Cerebot Bluetooth Robot Remote Reference Design

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Cerebot32MX4 Bluetooth Remote Control

Overview

This project demonstrates the use of the pmodlib C library in conjunction with the PmodJSTK, PmodCLS, Pmod8LD, and PmodBT2 and Cerebot32MX4 microcontroller as a Bluetooth remote control for a robot. The companion project (the robot) is the Cerebot32MX4 Bluetooth Robot.

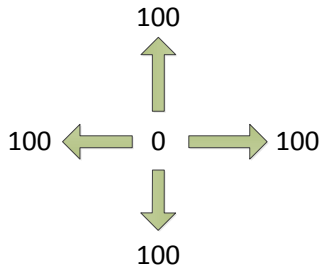
Functional Description

This project consists of a custom made remote chassis that will house the Cerebot32MX4 along with two PmodJSTK, battery case, PmodCLS, PmodBT2, and Pmod8LD. Remote input is taken in through two PmodJSTK modules, each monitoring a separate axis. JSTK1: y-axis (fwd/rev) JSTK2: x-axis(left/right). Commands sent to the robot are transmitted using the PmodBT2 Bluetooth module. Information received from the robot (rpm, battery voltage and direction) are displayed on the PmodCLS. Joystick calibration instructions and initialization status are also displayed on the PmodCLS during startup.

Once power is applied to the remote, the Bluetooth module initialization process begins, "Initializing" is displayed on the PmodCLS until complete. Once the PmodBT2 has been initialized joystick calibration begins, the goal of calibration is to determine the minimum and maximum bounds for the X and Y axes. PmodJSTK LD1 will illuminate on the joystick currently in calibration, the PmodCLS will display the direction and axis to calibrate. To calibrate, apply full deflection in the direction requested (x-, x+, y-,y+) on the PmodJSTK with LD1 illuminated. While maintaining full deflection , press BTN1 on the same PmodJSTK. Repeat as directed for other axes. If either axis range calculated at the end of calibration is inadequate the process will repeat.

After calibration, the remote will attempt to locate the address of the robot by performing a Bluetooth inquiry for "CEREBOTROBOT"(configurable), resolving this name to an address. The remote will then attempt to connect, "Connecting..." will be displayed on the PmodCLS during the inquiry and connection process. Once connected, the Pmod8LD will illuminate, Left/Right wheel RPM, robot battery voltage and direction of travel will be displayed on the PmodCLS. If the remote fails to connect, the inquiry and connect process will execute a specified number of times (configurable), once the number of tries expires the remote will require a reset. If the remote loses its connection to the robot during operation, it will initiate the inquiry process and attempt to reconnect.

Once the remote has successfully connected , deflecting the fwd/rev joystick in the y+ direction will move the robot forward, y- will cause it to reverse direction. Deflecting the left/right joystick in the x-direction turn the robot left, x+ will turn the robot right, x axis movements only turn the robot while it is motion



Joystick movements will transmit the percentage of deflection on the axis monitored as displayed in the figure to the left. Position of the joystick in the positive or negative position relative to its axis is determined and sent to the robot indicating FWD/REV or LEFT/RIGHT. Due to potential inaccuracies during joystick calibration, axis limits and range values are recalculated during operation when a min or max range value has been exceeded.

Bluetooth connection state is monitored by polling the STATUS pin of the PmodBT2, which is driven high when connected and low otherwise.

Source code for the remote is located in the directory titled "Cerebot Remote". This project was created using MPLAB IDE v8.80 and written entirely in C utilizing the Microchip and pmodlib libraries.

Configuration
*All settings referenced in this section are in "cerebot_robot_remote.c"

Processor: configuration settings are located in the "PIC32 Configuration Settings" section.

Pmod IO/Ports - IO ports/bits and channels have been defined as macros for easy configuration under //IO PORT/CHANNEL DEFINITIONS. Changes in hardware location must be reflected in this section.

