PROJECT DOCUMENTATION

Project Name : USB Slingshot

Team Name : Technozion

Team Members: Rohit Agrawal, Chandramauli Singh, Ravi Jaiswal, Divya Prakash

Aim of Project :

To build a real slingshot as a plug and play USB peripheral to play Angry Birds game.

Requirements :

- **Hardware :**
  - MBED microcontroller
  - MMA7361L Accelerometer
  - Linear Potentiometer
  - USB Female
- **Software :**
  - USB Driver
  - Libraries (USBDevice, MMA7361L, Mbed)
  - Docklight (For Serial communication test)
  - Mbed online compiler

Theory:

Individual Hardware Explanation:

Mbed:

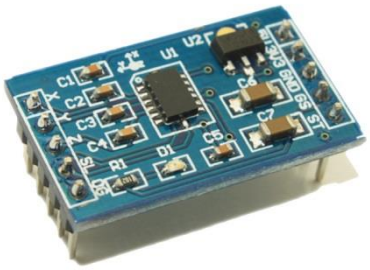
Main brain of our project is *Mbed NXP LPC1768* .It includes SPI, UART, and ADC interfaces and is supported by Mbed online resources and a full set of USB libraries. In our project we have used the analog input and USB feature of Mbed. Analog input feature enable us to take reading from the accelerometer and potentiometer in the range of 0-1V. USB feature allow us to communicate and transfer information/commands from Mbed to other devices and vice-versa without using SPI or serial communication. Mbed provides us several families of pins which are predefined to perform certain kind of tasks and make our work easier like (SPI, AnalogIn, Serial, pwmout etc.). We start by setting the mode of the Mbed I/O pins (analog/digital).Pin no. 7, 11, 12, 13 are defined as digital input pins to receive the data in the form of only 0 or 1.The pin connected to the accelerometer and potentiometer are meant to take data in the range of 0-1 from them and so are defined as Analog input pins which are pin no. 15, 16, 17, 19. Pin no. 8, 9, 10 are defined as BUS type which means these three pins are read as a single entity. Depending on the combination of digital value on the three pins we control the color of the RGB led. Pin no. [31, 32](USB pins (d+, d-)), 39, 1 serve as connection from Mbed to the USB and require no declaration in code.

Mbed Pin	Type	Connected to
p1	Ground	USB Female, Accelerometer, Potentiometer
p15,p16,p17	AnalogIn	Accelerometer(x, y, z pins)
p19	AnalogIn	Potentiometer(Output pin)
p8, p9, p10	BusOut	RGB Led
p31	USB	USB Female(d+)
p32	USB	USB Female(d-)
P7,p11,p12,p13	DigitalIn	Switches
p39	USB Out	USB(Vcc)
p40	Vout(3.3V)	Accelerometer(Vcc),Potentiometer(Vcc)

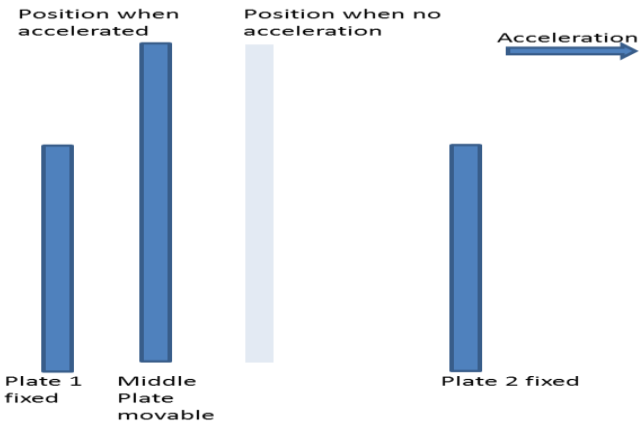
For full Pinout Details of Mbed please refer to

http://mbed.org/handbook/mbed-NXP-LPC1768

MMA7361L Accelerometer:



It's a three axis accelerometer connected to Mbed through which we receive the tilt and the acceleration data and analyze it to control the movement of mouse and tilt of catapult. It detects the acceleration in any particular direction using the principal of change of capacitance.



