int CMobotGroup::motionInchwormLeft(int num);
int CMobotGroup::motionInchwormLeftNB(int num);
```

Purpose

Make all robots in the group perform the inch-worm gait to the left.

Return Value

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

Parameters

`num`	The number of times to perform the inchworm gait.

Description

CMobot::motionInchwormLeft()
This function causes the robots to perform a single cycle of the inchworm gait to the left.

CMobot::motionInchwormLeftNB()
This function causes the robots to perform a single cycle of the inchworm gait to the left.

The function `motionInchwormLeft()` is blocking, and the function will hang until the motion has finished. The alternative function, `motionInchwormLeftNB()` will return immediately, and the motion will execute asynchronously.

See Also

`motionInchwormRight()`

CMobotGroup::motionInchwormRight()
CMobotGroup::motionInchwormRightNB()

Synopsis

```
#include <mobot.h>
int CMobotGroup::motionInchwormRight(int num);
int CMobotGroup::motionInchwormRightNB(int num);
```

Purpose

Make all the robots in the group perform the inch-worm gait to the right.

Return Value

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

Parameters

`num` The number of times to perform the inchworm gait.

Description

CMobot::motionInchwormRight()
This function causes the robots to perform a single cycle of the inchworm gait to the right.

CMobot::motionInchwormRightNB()
This function causes the robots to perform a single cycle of the inchworm gait to the right.

This function has both a blocking and non-blocking version. The blocking version, `motionInchwormRight()`, will block until the robot motion has completed. The non-blocking version, `motionInchwormRightNB()`, will return immediately, and the motion will be performed asynchronously.

See Also
`motionInchwormLeft()`

CMobotGroup::motionRollBackward()
CMobotGroup::motionRollBackwardNB()

Synopsis
```
#include <mobot.h>
int CMobotGroup::motionRollBackward(double angle);
int CMobotGroup::motionRollBackwardNB(double angle);
```

Purpose
Use the faceplates as wheels to roll all the robots in a group backward.

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

Parameters

`angle` The angle to turn the wheels, specified in degrees.

Description

CMobot::motionRollBackward()
This function causes each of the faceplates to rotate 90 degrees to roll the robots backward.

CMobot::motionRollBackwardNB()
This function causes each of the faceplates to rotate 90 degrees to roll the robots backward.

This function has both a blocking and non-blocking version. The blocking version, `motionRollBackward()`, will block until the robot motion has completed. The non-blocking version, `motionRollBackwardNB()`, will return immediately, and the motion will be performed asynchronously.

See Also
`motionRollForward()`

CMobotGroup::motionRollForward()
CMobotGroup::motionRollForwardNB()

Synopsis

```
#include <mobot.h>
int CMobotGroup::motionRollForward(double angle);
int CMobotGroup::motionRollForwardNB(double angle);
```

Purpose
Use the faceplates as wheels to roll robots forward.

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

Parameters

`angle` The angle to turn the wheels, specified in degrees.

Description

CMobot::motionRollForward()
This function causes each of the faceplates to rotate 90 degrees to roll the robots forward.

CMobot::motionRollForwardNB()
This function causes each of the faceplates to rotate 90 degrees to roll the robots forward.

This function has both a blocking and non-blocking version. The blocking version, `motionRollForward()`, will block until the robot motion has completed. The non-blocking version, `motionRollForwardNB()`, will return immediately, and the motion will be performed asynchronously.

See Also
`motionRollBackward()`

CMobotGroup::motionSkinny()
CMobotGroup::motionSkinnyNB()

Synopsis
```
#include <mobot.h>
int CMobotGroup::motionSkinny(double angle);
int CMobotGroup::motionSkinnyNB(double angle);
```

Purpose
Move the robots in the group into a skinny profile.

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

Parameters

`angle` The angle in degrees to move the joints. A value of zero means a completely flat profile, while a value of 90 degrees means a fully skinny profile.

Description

CMobot::motionSkinny()
This function makes the robots assume a skinny rolling profile.

CMobot::motionSkinnyNB()
This function makes the robots assume a skinny rolling profile.

This function has both a blocking and non-blocking version. The blocking version, `motionSkinny()`, will block until the robot motion has completed. The non-blocking version, `motionSkinnyNB()`, will return immediately, and the motion will be performed asynchronously.

See Also

CMobotGroup::motionStand()
CMobotGroup::motionStandNB()

Synopsis

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

Purpose

Stand robots up on a faceplate.

Return Value

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

Parameters

None.

Description

CMobot::motionStand()
This function causes the robots to stand up into the camera platform.

