EMBEDDED SYSTEMS-II (MCT-338L)

Semester Project Report
Switch Bot

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Table of Contents

INTRODUCTION: 2
HARDWARE COMPONENTS: 2
TIVA C MICROCONTROLLER: 2
SERVO MOTOR (SG-90): 2
BLUETOOTH MODULE (HC-05): 3
CHARGING MODULE (TP4056): 3
LITHIUM ION CELL: 4
PUSH BUTTON: 4
PIN CONFIGURATION: 5
CIRCUIT DIAGRAM: 6
BILL OF MATERIALS (BOM): 7
MOBILE APPLICATION: 7
BLOCK LOGIC: 8
FINAL HARDWARE: 10
REFERENCES: 11

INTRODUCTION:

This is the report of a semester project in which hardware is designed that uses servo motor to push the switch on distribution board as ON and OFF. The servo motor rotates at 90°. The internal mechanism of the circuit is that a Microcontroller named TIVA C is connected to a Bluetooth Module named HC-05 and by programming TIVA using Keil Microvision, that Bluetooth module is further operated by a 3rd Party app. When the button "On" is pressed on the app, servo motor rotates and make the switch turn on. Similarly, by pressing the "Off" button, the servo motor rotates again, and switch is turned off. The complete detail of components and how the hardware is manufactured is given below:

HARDWARE COMPONENTS:

TIVA C MICROCONTROLLER:

Texas Instruments develops a microcontroller called the TM4C123GH6PM popularly known as TIVA C series that is based on the ARM Cortex-M4 CPU. It is a capable 32-bit microcontroller that excels in a variety of applications, including industrial control, medical equipment, and consumer electronics. It also includes a range of peripherals such as timers, analog-to-digital converters (ADCs), and communication interfaces such as UART, SPI, and I2C[1].

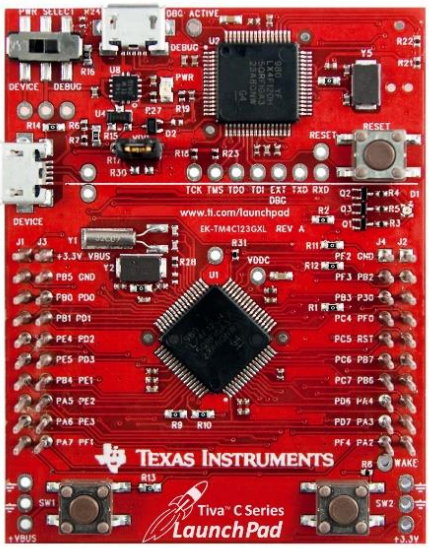

Figure 1 Tiva C MicroController

SERVO MOTOR (SG-90):

Micro Servo Motor SG90 is a tiny and lightweight server motor with high output power. Servo can rotate approximately 180 degrees (90 in each direction) or 360 degrees and works like the standard kinds but smaller. You can use any servo code, hardware, to control these servos[2].

Figure 2: Servo Motor

BLUETOOTH MODULE (HC-05):

The HC-05 is a class 2 Bluetooth module designed for transparent wireless serial communication. It is pre-configured as a slave Bluetooth device. Once it is paired to a master Bluetooth device such as PC, smart phones and tablet, its operation becomes transparent to the user. All data received through the serial input is immediately transmitted over the air. When the module receives wireless data, it is sent out through the serial interface exactly at it is received[3].

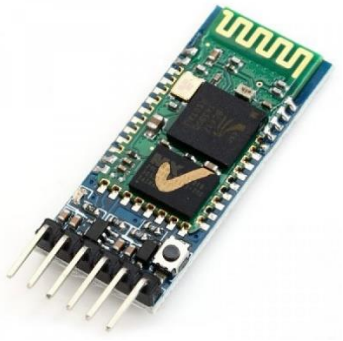

Figure 3: HC-05 Bluetooth Module

CHARGING MODULE (TP4056):

The 3.7V Battery Charger TP4056 module is made for charging rechargeable lithium batteries using the constant-current/constant-voltage (CC/CV) charging method. TP4056 BMS Board also provides the necessary protection required by lithium batteries. The TP4056 is suitable for USB power and adapter power supplies. The charging voltage is fixed at 4.2V, and the charging current can be externally set by a resistor[4].