Basically it has two side movable plates and a middle fixed plate. Upon acceleration in a particular direction middle plate comes nearer to one and moves farther from other.

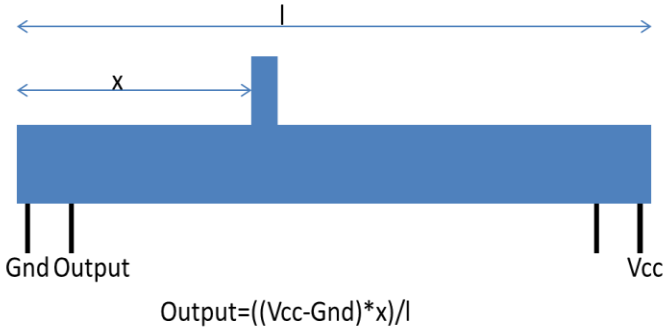
Detecting the change in capacitance of the two capacitors using ASIC (Application-Specific Integrated Circuit) the acceleration in any particular direction can be calculated. It's X, Y, Z pins give the data of

acceleration in X, Y, Z direction respectively in the form of Analog Signal ranging between 0-1. It's g-Select pin sets the sensitivity of the measurement in terms of analog signal. 0g pin detects the free fall condition of the accelerometer. It's X, Y, Z pins are connected to the Mbed AnalogIn pins (p15, p16, p17) and using the MMA7361L library functions accel.getTiltX(), accel.getTiltY(), accel.getTiltZ() we extract the tilt of the slingshot in X, Y Z direction respectively. In our code we move the mouse in the direction which has a tilt greater than the magnitude of 15 degrees. And in the case of stretching tilt gives the direction of position vector of slingshot in game.

Pinout Details

MMA7361L Pin	Mbed Pin	MMA7361L Pin	Mbed Pin
5V	VOut	0g	p25
Gnd	Gnd	G-Select	P26
Z	P17	Sleep	P24
X	p15	ST	NC
Y	P16	3V3	NC

Linear Potentiometer:



Output=((Vcc-Gnd)*x)/l

It's a simple potentiometer which linearizes the potential difference between the two ends and gives the output voltage according to the slider position using formula shown

in figure.

PinOut description:

Potentiometer Pin	Mbed Pin
Gnd	Gnd
Vcc	Vout(3.3V)
Output	p20

USB Female:

The USB Female is used to connect the angry bird controller to the PC. It allows plug and play feature. It uses serial communication feature of Mbed to connect to the PC.

PinOut description:

USB Female Pin	Mbed Pin
Vcc	Vout
Gnd	Gnd
D+	p31
D-	p32

Software Part Explanation

Libraries

Mbed.h

This is the standard library of the Mbed microcontroller which provides coding interface to control the functioning of all the Mbed tools. It has several inbuilt function to control all the functioning that Mbed offers including controlling it's pin configuration.

Here is the list of functions used in our code of this library with their work:

Mbed Library Functions	Use of the Function
DigitalIn	Configure and control a digital input pin
AnalogIn	Read the voltage applied to the analog input pin
BusOut	Way to write multiple DigitalOut pins as one value
Timer	Create, start, stop, read the timer

USBMouseKeyboard.h

This library allows us to use the command and function for various USB devices connected to Mbed like USB mouse, USB Keyboard, serial communication etc. As it's argument we have to set whether we are going to use relative mouse or absolute mouse.

List of functions and their work used in our code:

USBMouseKeyboard Library Function	Use of the function
Click	Takes MOUSE_LEFT/RIGHT as argument and emulates the mouse click
Press	Takes MOUSE_LEFT/RIGHT as argument and emulates the mouse button press
ScrollUp	Makes the screen to scroll up
ScrollDown	Makes the screen to scroll down
Move	Takes (x, y) co-ordinates as the argument to move the mouse to that position
Putc	Sends a keyboard key command

MMA7361L.h

This library allows us to connect MMA7361L accelerometer to Mbed and extract tilt and acceleration data from it using predefined functions. It takes as argument the pins of Mbed which are to be connected to the various accelerometer pins.

