CUED - Engineering Tripos Part IIB 2021-2022 **Module Coursework**

Module	4B25	Title of report	Game Controller Implementation with Built-in Motion Sensor
Date submitted: 11/01/2022		Assessment for this module is ☑ 100% / ☐ 25% coursework of which this assignment forms 35 %	

UNDERGRADUATE STUDENTS ONLY		POST GRADUATE STUDENTS ONLY			
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Feedback to the student

☐ **See also comments in the text**

		Very good	**Good**	Needs improvmt
CONTENT	**Completeness, quantity of content:** Has the report covered all aspects of the lab? Has the analysis been carried out thoroughly?			
	Correctness, quality of content Is the data correct? Is the analysis of the data correct? Are the conclusions correct?			
	Depth of understanding, quality of discussion Does the report show a good technical understanding? Have all the relevant conclusions been drawn?			
	Comments:			
PRESENTATION	**Attention to detail, typesetting and typographical errors** Is the report free of typographical errors? Are the figures/tables/references presented professionally?			
	Comments:			

Indicative grades are not provided for the FINAL piece of coursework in a module

Assessment (circle one or two grades)		A*	A	B	C	D
Indicative grade guideline		>75%	65-75%	55-65%	40-55%	<40%
Penalty for lateness:		*20% of maximum achievable marks per week or part week that the work is late.*				

Marker: Date:

Game Controller Implementation with Built-in Motion Sensor.

This project target is to build a game controller with a 2/3-Dimention motion sensor. As game-lovers have experienced too many computer games with keyboard and mouse, game provider tends to enhance their product experience by providing motion sensing games. Therefore, different motion sensing game controllers appeared on the market, including the one we are going to implement, the hand motion sensing game controller. It will enhance gamers' gaming experience to an amazing different level if carefully designed. ***Game providers or game console manufactures who are looking into this field, especially at the low-cost game controller market, would be interested in this project proposal*.**

The current state of the art of game motion control techniques is mainly based on camera video processing and artificial intelligence software algorithm to recognise human body parts. A typical example is Xbox Kinect which includes an RGB colour VGA video camera, a depth sensor and a multi-array microphone. The Camera detects body-type and facial features with a resolution of 640*480 at a frame rate of 30 fps. The depth sensor contains an infrared projector and a monochrome CMOS sensor which helps create 3D image throughout the room. It also tracks different parts of body by measuring infrared light travel distance. Four embedded microphones provide a better voice control for players. Another game platform, PlayStation, adapted similar theory to enable body/hand motion control.

The hand motion controller implemented in this project is based on another method and provides a low cost and accuracy-acceptable solution. It mainly uses 3-D accelerometer measuring the angle between the game controller, FRDM-KL03Z board, and the horizontal line to track human hand motion, as shown in Figure 1. When the left side of board is moving down on y-axis, the accelerometer on board gives a negative value depending on the angle indicated in the figure. The bigger the angle, the smaller the value. The relationship between raw data and angle is shown in Figure 2.