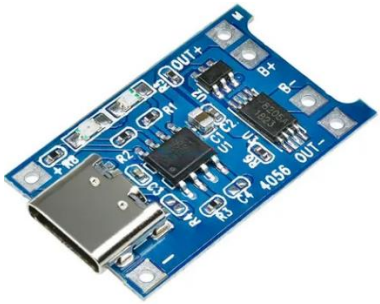

Figure 4: TP4056

LITHIUM ION CELL:

Lithium-ion batteries power the devices we use every day, like our mobile phones and electric vehicles. Lithium-ion batteries consist of single or multiple lithium-ion cells, along with a protective circuit board. They are referred to as batteries once the cell, or cells, are installed inside a device with the protective circuit board[5].

Figure 5: Li-ion Cell

PUSH BUTTON:

A push button switch is a mechanical device used to control an electrical circuit in which the operator manually presses a button to actuate an internal switching mechanism. They come in a variety of shapes, sizes, and configurations, depending on the design requirements. They are also referred to as pushbutton switches, push switches, or simply push buttons.

Figure 6: Push Button

PIN CONFIGURATION:

The pin-out of each component for connection in circuit is given below with proper labelling:

1. Tiva C Microcontroller:

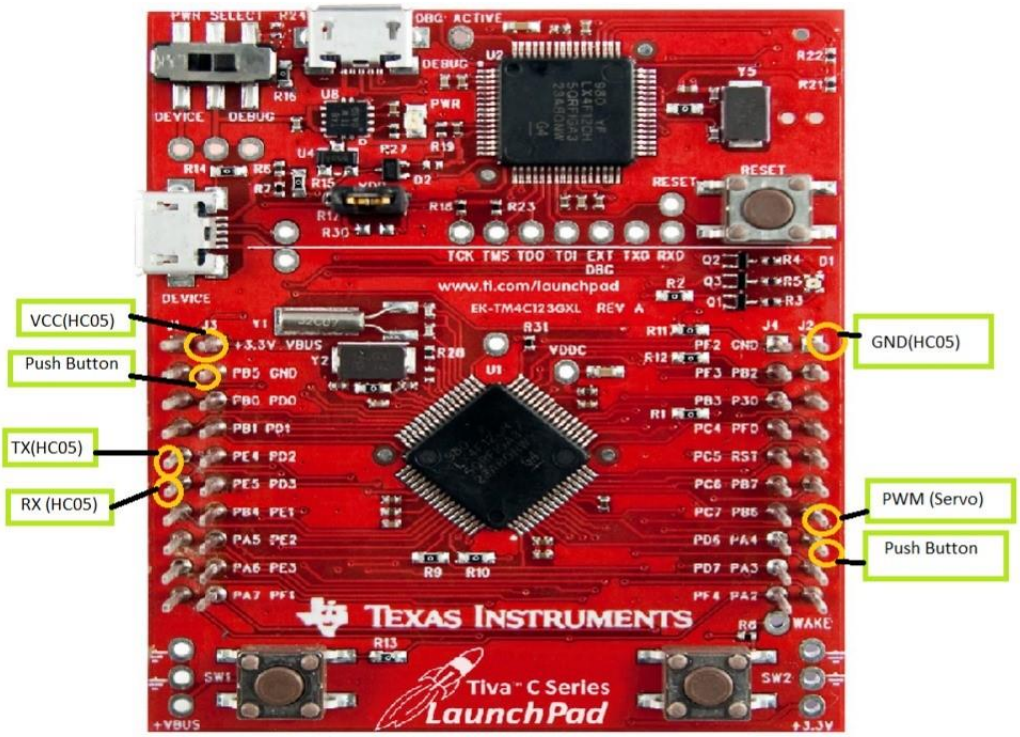

Figure 6 Pinouts of Tiva C Controller

2. HC-05 Bluetooth Module:

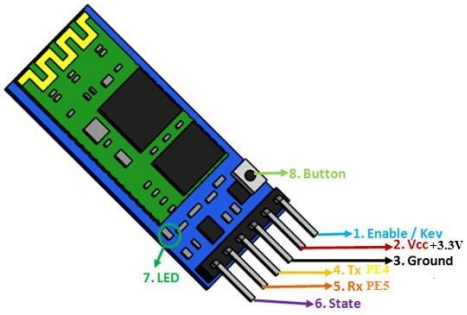

Figure 7: Pinouts of HC-05

3. SG-90 Servo Motor:

Figure 8: Pinouts of Servo Motor

CIRCUIT DIAGRAM:

The complete circuit diagram of this project is shown as:

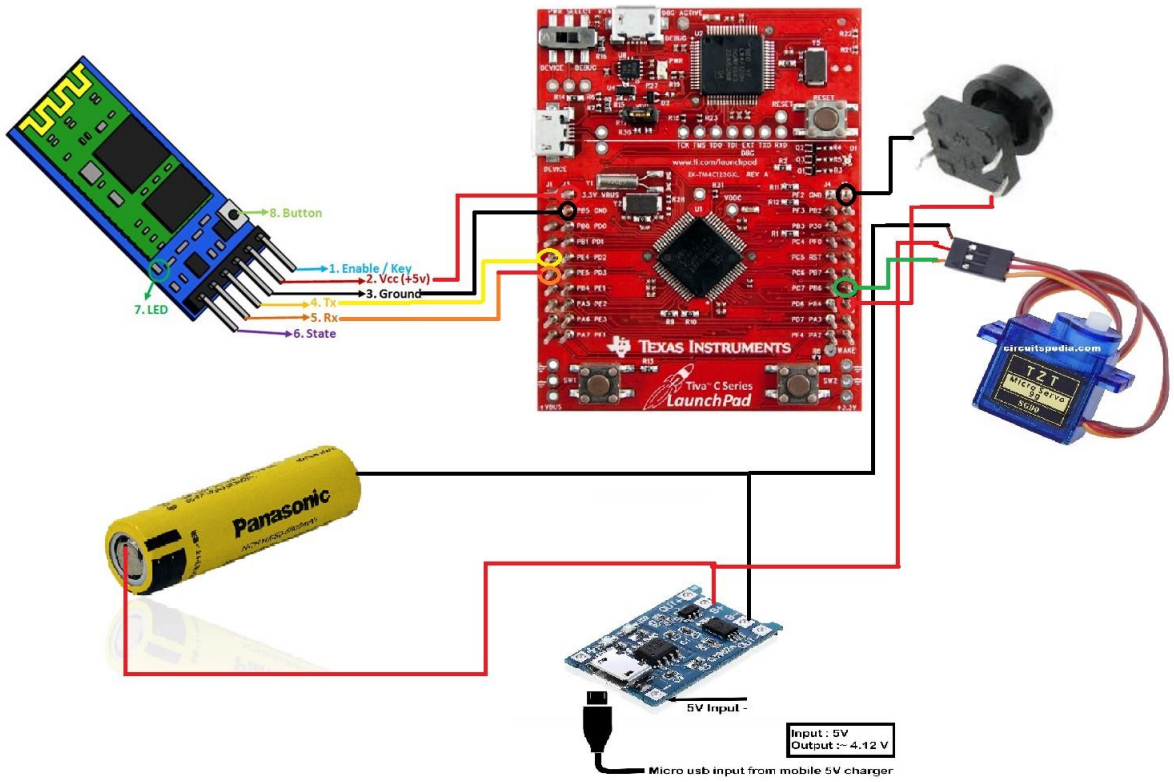

Figure9: Circuit Diagram

BILL OF MATERIALS (BOM):