List of functions and their work used in our code:

MMA7361L Library Function	Use of the Function
accel.getTiltX()	Gives the tilt in X direction(+ve & -ve)
accel.getTiltY()	Gives the tilt in Y direction(+ve & -ve)
accel.getTiltZ()	Gives the tilt in Z direction(+ve & -ve)
setScale	Sets the scale and Format(1_5g/6g)
Calibrate	Confines the data of the axes between the two limits set as argument of this

Code:

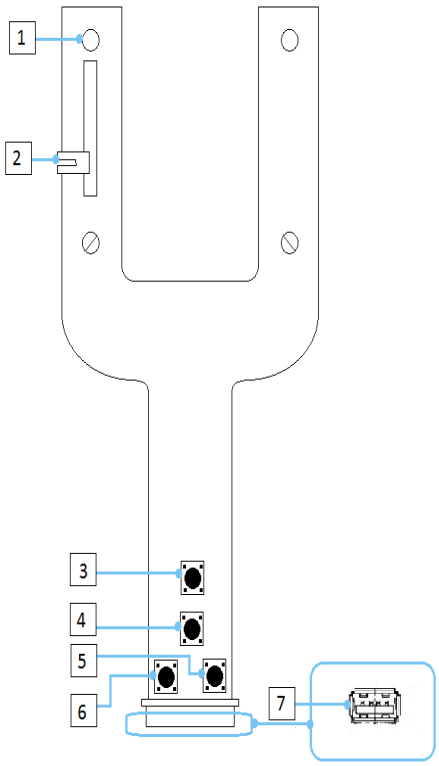
Link to our code

https://docs.google.com/document/d/1UZ1Wr7Whx1EU3WiWiE1rBGyVeBzLdFoERpE4LkL3R0o/edit

Overall Functioning:

We have used Absolute Mouse functioning mode of the moue. So we need to select resolution as the first step. We have buttons to select the resolutions for 1080p and 768p computers. The tilt from accelerometer in our slingshot gives the direction of the position vector of the slingshot in game and the data from potentiometer is calibrated to give the magnitude of the position vector of the

slingshot in game.



It consists of two modes:

First is the normal mouse mode when there is not enough stretch. This allows us to control the movement of mouse pointer and zoom out and zoom in the screen of angry bird window.

Second mode is the stretch mode when there is enough stretch. In this state only slingshot direction and length can be controlled through tilt of our actual slingshot and stretch of potentiometer.

For shift from first state to second state we need just to stretch enough and for shift from second to first one rapid decrease in stretch is needed i.e. the release of actual slingshot.

To use the special feature of a particular bird in the game there is a special click button pressing which unleashes the power of that particular bird.

Conclusion:

It has been a whole new level of experience for us and learned a lot about various embedded systems while making the project and finally we are ready with our embedded Plug n Play USB Slingshot to take the experience of playing angry birds game to a whole new different level.

Further Development and Future Scope:

There is never the end of possibilities and scopes with a powerful microcontroller as Mbed. The same concept can be used to make these type of controller for other games and not only this there is

also scope of making it wireless and even connect to the other devices than pc like mobile, I-pod, tablet.

Acknowledgement:

We want to thank all those who have helped us in completing this project. We especially want to thank our mentors R.P. Suman and Anant Raj without whom this project would not have been a success. Also thanks to the E-club for giving us the opportunity to utilize our summers and learn a whole lot of new things.

Useful link:

http://mbed.org/

http://www.freescale.com/files/sensors/doc/data_sheet/MMA7361L.pdf

http://mbed.org/users/yamaguch/libraries/MMA7361L/m90zd4

http://mbed.org/users/zackc/programs/USBKeyboardMouse/ll674c

http://mbed.org/cookbook/Homepage

Video Link

http://www.youtube.com/watch?v=CrUE1PxDklE&feature=share