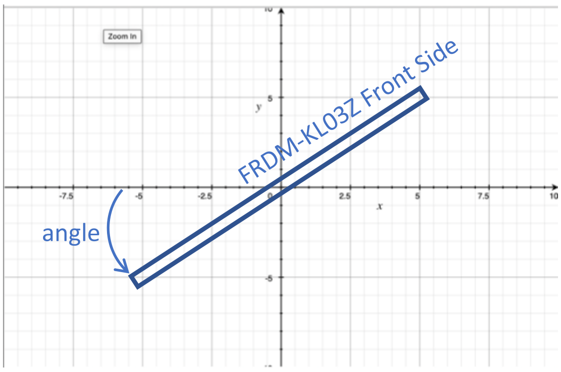

Figure 1: Hand motion game controller based on FRDM-KL03Z board

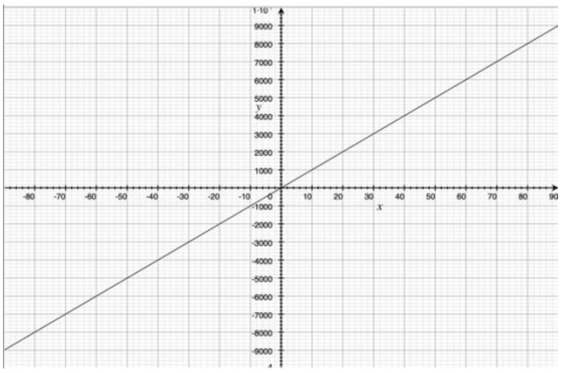

Figure 2: Relationship between raw data (y) from accelerometer and angle (x) shown in Figure 1

By observing Figure 2, it is identified that the raw data from accelerometer is between -9000 to 9000, corresponding to an angle of -90 degree to 90 degree. When the FRDM-KL03Z board is put on horizontal surface, it is a zero-degree angle which will direct a blue arrow on OLED screen towards straight up. Similarly, as shown in Figure 3, a negative angle (board turned left) will direct the blue arrow to left. A positive angle will direct the arrow towards right.

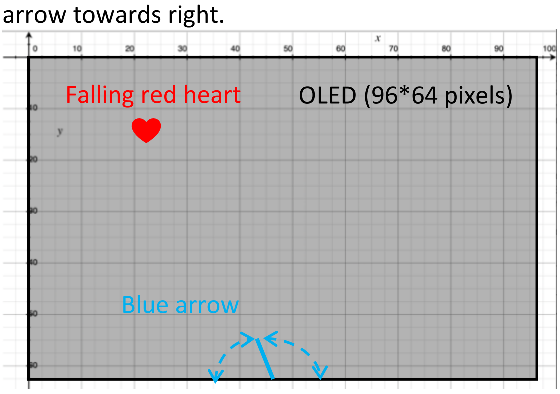

Figure 3: Blue arrow on OLED screen controlled by accelerometer on FRDM-KL03Z board

With fast and continuing accelerometer read, the blue arrow direction is updated in real time based on FRDM-KL03Z board motion (or hand motion). When game players find a suitable arrow angle, press a switch (SW3) on board will shot the blue arrow. When the arrow is close enough to the falling red heart, both will disappear from the OLED screen, indicating a nice arrow shotting. Otherwise, the red heart falls to the bottom of screen and the blue arrow disappears at the edge of screen. Next round of game continues afterwards. ***The hardware implementation result*** is shown in Figure 4.

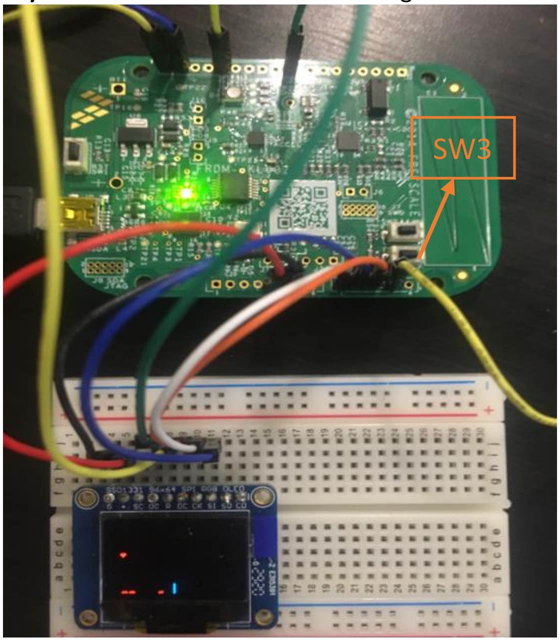

Figure 4: Hardware implementation of the game system, including hand motion controller and OLED display

In addition to Figure 4 showing blue arrow straight up, another three figures following show blue arrow towards left when board turned left, arrow towards right and shotting arrow when sw3 is pressed.