BILL OF MATERIALS

Item to be created: Switch Bot

Serial No.	COMPONENT	DESCRIPTION	QUANTITY	COST PER UNIT	TOTAL COST	Vendor
1	TM4C123GH6PM	Tiva C Series Launchpad	1	8500	8500	https://hallroad.org/products/tm4c123gxl-tm4c123g-launchpad-evaluation-kit-in-pakistan-en?_pos=1&_psq=tm4c123&_ss=e&_v=1.0
2	3D Printed Assembly	Hardware design clamped on Switch Board	1 (57 gram)	15/g	860	https://waleedqayyum026.wixsite.com/productdesigner/rapid-prototyping
3	HC-05	Bluetooth Module	1	750	750	https://digilog.pk/products/05-bluetooth-module-pakistan
4	SG-90	Servo Motor	1	310	310	https://epro.pk/product/tower-pro-sg90-9g-micro-servo-motor-with-accessories-blue/
5	Li-Ion Cell	Cell used for Power Supply	2	200	400	https://epro.pk/product/18650-li-ion-laptop-battery-cell-1600mah-3-7v-in-pakistan-stock-lot/
6	Case Holder	Cover Case for Li-Ion Cell	2	35	70	https://epro.pk/product/battery-cell-holder-2xaa-square-case-housing/
7	TP4056	Charging Module for Cell	1	70	70	https://epro.pk/product/li-ion-battery-charging-module/
8	Acrylic	Back cover for Electric Box	1	100	100	Lakshmi Chowk, Lahore
9	Plastic Switch Box	To hold all components	1	50	50	https://digilog.pk/products/10cm-pin-to-pin-jumper-wire-dupont-line-40-pin-male-to-male-arduino-jumper-wires-in-pakistan
10	Push Button	2x12X7.5MM Tactile Switch	1	12	12	https://epro.pk/product/12x12x7-5mm-push-button-price-in-pakistan/
11	Bolts	For Tightening Acrylic piece	4	5	20	Shop no : 305 Bazar Al-Hadeed Lahore، Punjab Lahore, 54000, Pakistan
12	Conecting Wires	For Motor Connections	1	140	140	H879+M63, Garhi Shahu, Lahore, Punjab 54000, Pakistan
				Total Cost = Rs	**11282**	

MOBILE APPLICATION:

The 3rd party mobile application to connect with the Bluetooth module is created on MIT App Inventor to serial interface with the Module. The steps to develop mobile application are:

- Initially we are having the main screen and changing the color to black as per the requirement.
- Adding the main label and setting the font size and one can also import the font family from the "**Google Fonts**". For this one has to add the extension named as '**YourFont1**'.

- Adding a "**List Picker"** next for getting the names and the addresses of the Bluetooth devices nearby. For this it is needed to add the Bluetooth Client to main screen by drag drop.