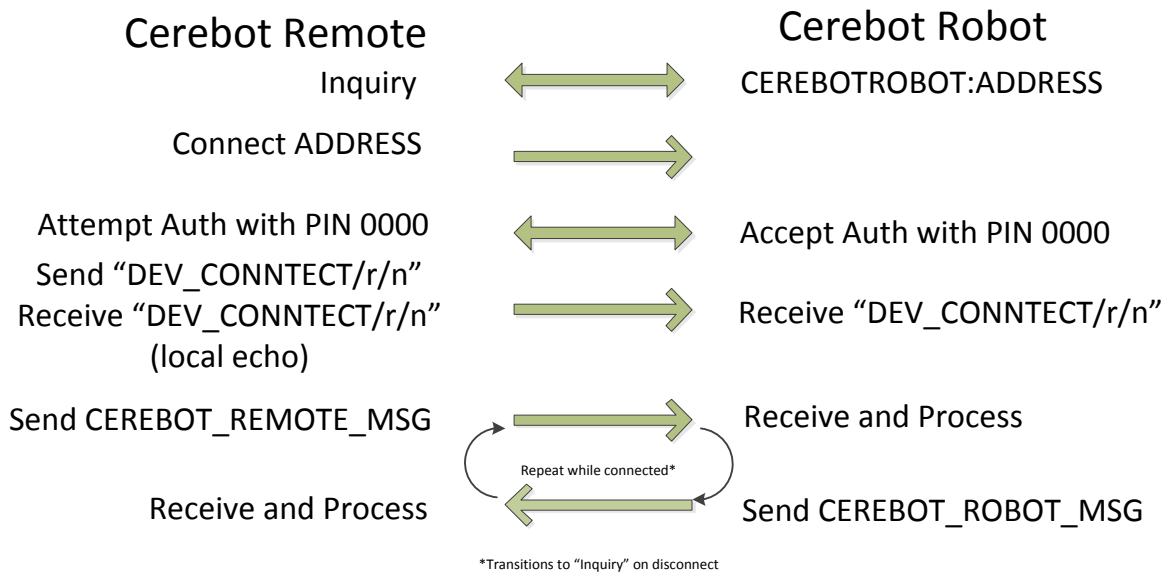
Bluetooth Communication/Status - The Bluetooth name of the remote control is a macro defined as BLUETOOTH_REMOTE_NAME, the remote side (the robot) is defined as BLUETOOTH_ROBOT_NAME and is used during inquiry to resolve the address of the robot. The use of the Pmod8LD for connection status is optional, to use LD1 on the Cerebot 32MX4 modify macro BLUETOOTH_STAT_LED, a value of 0 will use LD1, 1 will use PmodLD8, any other value will disable connection status notification. Additional Bluetooth parameters are set in initPmodBT2(), detailed explanations of these settings are available in the Roving Networks RN-42 Advanced User Manual.

Clock Rates:
Processor Freq: 80Mhz
Peripheral Bus: 40Mhz

Port Bitrates:
UART1 - PmodCLS: 9600
UART2 - PmodBT2: 115200
SPI1 - PmodJSTK: 156250
SPI2 - PmodJSTK: 156250