CMobot::motionStandNB()
This function causes the robots to stand up into the camera platform.

This function has both a blocking and non-blocking version. The blocking version, `motionStand()`, will block until the robot motion has completed. The non-blocking version, `motionStandNB()`, will return immediately, and the motion will be performed asynchronously.

See Also

CMobotGroup::motionTumble()
CMobotGroup::motionTumbleNB()

Synopsis

```
#include <mobot.h>
int CMobotGroup::motionTumble(int num);
int CMobotGroup::motionTumbleNB(int num);
```

Purpose

Make the robots in the group tumble end over end.

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

Parameters

`num` The number of times to tumble.

Description

CMobot::motionTumble()
This causes the robot to tumble end over end. The argument, `num`, indicates the number of times to tumble.

CMobot::motionTumbleNB()
This causes the robot to tumble end over end. The argument, `num`, indicates the number of times to tumble.

This function has both a blocking and non-blocking version. The blocking version, `motionTumble()`, will block until the robot motion has completed. The non-blocking version, `motionTumbleNB()`, will return immediately, and the motion will be performed asynchronously.

See Also

CMobotGroup::motionTurnLeft() CMobotGroup::motionTurnLeftNB()

Synopsis
```
#include <mobot.h>
int CMobotGroup::motionTurnLeft(double angle);
int CMobotGroup::motionTurnLeftNB(double angle);
```

Purpose
Rotate the robots using the faceplates as wheels.

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

Parameters

`angle` The angle in degrees to turn the wheels. The wheels will turn in opposite directions by the amount specifid by this argument in order to turn the robot to the left.

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

This function has both a blocking and non-blocking version. The blocking version, `motionTurnLeft()`, will block until the robot motion has completed. The non-blocking version, `motionTurnLeftNB()`, will return immediately, and the motion will be performed asynchronously.

See Also
`motionTurnRight()`

CMobotGroup::motionTurnRight()
CMobotGroup::motionTurnRightNB()

Synopsis
```
#include <mobot.h>
int CMobotGroup::motionTurnRight(double angle);
int CMobotGroup::motionTurnRightNB(double angle);
```

Purpose
Rotate the robots using the faceplates as wheels.

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

Parameters

`angle` The angle in degrees to turn the wheels. The wheels will turn in opposite directions by the amount specifid by this argument in order to turn the robot to the right.

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

This function has both a blocking and non-blocking version. The blocking version, `motionTurnRight()`, will block until the robot motion has completed. The non-blocking version, `motionTurnRightNB()`, will return immediately, and the motion will be performed asynchronously.

See Also
`motionTurnLeft()`

CMobotGroup::motionUnstand()
CMobotGroup::motionUnstandNB()

Synopsis
```
#include <mobot.h>
int CMobotGroup::motionUnstand();
int CMobotGroup::motionUnstandNB();
```

Purpose
Move robots currently standing on a faceplate back down into a prone position.

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

Parameters
None.

Description

CMobot::motionUnstand()
This function causes the robot to move down from the camera platform.

CMobot::motionUnstandNB()
This function causes the robot to move down from the camera platform.

This function has both a blocking and non-blocking version. The blocking version, `motionUnstand()`, will block until the robot motion has completed. The non-blocking version, `motionUnstandNB()`, will return immediately, and the motion will be performed asynchronously.

See Also

CMobotGroup::move()
CMobotGroup::moveNB()

Synopsis

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

Purpose

Move all of the joints of robots in a group by specified angles.

Return Value

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

Parameters

`angle1`	The amount to move joint 1, expressed in degrees relative to the current position.
`angle2`	The amount to move joint 2, expressed in degrees relative to the current position.
`angle3`	The amount to move joint 3, expressed in degrees relative to the current position.
`angle4`	The amount to move joint 4, expressed in degrees relative to the current position.

Description

CMobot::move()

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

CMobot::moveNB()

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

The function `moveNB()` is the non-blocking version of the `move()` function, which means that the function will return immediately and the physical robot motion will occur asynchronously. For more information on blocking and non-blocking functions, please refer to Section 8 on page 26.

Example

See Also

CMobotGroup::moveContinuousNB()

Synopsis

```
#include <mobot.h>
int CMobotGroup::moveContinuousNB(
  robotJointState_t dir1,
  robotJointState_t dir2,
  robotJointState_t dir3,
  robotJointState_t dir4);
```

Purpose
Move the joints of grouped robots 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:

- `ROBOT_NEUTRAL` : The joint should not move.
- `ROBOT_FORWARD` : The joint will begin moving in the positive direction.
- `ROBOT_BACKWARD`: The joint will begin moving in the negative direction.
