Description of 3pi/m3pi robots

Overview of robot

The Pololu 3pi robot is a ready out-of-the-box mobile robot. The robot features include two motors, 5 reflectance sensors, an 8x2 character LCD, LED lights, a buzzer (noise maker), and three user push buttons all connected to a C-programmable ATmega328p microcontroller. The microcontroller runs at 20 MHz and features 32 KB of flash program memory, 2 KB RAM, and 1 KB of persistent EEPROM memory.

These features are combined so the robot can be conveniently programmed to navigate tracks and grids. The sensors are used to detect turns in a grid, the memory and processing capabilities of the robot are used to keep track of the robot’s position on the grid, and the buttons, LCD, and buzzer provide ways for users to interact with the robot.

The m3pi robot is the 3pi robot with added functionality. Added on are wireless communication capabilities, more LEDs, more processing power, more memory, and a file system. By including another microcontroller unit and an XBee 802.15.4 (a wireless communication module) usable by the added microcontroller, the 3pi robots are able to wirelessly communicate data between other devices who have an XBee module. The microcontroller unit development board used is the mbed NXP LPC1768. It is C++ programmable and has a 32-bit ARM Cortex-M3 processor running at 96 MHz with 512 KB flash and 32 KB RAM.

The added features in the m3pi robot are used with features from the base 3pi to allow multiple robots to navigate grids in programmed ways and to programatically avoid collision.

The 3pi robot is programmed with the integrated development environment (IDE) Atmel Studios using the C language and Pololu provided libraries to use 3pi robot features. The m3pi robot is programmed with the mbed online compiler on the mbed development site using C++ and mbed provided libraries to use the m3pi robot features.

Lower level description of features

3pi robot

In the 3pi robot, the C programmable ATmega328p microcontroller is able to control all features of the robot. For example, depending on data received by the sensors, the 3pi robot could be programmed to play music from the buzzer, display a message on the LCD, and move the motors to turn the wheels of the robot.
The 3pi robots have 5 reflectance sensors. Each sensor measures how long it takes light to be reflected from the area under it back to the sensor. The sensor then uses that information to calculate a value that represents how dark the area under the sensor is. Before being able to use the sensors, they are first calibrated. They are calibrated by exposing the sensors to the entire range of color lightness/darkness of the track or grid it is expected to navigate through. By knowing the range, each sensor can then tell you if it is over a dark area (like a part the grid) or over a light area and how far left or right it is over that area.

The 3pi robot has 2 motors to control each tire. The motors can operated independently of each other and can make the tires turn forward or backwards. The motors can: turn the tires forward at the same speed to make it move straight forward, turn the tires backwards at the same speed to make it move straight backwards, turn one tire and leave the other still to make a left or right turn as one tire is used as a pivot, or also turn both tires in opposite directions to make a left or right turn in place.

The buzzer uses musical notes played sequentially to either make noise or construct songs.

Other features like the LED lights and buttons can be controlled programmatically to interact with the robot.

**M3pi robot**

In the m3pi robot, the mbed NXP LPC1768 is able to control all features of the 3pi robot and the added features of the m3pi robot. This is done by serial communication between the m3pi expansion board and the connective pins between the base 3pi robot and the m3pi.

With serial communication, raw bytes are back and forth between the 3pi robot the and m3pi robot. These raw bytes are mapped to commands. For example, the m3pi robot sends “0x12” to the 3pi robot. The 3pi robot then executes the command mapped to “0x12”, which is to call the “turn” command.

Likewise to use the XBee wireless communication module, raw bytes are sent as well. Information to configure the XBee module, information to configure how messages should be sent, and information to send as messages to other devices with the XBee modules are sent as raw bytes.

Other features like the LED lights can be controlled programmatically to interact with the robot.