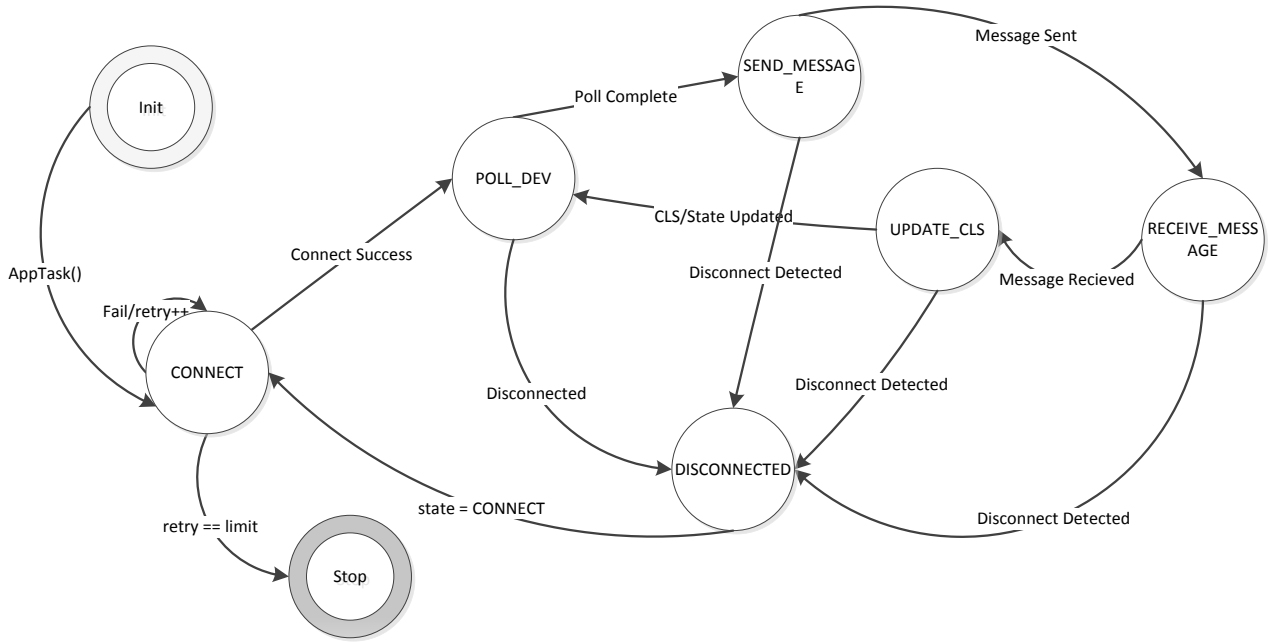
Communication Protocol :

Messages sent/received via serial communication through the PmodBT2 utilize structs CEREBOT_REMOTE_MSG and CEREBOT_ROBOT_MSG located in "cerebot_robot_remote_types.h" .



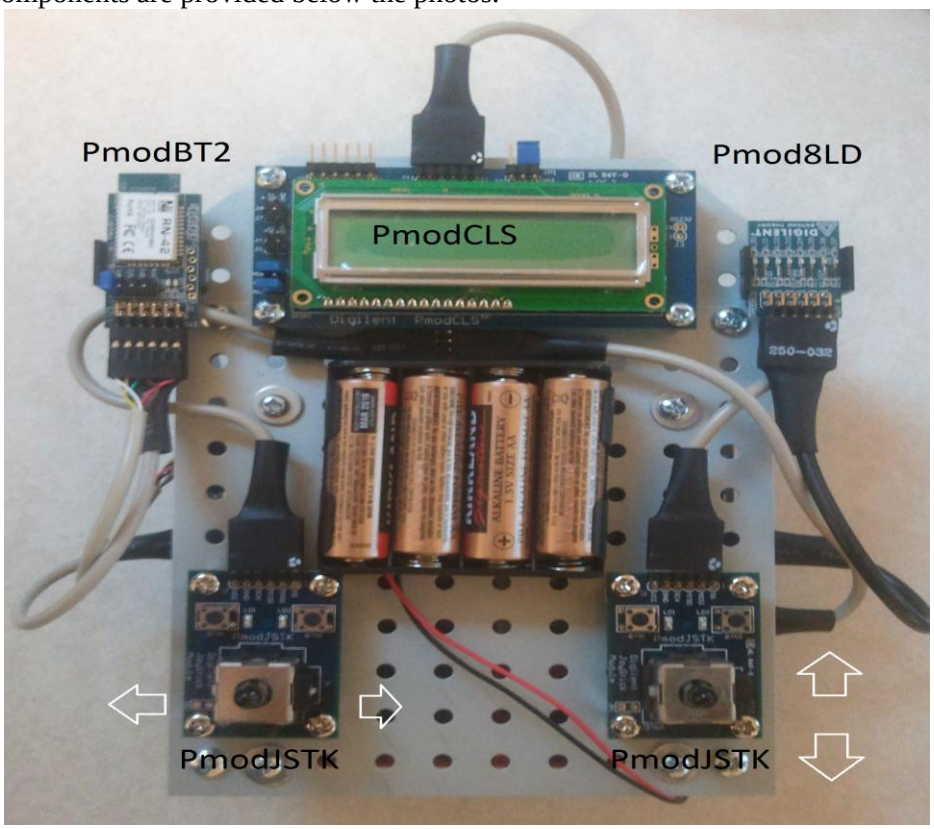
Remote State Diagram:

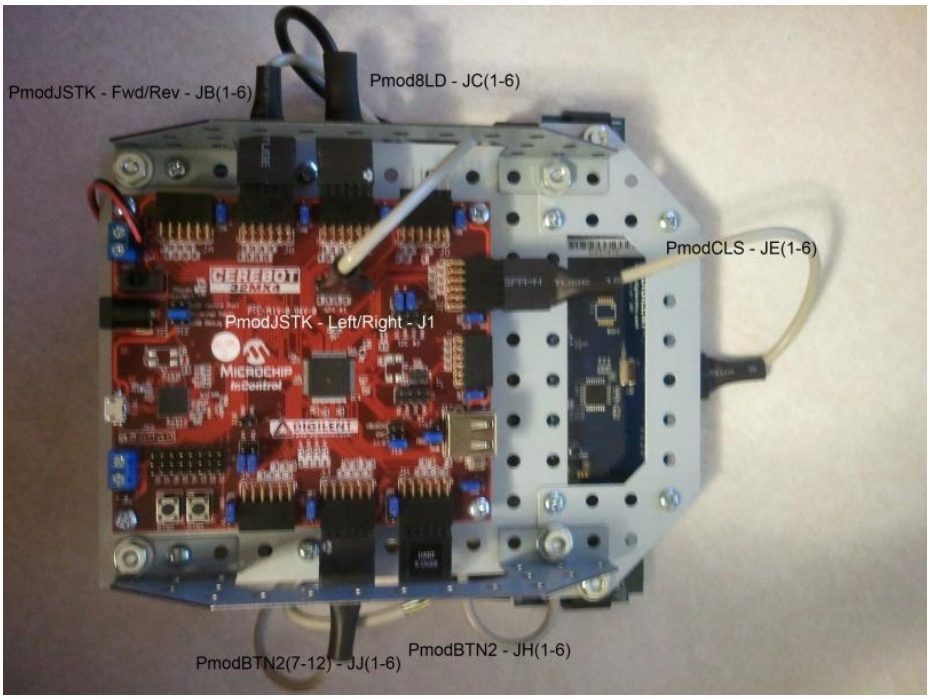
The following state transition diagram represents the main program loop of the remote keying on specific events that trigger a transition from one state to the next. State names line up with states present in appTask() prefixed with STATE_.



Assembly:

The photos below show how the remote should look after assembly. Tables detailing the electrical connections of the different components are provided below the photos.





The table below details the electrical connections between the different components of the remote. All jumpers are in their default positions except J12 which is shorted on "External Power".

Cerebot 32MX4				
Header	Description	Connections		
J1	Left/Right Joystick (SPI1)	Pin	Peripheral Header	Peripheral Pin
		SS	PmodJSTK - J1	1
		SDO	PmodJSTK - J1	2
		SDI	PmodJSTK - J1	3
		SCK	PmodJSTK - J1	4
		GND	PmodJSTK - J1	5
		VCC	PmodJSTK - J1	6
JB	Fwd/Rev Joystick(SPI2)	Pin	Peripheral Header	Peripheral Pin
		1	PmodJSTK - J1	1
		2	PmodJSTK - J1	2
		3	PmodJSTK - J1	3
		4	PmodJSTK - J1	4
		5	PmodJSTK - J1	5
		6	PmodJSTK - J1	6
JC	Bluetooth connected status indicator	Pin	Peripheral Header	Peripheral Pin
		1	Pmod8LD - J1	1
		2	Pmod8LD - J1	2
		3	Pmod8LD - J1	3
		4	Pmod8LD - J1	4
		5	Pmod8LD - J1	5
		6	Pmod8LD - J1	6
		7	Pmod8LD - J1	7
		8	Pmod8LD - J1	8
		9	Pmod8LD - J1	9
		10	Pmod8LD - J1	10
		11	Pmod8LD - J1	11
		12	Pmod8LD - J1	12
JE	LCD status display	Pin	Peripheral Header	Peripheral Pin
		1	PmodCLS - J2	1
		2	PmodCLS - J2	2
		3	PmodCLS - J2	3
		4	PmodCLS - J2	4
		5	PmodCLS - J2	5
		6	PmodCLS - J2	6
JH	Bluetooth UART connection (Using UART X-Over Cable)	Pin	Peripheral Header	Peripheral Pin
		1	PmodBT2 - J1	1
		2	PmodBT2 - J1	4