- `ROBOT_HOLD`: The joint will hold its current position.

More documentation about these types may be found at Section A.2 on page 35.

Description
This function causes joints of robots 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. This function is a non-blocking function.

Example

See Also

CMobotGroup::moveContinuousTime()

Synopsis

```
#include <mobot.h>
int CMobotGroup::moveContinuousTime(robotJointState_t dir1,
                                    robotJointState_t dir2,
                                    robotJointState_t dir3,
                                    robotJointState_t dir4,
                                    int msecs);
```

Purpose
Move the joints of robots continuously in the specified directions.

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

Parameters
Each of the direction parameters, `dir1, dir2, dir3,` and `dir4`, specifies the direction the joint should move. The types are enumerated in `mobot.h` and have the following values:

- `ROBOT_NEUTRAL` : The joint should not move.
- `ROBOT_FORWARD` : The joint will begin moving in the positive direction.
- `ROBOT_BACKWARD`: The joint will begin moving in the negative direction.
- `ROBOT_HOLD`: The joint will hold its current position.

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

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

Example

See Also

CMobotGroup::moveTo()
CMobotGroup::moveToNB()

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

Purpose
Move all of the joints of robots in the group to the specified positions.

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

Parameters

`angle1`	The absolute position to move joint 1, expressed in degrees.
`angle2`	The absolute position to move joint 2, expressed in degrees.
`angle3`	The absolute position to move joint 3, expressed in degrees.
`angle4`	The absolute position to move joint 4, expressed in degrees.

Description

CMobot::moveTo()
This function moves all of the joints of robots in the group to the specified absolute positions.

CMobot::moveToNB()
This function moves all of the joints of robots in the group to the specified absolute positions.

The function `moveTo()` is a blocking function, which means that the function will not return until the commanded motion is completed. The function `moveToNB()` is the non-blocking version of the `moveTo()` function, which means that the function will return immediately and the physical robot motion will occur asynchronously. For more details on blocking and non-blocking functions, please refer to Section 8 on page 26.

Example
Please see the demo at Section 4.1.2 on page 16.

See Also

CMobotGroup::moveJoint()
CMobotGroup::moveJointNB()

Synopsis
```
#include <mobot.h>
int CMobotGroup::moveJoint(robotJointId_t id, double angle);
int CMobotGroup::moveJointNB(robotJointId_t id, double angle);
```

Purpose
Move a joint on the robots in the group by a specified angle with respect to the current position.

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

Parameters

`id`	The joint number to wait for.
`angle`	The angle in degrees to move the motor, relative to the current position.

Description

CMobot::moveJoint()
This function commands the motor to move by an angle relative to the joint's current position at the joints current speed setting. 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 `moveJoint()` function.

CMobot::moveJointNB()
This function commands the motor to move by an angle relative to the joint's current position at the joints current speed setting. 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 `moveJoint()` function.

The function `moveJoint()` is a blocking function, which means that the function will not return until the commanded motion is completed. The function `moveJointNB()` is the non-blocking version of the `moveJoint()` function, which means that the function will return immediately and the physical robot motion will occur asynchronously. For more details on blocking and non-blocking functions, please refer to Section 8 on page 26.

Example
Please see the example in Section 4.1.2 on page 16.

See Also
`connectWithAddress()`

CMobotGroup::moveJointTo()
CMobotGroup::moveJointToNB()

Synopsis
```
#include <mobot.h>
int CMobotGroup::moveJointTo(robotJointId_t id, double angle);
int CMobotGroup::moveJointToNB(robotJointId_t id, double angle);
```

Purpose
Move a joint on robots to an absolute position.

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

Parameters

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

Description

CMobot::moveJointTo()
This function commands the motor on robots in a group 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.

CMobot::moveJointToNB()
This function commands the motor on robots in a group 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.

The function `moveJointTo()` is a blocking function, which means that the function will not return until the commanded motion is completed. The function `moveJointToNB()` is the non-blocking version of the `moveJointTo()` function, which means that the function will return immediately and the physical robot motion will occur asynchronously. For more details on blocking and non-blocking functions, please refer to Section 8 on page 26.

Example
Please see the example in Section 4.1.2 on page 16.

See Also

CMobotGroup::moveJointWait()

Synopsis

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

Purpose
Wait for a joint to stop moving on all robots in a group.

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 `moveJointToNB()` and `moveJointNB()` 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 joint 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 4.1.2 on page 16.

See Also
`moveWait()`

CMobotGroup::moveWait()

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

Purpose
Wait for all joints of all robots in the group 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 `moveJointToNB()` and `moveJointNB()` 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 4.1.2 on page 16.