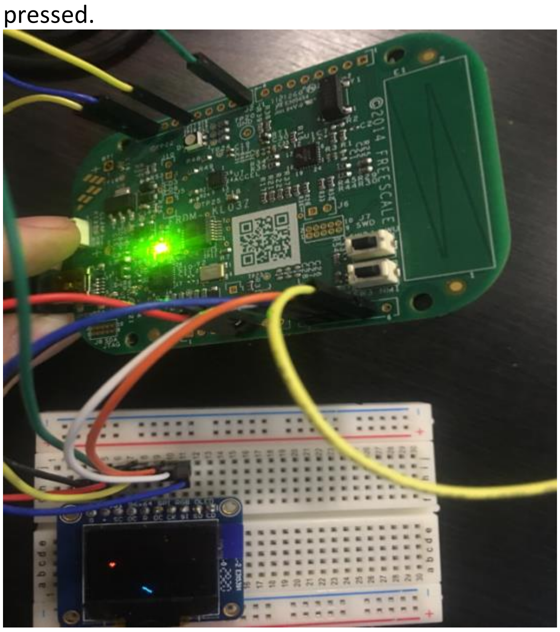

Figure 5: Blue arrow towards left when board turned left

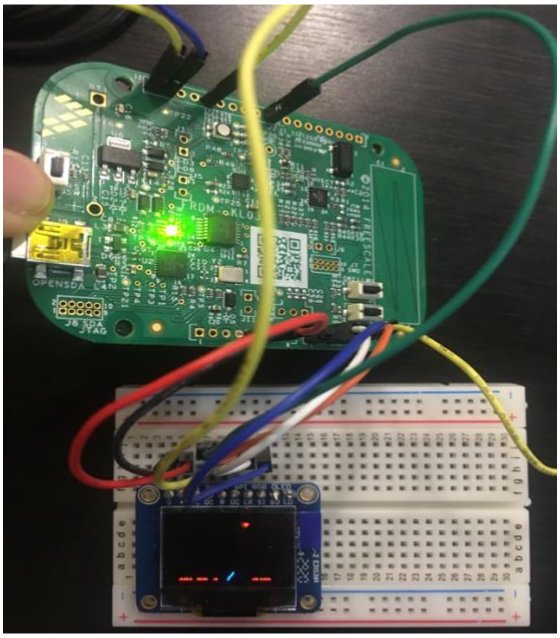

Figure 6: Blue arrow towards right when board turned right

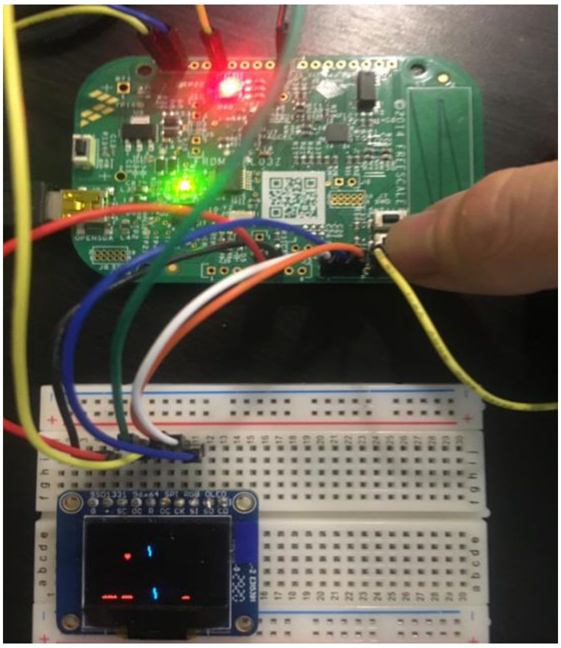

Figure 7: Shotting blue arrow when pressing SW3

Note: In order to make calculation and operation on OLED easier, the angle discussed previously is shifted 90 degrees, ending up a range of 0 to 180 degree in the code. This range is then divided by 7 degrees to give a suitable angle resolution (25 different angles) for arrow shotting on this OLED screen. Besides, a bug about game image processing was noticed during testing, however, it is trivial considering the main target of this project.