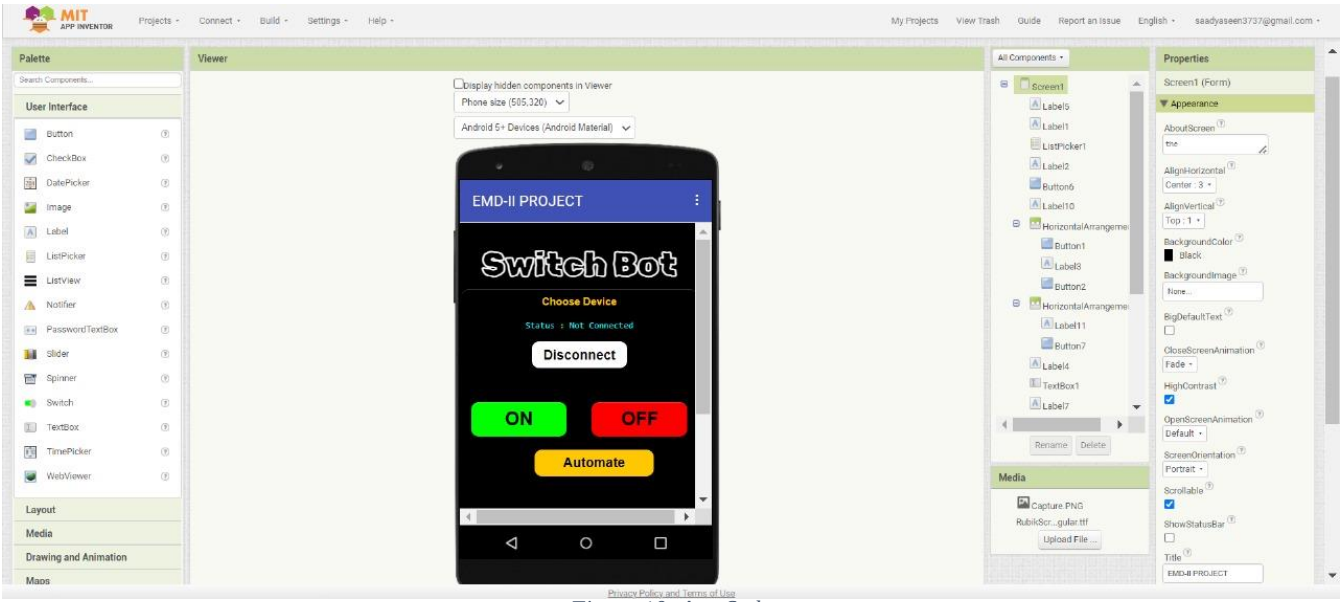

Figure 10: App Style

- Also adding another label for the status update of Bluetooth connectivity.
- Adding the button to disconnect the Bluetooth connection.
- Further adding two buttons for turning ON and OFF the switch.
- For doing automation (automatic switching timer) adding the button.
- For setting the timer adding the textbox and a button for confirmation.

BLOCK LOGIC:

The block code logic that is used in the app as given below:

- Clicking the "Choose Device" list picker1 will give the list of the Bluetooth devices (names and addresses) nearby given by the Bluetooth Client.
- The selected element of the list will be connected by using the function call of the bluthooth client1 named as **Connect address.**
- If the selected Bluetooth device would be connected which is confirmed by the function named as isConnect then the status connectivity label would become '**Connected**' by setting the label text if not connected, then become '**not Connected**'
- When clicking the disconnect button it will call the function named as '**Disconnect**' of the Bluetooth client and update the status to "**Disconnect**".
- Clicking the "**ON**" button will send the character 'A' through Bluetooth client to microcontroller.

- Clicking the "**OFF**" button will send the character 'B' through Bluetooth client to microcontroller.
- Initializing the global variable named as "state" and set its value to "**0**". This would help

