Title of script: LCD interfacing on firebird-V robot

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| Slides | Narration |
| 01.  Title | * Hello Friends. * Welcome to the spoken tutorial on Firebird V Robotics Research Platform. * This platform is based on LPC 2148 microcontroller which belongs to ARM architecture based microcontroller family. * In this tutorial, we will learn about **LCD interfacing on Firebird V robot**.  |  | | --- | |  |   **(press next)** |
| 02.  Agenda | * Now let us see the agenda for discussion in this tutorial. * The presentation will start with the overview of LCD. Then we will discuss about LCD pin-configuration which will include the discussion of control and data pins of LCD. After understanding the pin configuration we will discuss how to send command and data to the LCD and then write a program to Display some string on the LCD.   **(press next)** |
| 03.  What are Ports? | * So, what is Liquid Crystal Display? **(press next)** * A liquid crystal display or LCD in simple word can be defined as a thin flat panel device used for displaying some kind of text or images or animations in a user defined format **(press next)** * LCDs are economical and easy to use device which makes it suitable for being used as display device in any embedded system application. LCDs are available in various flavors and are characterized by character set it can display. Commonly available LCD can display 16 to 20 character in one to four line **(press next) (press next)** * These are some typical embedded system like calculators, digital clocks etc, where we usually see the application of LCD   **(press next)** |
| 04.  Dot-Matrix LCD | * The LCD we are using is referred as a Dot-Matrix liquid crystal display **(press next)** * This LCD has a hitachi manufactured lcd controller, referred as HD44780. The LCD is called as 16 by 2 Alpha numeric LCD because lcd can display 16 characters in two lines and characters can be both alphabets and numbers **(press next)** * HD44780 is a standard lcd controller used to drive any dot-matrix lcd with 8 and 4 bit microcontroller. * This is the 16 by 2 dot-matrix lcd which we are using. **(press next)** |
| 05.  Pin-Configuration | * Now let us see the pins of LCD in detail. **(press next)** * LCD is a 16-pin device as shown. **(press next)** * Now we will see function of each pin one by one **(press next)** * First pin is Vss or the ground pin **(press next)** * second pin is Vdd or the supply voltage **(press next)** * third pin is Vee or the contrast voltage adjustment pin. Normally a pot is connected at this pin and by changing the pot, contrast of lcd display changes. **(press next)** * Then fourth pin is RS or Register Select pin **(press next)** * fifth pin is RW or the read-write pin**(press next)** * Then we have a enable pin represented by capital E **(press next)** * Pin D0 to D7 are the data pins used for sending commands and or display items. **(press next)** * Last two pins Vdd and Vss are used as backlight supply for the lcd. * Now let us discuss the pins in more details   **(press next)** |
| 06.  Control Pins | * For easy of understanding we have divided pins in two groups, the first group we call as Control pins. These pins are used for controlling the way lcd works. **(press next)** * The first pin in this group is Register Select or the RS pin. This pin is used to select command or data register. **(press next)** * So, if RS is made 0, command register is selected and anything put on the data bus is taken as command for LCD to work in certain desired way, which we will discuss in coming slides. So when this pin is low, data on data bus will not be displayed. **(press next)** * If RS is set a value of one, data present on data bus is displayed on LCD in a way as set by user giving certain set of commands **(press next)** * Next is Read/Write Select pin. This pin is used to select whether we want to write on the lcd or we want to read from it. **(press next)** * So if we write RW equals to Zero, it means we are writing to the LCD. **(press next)** * And if we write RW equals to one, it means we are reading from the LCD. **(press next)** * The third pin in this group of control pins is the Enable pin. **(press next)** * So the enable pin is used to latch the data present on the data pins. Now as a user we can send different data at different times and lcd need to differentiate amongst them. For this lcd latches the current set of data on the data pin until the next data is not needed. **(press next)** * So for latching we need to send a high-to-low pulse on enable pin whenever new data is to be sent over the data pins. So the LCD interprets and executes our command at the instant the EN line is brought low. If you never bring enable pin to low, data on data pins will not be read at all.   **(press next)** |
| 07.  Data Pin | * So with this we complete the discussion of using Control pins of lcd. Now the next group of pins is known as Data pins. Let us look at those in details in this slide. **(press next) (press next)** * So there are total eight data pins named from D0 to D7**(press next)** * Same eight data pins are used to send both, the command and the data. **(press next)** * The lcd is a alpha numeric type and understand only ASCII format **(press next)** * We can interface lcd in either eight-bit mode or in four-bit mode. In eight bit mode all eight data pins are connected with the microcontroller whereas in four bit mode only four data pins are connected to the microcontroller. So generally in order to save the microcontroller pins, lcd is interfaced in four bit mode only. **(press next)** * In firebird robot, LCD is interfaced in four-bit mode. So Data pin D4 to D7 is only used for interfacing.   **(press next)** |
| 08  LCD Interfacing | * Now let us see the pin connection between LCD and LPC 2148 microcontroller**(press next)** * As shown in the figure, Control pins of LCD i.e. RS, RW and Enable are connected to Port 1 pin number 19, 18 and 17 respectively. The four data pins of LCD are also connected to port 1 from pin 22 to pin 25**.**   **(press next)** |
