

Lab 4

Modify Lab 3's developed program to incorporate a second microcontroller platform for remote operation. The Controller module will be the mbed LPC1768, connected to the game system via serial. Any hardware serial port on the mbed LPC1768 to serial port 2 of the PIC18F45K22.

The game will now react to remote commands from the remote controller system. No pushbutton interface will be on the TicTacToe system and it will only be given placements and events based on serial communication.

Operational Characteristics:

Hardware

1. Add the mbed LPC1768 module to the circuit connected in a direct serial port to serial port method. PIC Tx -> mbed Rx and mbed Tx -> PIC Rx.
2. Transfer the push buttons circuit to connect with any of the digital IO pins of the mbed LPC1768 module.
3. **Modify / create** a complete schematic for the entire TicTacToe system which includes the main system, previously developed, and the addition of the mbed LPC1768 with attached push buttons.

The schematic MUST conform to the program conventions and must be easily readable and not contain awkward turns or bents, symbol misalignment or scattered peripherals. The game board LEDs will be together, the push button circuit will be together and the microcontrollers will be labelled.

If the schematic is awkwardly drafted, hard to read or otherwise unprofessional, demonstration will not be viewed.

Software

PIC18F45K22:

Create a new folder directory and an MPLab project using the C18 tool suite. Name the project ELNC6007(your initials)Lab4, without the brackets.

Copy and rename the source code file from Lab 3. Do not forget the pragmas.h file. Do not work in the same source code file without maintaining a copy of Lab 3's completed work.

1. Create all the separate functions required for serial reception, as illustrated in lectures. The only way the TicTacToe (PIC) system can make a placement is through serial communication with the Controller system (mbed LPC1768).
2. Ensure character reception is collected from the receiver of serial port 2 on a byte by byte basis. A global flag variable must be used to identify when a full sentence has been received and is ready for further processing. Name this flag variable accordingly.
3. Sentence structures to be transmitted or received will follow the tables below. If there is a blank space in the sentence table, do not include the blanks and add the rest of the data within the remaining table to the communication sentence.

New Communication Sentence Format								
Header Char	Cmd Statement	Address To	Address From	Row	Column	Player	Checksum	End Char
\$	PLYPMT,	XX,	XX,	X,	X,	XXX,	XXX	^
Start	Defines Action	Receiver	Sender	2D Gameboard 1	2D Gameboard 2	Which Player?	Verification	Stop

Sent when a placement has been made, automatically or manually.

New Communication Sentence Format								
Header Char	Cmd Statement	Address To	Address From	TRUE / FALSE			Checksum	End Char
\$	GAMRST,	XX,	XX,	X,			XXX	^
Start	Defines Action	Receiver	Sender	Yes or No			Verification	Stop

Sent when a reset to the game has been made

New Communication Sentence Format								
Header Char	Cmd Statement	Address To	Address From	Game Result	Winner	Game Time	Checksum	End Char
\$	GAMEND,	XX,	XX,	X,	X,	XXXX,	XXX	^
Start	Defines Action	Receiver	Sender	Won or Draw	X', 'O', 'N'one	2 byte int MMSS	Verification	Stop

Sent when a game ends

4. Turn Time is still controlled by the TicTacToe system (PIC). If an automatic placement is executed, the TicTacToe system will create, package and send a PLYPMT communication sentence to the Controller system (mbed LPC1768).
5. When the game ends a GAMEND communication sentence will be created, packaged and sent to the Controller system (mbed LPC1768).
6. The TicTacToe system (PIC) must react to the incoming communication sentences in real time. When a placement command has been received, the game board should update and display appropriately.
7. Remove the push button read operations from the TicTacToe system (PIC). They will now be performed on the Controller side program.
8. Remove the Row Column and select features from the display process. Keep and display all other aspects of Lab 3's display.

Example display:

```
TicTacToe455   Game Time: 01:21   Status: Playing
Player: O      Turn Count: 7
                Turn Time: 30

                COLUMN
                0  1  2
0  X | O |
R  -----
O 1 O |  |
W  -----
2  | X |
```

mbed LPC1768:

9. Duplicate the aspects of the PIC program that are required for control, the system data structure object, buffer for communication, terminal display and push button operation. Minimal modification should be required to accomplish this.
10. Create all the separate functions required for serial reception, as illustrated in lectures. Ensure the character reception process is on a byte by byte basis. A global flag variable must be used to identify when a full sentence has been received and is ready for further processing. Name this flag variable accordingly.

11. The placement selection will now be executed on the Controller (mbed LPC1768) side. When the user selects a placement, the Controller will create, package and send a PLYPMT sentence to the TicTacToe system (PIC) for execution.
12. When a reset input is read by the Controller, the Controller system (mbed LPC1768) will create, package and send a GAMRST sentence to the TicTacToe system (PIC) for execution.
13. When a GAMEND sentence is received, the Controller system will display who won the game or a draw and the game time received from the TicTacToe system (PIC). Use the USB serial port for the Controller's terminal output.
14. Duplicate the display aspects necessary for the Controller system to interface with the user. The display will show everything from Lab 3's developed program except for the turn time, status and game time.

Example display:

```
Controller 1
Player: O      Turn Count: 7
Row or Column
Select: 0

      COLUMN
      0 1 2
0 X | O |
R -----
O 1 O |  |
w -----
2  | X |
```

Multiple TeraTerm windows can be opened at the same time, connected to different serial port inputs.

Demonstrate a completed, tested and functional system to the Lab Instructor. Be prepared to offer rational or answers in response to questions. Failure to answer questions or provide rational will void demonstration. Each student's own original program must be uploaded to the FoL submission box as a .txt file with the mbed LPC1768 program on TOP and the PIC program on the bottom. No exceptions.

This completed exercise is due the week of: **Dec 7th, 2020** in the regular scheduled Lab session. No extensions can be allowed due to the time constraints of the 20F term.