		3	PmodBT2 - J1	3
		4	PmodBT2 - J1	2
		5	PmodBT2 - J1	5
		6	PmodBT2 - J1	6

Cerebot 32MX4 (Continued)

Header	Description	Connections		
JJ	Bluetooth Connection and Status	Pin	Peripheral Header	Peripheral Pin
		1	PmodBT2 - J1	7
		2	PmodBT2 - J1	8
		3	PmodBT2 - J1	9
		4	PmodBT2 - J1	10
		5	PmodBT2 - J1	11
		6	PmodBT2 - J1	12
J14	External Power (Battery Holder)	Pin	Peripheral Header	Peripheral Pin
		GND	Battery	Black
		VEXT	Battery	Red

PmodCLS

Header	Description	Connections		
J2	UART Communication	Pin	Peripheral Header	Peripheral Pin
		1	Cerebot 32MX4 - JE	1
		2	Cerebot 32MX4 - JE	2
		3	Cerebot 32MX4 - JE	3
		4	Cerebot 32MX4 - JE	4
		5	Cerebot 32MX4 - JE	5
		6	Cerebot 32MX4 - JE	6
JP2	Mode Selection	REV E MD0 = shorted MD1 = open MD2 = shorted		REV D MD0 = open MD1 = shorted MD2 = open

PmodJSTK(Left)

Header	Description	Connections		
J1	SPI Communication	Pin	Peripheral Header	Peripheral Pin
		1	Cerebot 32MX4 - JB	1
		2	Cerebot 32MX4 - JB	2
		3	Cerebot 32MX4 - JB	3
		4	Cerebot 32MX4 - JB	4
		5	Cerebot 32MX4 - JB	5
		6	Cerebot 32MX4 - JB	6

PmodJSTK(Right)				
Header	Description	Connections		
J1	SPI Communication	Pin	Peripheral Header	Peripheral Pin
		1	Cerebot 32MX4 - J1	SS
		2	Cerebot 32MX4 - J1	SDO
		3	Cerebot 32MX4 - J1	SDI
		4	Cerebot 32MX4 - J1	SCK
		5	Cerebot 32MX4 - J1	GND
		6	Cerebot 32MX4 - J1	VCC

PmodBT2				
Header	Description	Connections		
J1	Bluetooth UART connection (Using UART X-Over Cable)/ Bluetooth Connection and Status	Pin	Peripheral Header	Peripheral Pin
		1	Cerebot 32MX4 - JH	1
		2	Cerebot 32MX4 - JH	4
		3	Cerebot 32MX4 - JH	3
		4	Cerebot 32MX4 - JH	2
		5	Cerebot 32MX4 - JH	5
		6	Cerebot 32MX4 - JH	6
		7	Cerebot 32MX4 - JJ	1
		8	Cerebot 32MX4 - JJ	2
		9	Cerebot 32MX4 - JJ	3
		10	Cerebot 32MX4 - JJ	4
		11	Cerebot 32MX4 - JJ	5
		12	Cerebot 32MX4 - JJ	6
JP1 - 4	See PmodBT2 RM	Open		

Parts List

Digilent
(1) Cerebot 32MX4
(1) PmodBT2
(2) PmodJSTK
(1) Pmod8LD
(1) UART Crossover Cable
(5) 6 Pin Cable Connector
(1) 2x6 Pin Cable
(4) 6 Pin Header & Gender Changer
(1) 2x6 Pin Header
(4) Standoffs (contains 4ea)
(1) Battery Holder (4 x AA)
(1) Base Plate Expansion Kit
(1) Angled Plate Expansion Kit
(1) Angled Plate Expansion (90˚ flange)
(2) Pmod Clip