| 09  Some Important Command | * Now let us look at some important and commonly used commands with the lcd interfaced **(press next) (press next)** * The first command in the list is used for initialing the lcd in 8-bit mode. So if suppose lcd would have been connected in 8-bit mode, then we would have send a value of thirty-eight over data pin and as the data pin is sending command, we should have kept the value of Register select control pin as zero i.e set in command mode. **(press next)** * Now this is our case, where lcd is interfaced in 4-bit mode. In our case we need to send the value twenty eight over the data pins in order to tell lcd that it is interfaced in four bit mode.**(press next)** * Next command is to clear the display of lcd. When lcd is cleared, it means nothing is being displayed on it. So this can be taken as analogous to erasing everything from the classroom board when new teacher starts giving a lecture. So the hex value for clearing the display is zero one. **(press next)** * Return home means cursor comes to the first row first column on the lcd **(press next)** * Similarly there is command for making cursor blinking. So when you want cursor to blink on lcd, send the hex value of zero F as command. **(press next)** * This is the address of first character on line one. You can similarly increment this value by one to move on from one character right **(press next)** * Similarly C zero is the address of first character on second line. **(press next)** * And 0C is the command used when you don’t want a cursor to appear on screen. **(press next)** * So these were few set of commands commonly used. You can find more commands in the datasheet of hd 44780.   **(press next)** |
| 10  Steps for LCD initialization | * Now lcd is a device connected to microcontroller, but before using it we need to initialize the lcd. So in this slide we will see steps for lcd initialization **(press next)** * First step is to define the port where lcd is connected as GPIO. So in case of firebird lcd is connected to Port 1, so define port 1 as GPIO. **(press next)** * Then the second step is to set port 1 as output port.(**press next**) * Next step is to set the control pins. Now at present stage we are going to send some commands to initialize the lcd, so RS and RW must be given a low value **(press next)** * Next we will send value of 0x28 to tell lcd controller that it is interfaced in four-bit mode **(press next)** * The value twenty eight on data pin will be read only when we send a high to low pulse on enable pin. So this comprises our step four. After this we will send some commands which will set lcd in a default mode. **(press next)** * So we will first send a command to clear the display screen. This is desirable because it may be possible that previously lcd has something on it’s display. And if we send some new display text, it will overlap with the previous displayed text which is unwanted. So by sending a value of 0x01 we are clearing the display of lcd. **(press next)** * Then we make the display on for lcd in order to see what is being displayed at lcd. **(press next)** * Lastly we have palced the cursor at home position i.e. first line first character. All these steps are very important without which lcd will not at all function. We will see how to use it once we start writing the program   **(press next)** |
| 11  Syntax for C program | * Let us now begin writing the C program. In this slides we put the syntax for writing the C program. **(press next)** * So the standard C program begin with including the header files. **(press next)** * Here in this program we include some of header files which are   #include<lpc214x.h>  #include “LCD.h”  Now here we have included a new user-defined header file by name of LCD. This header file comprises of many built-in functions which you can use to easily program the lcd. We will look at the content of this header file in next slide. For now make a note that whenever you using this user-defined header you need to copy the header file into your project folder. This header file is given to you in the folder named “Header\_File”. So just copy the file from that folder and paste in the project folder.  **(press next)**   * Let us now look at the main program **(press next)** * In main program we have called various functions. These functions are written inside the header file and so can be used directly. The first line is Init\_LCD\_pin functions which will include the port configuration function. So for lcd, port 1 needs to be set as output. Next function is LCD\_Init. This function contains the lcd initialization which we already discussed step by step in previous slide. Then the function lcd\_cursor place the cursor at first line first character. So this functions actually contains two parameter first is row number and second is the column number. The function lcd\_string prints the string from the location specified by lcd\_cursor function. So in this example we are printing E-Yantra from first line first character and IIT-Bombay from second line third character.   **(press next)** |
| 12.  LCD.h header file | * **We have already understood few functions of the header file in the previous program we discussed. Now let us see all the functions defined inside the header file. It is suggested that you open the header file and have a look at how functions are defined in it. The header file is in C-language. (press next)** * As I have stated earlier, for any user-defined header file you use in the program, you need to copy that into your project folder. **(press next)** * The first function is of init\_LCD\_pin which defines port where lcd is connected. **(press next)** * Then we have lcd\_init function which initializes the lcd in 4-bit mode. **(press next)** * Lcd\_command function is used for sending command over the data pins. You can send hex value of command as parameter of this function. For example if you want to send zero one for clearing the display, you can do that simply by writing lcd\_command within brackets 0x01. The other steps of setting control pins and latching data is already defined in this function. **(press next)** * Lcd\_data function is used to print single character at a time. Its can be used when you have to display some numbers or single letters. For example try to display letters from A to Z one at time and with some delay between each letter displayed. **(press next)** * Then we have a function named as lcd\_string. We have already used this function to display a string of letter in example discussed in last slide. **(press next)** * Lcd\_cursor allows us to choose the location to start displaying by specifying the row and column position. **(press next)** * Last function is of lcd\_print. This function has four parameters, row, column, value and digit. Row and column specify the location, value is the integer value we want to display on lcd and digit allow us to control the number of digits we want to display. Suppose if we have value in five digits but want to show only three and truncate the rest two. so we can simply put value as three in place of digit in the function parameter. |
| 18.  Thank you | With this we have come to end to this tutorial. Thank you for listening. For any queries or doubts you can visit <http://qa.e-yantra.org/>  This is bhumika varshney Signing off!! |