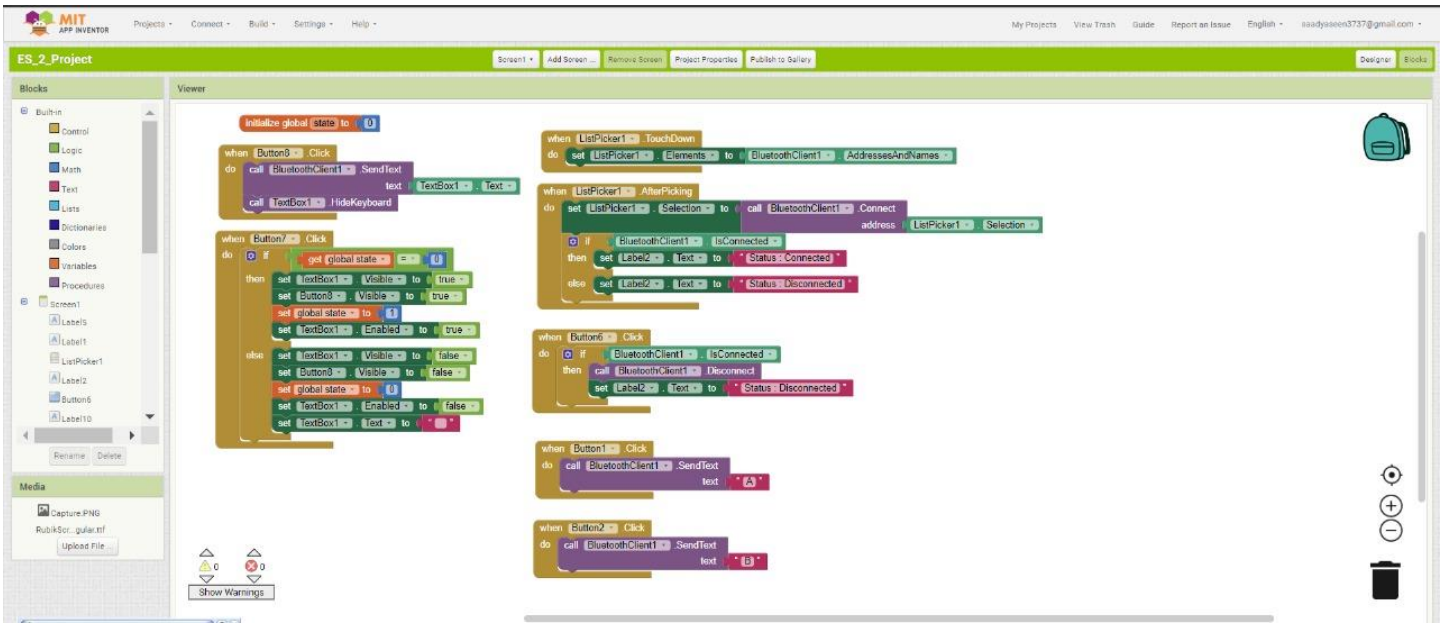

Figure 11: Block Logic for App

in the toggling the functionality of the "**Automate**" button.

- Initially when click on the "**Automate**" button it will visible the hided "**Textbox**" and the "**Enter**" button. And also setting the variable value to '**1**'.

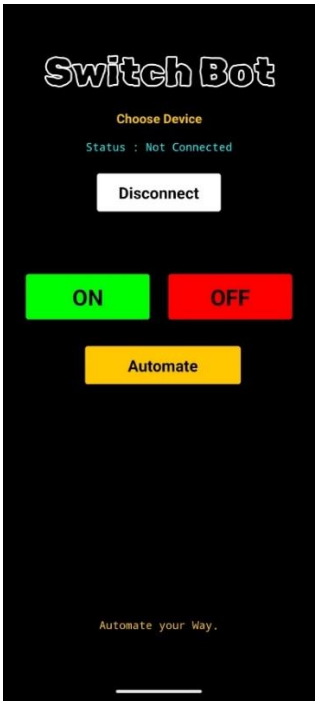

Figure 12 App Display

- Entered number in the text box would be send to the microcontroller by the Bluetooth client send text function.
- When the button is pressed again then it will hide the "**Textbox**" and the "**Enter**" button and setting the variable value '**0**'.

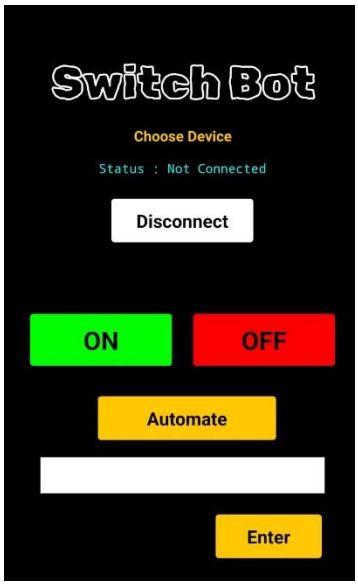

Figure 13: Automation Feature

FINAL HARDWARE:

The completed Hardware design of Project is:

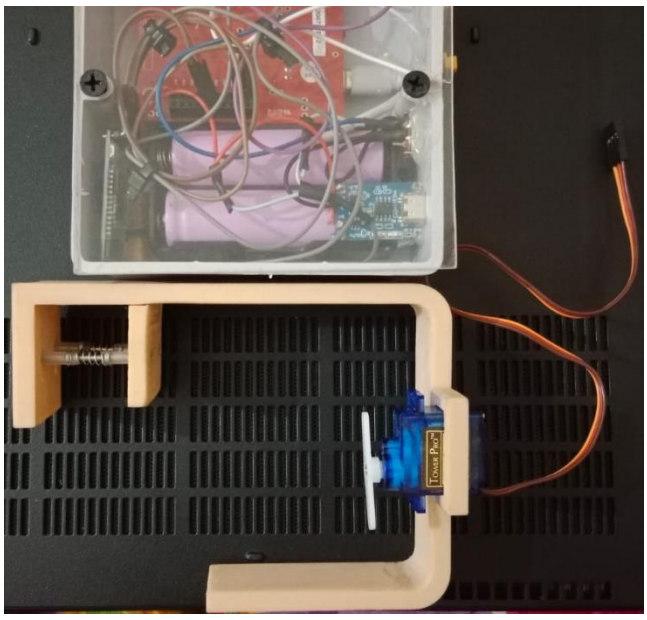

Figure 14: Final Hardware

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