See Also
`moveWait()`, `moveJointWait()`

CMobotGroup::moveToZero()

CMobotGroup::moveToZeroNB()

Synopsis

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

Purpose

Move all of the joints of robots in the group to their zero position.

Return Value

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

Parameters

None.

Description

CMobot::moveToZero()

This function moves all of the joints of robots in the group 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.

CMobot::moveToZeroNB()

This function moves all of the joints of robots in the group 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.

The function `moveToZero()` is a blocking function, which means that the function will not return until the commanded motion is completed. The function `moveToZeroNB()` is the non-blocking version of the `moveToZero()` function, which means that the function will return immediately and the physical robot motion will occur asynchronously. For more details on blocking and non-blocking functions, please refer to Section 8 on page 26.

Example

Please see the demo at Section 4.1.2 on page 16.

See Also

CMobotGroup::setJointSpeed()

Synopsis

```
\vspace{-8pt}
#include <mobot.h>
int CMobotGroup::setJointSpeed(robotJointId_t id, double speed);
```

Purpose

Set the speed of a joint on all robots in the group.

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` for the requested average angular speed in degrees per second.

Description
This function is used to set the angular speed of a joint of all robots in the group.
Example

See Also

CMobotGroup::setJointSpeedRatio()

Synopsis
```
#include <mobot.h>
int CMobotGroup::setJointSpeedRatio(robotJointId_t id, double ratio);
```

Purpose
Set the speed ratio settings of a joint on all robots in the group.

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

Parameters

`id`	Set the speed ratio setting of this joint. This is an enumerated type discussed in Section A.1 on page 35.
`ratio`	A variable of type double with a value from 0 to 1.

Description
This function is used to set the speed ratio setting of a joint for all robots in the group. The speed ratio setting of a joint is the percentage of the maximum joint speed, and the value ranges from 0 to 1. In other words, if the ratio is set to 0.5, the joint will turn at 50% of its maximum angular velocity while moving continuously or moving to a new goal position.

Example

See Also
`setJointSpeeds()`, `setJointSpeedRatio()`

CMobotGroup::setJointSpeedRatios()

Synopsis
```
#include <mobot.h>
int CMobotGroup::setJointSpeedRatios(double ratio1, double ratio2, double ratio3, double ratio4);
```

Purpose
Set the speed ratio settings of all joints on the robots in the group.

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

Parameters

`ratio1` The speed ratio setting for the first joint.
`ratio2` The speed ratio setting for the second joint.
`ratio3` The speed ratio setting for the third joint.
`ratio4` The speed ratio setting for the fourth joint.

Description
This function is used to simultaneously set the angular speed ratio settings of all four joints of a robot for all robots in the group. The speed ratio is a percentage of the maximum speed of a joint, expressed in a value from 0 to 1.

Example

See Also
`getJointSpeeds()`, `setJointSpeed()`, `getJointSpeed()`

CMobotGroup::setJointSpeeds()

Synopsis
```
#include <mobot.h>
int CMobotGroup::setJointSpeeds(double speed1, double speed2, double speed3, double speed4);
```

Purpose
Set the speed settings of all joints on all robot in the group.

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

Parameters
`speed1` The speed setting for the first joint, in units of degrees per second.
`speed2` The speed setting for the second joint, in units of degrees per second.
`speed3` The speed setting for the third joint, in units of degrees per second.
`speed4` The speed setting for the fourth joint, in units of degrees per second.

Description
This function is used to simultaneously set the angular speed settings of all four joints of all robots in the group. The joint speeds are expressed in degrees per second.

Example

See Also
`setJointSpeed()`

CMobotGroup::setTwoWheelRobotSpeed()

Synopsis
```
#include <mobot.h>
int CMobotGroup::setTwoWheelRobotSpeed(double speed, double radius);
```

Purpose
Roll the robots in the group at a certain speed in a straight line.

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

Parameters

`speed` The speed at which to roll the robot. The units used will be the units specified in the `unit` parameter.

`radius` The radius of the wheels attached to the robot. The units of the parameter should match the units provided in the `unit` parameter.

speed	radius
cm/s	cm
m/s	m
inch/s	inch
foot/s	foot

Description
This function is used to make a two wheeled robot roll at a certain speed. The desired speed and radius of the wheels is provided and the function will rotate the wheels at the appropriate rate in order to achieve the desired speed.

Example

See Also

CMobotGroup::stop()

Synopsis

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

Purpose
Stop all current motions on all robot in the group.

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

Description
This function stops all currently occuring movements on the robot. 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(), setJointSpeeds()`

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