SMART HOME AUTOMATION

CEP Report for Microprocessor Systems

ABSTRACT

Home automation is the automation process of home appliances and other home functions so that they can be controlled with your phone remotely. The main objective of this project is to interface a Bluetooth (or Wi-Fi) module with TIVA C board at the receiver end, while on the transmitted end, A GUI application on the cell phone sends ON/OFF commands to the receiver where loads (lights and Fans) are connected. By touching the specified location on the GUI, the loads can be turned ON/OFF remotely through the interface.

TEAM

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Abstract

A Smart Home Model is being designed by interfacing HC-05 Bluetooth module with TIVA C TM4C123GH6PM Launchpad. An Android phone will be used as the transmitter to send different commands that will be received by the microcontroller via UART communication. These commands will be used to turn on and off different device connected with the Launchpad. We have used four DC loads (2 fans and 2 LED lights) operating on a minimum of 7-9V. These loads are powered with L298N Motor Driver which is electrically isolated with the microcontroller through the PC817 Optocoupler. To control the speed of the fan, LM35 Precision Centigrade Temperature Sensor is used. When the temperature rises, the speed of the fan increases which is achieved by increasing the duty cycle of the input provided. While LDR Sensor Module adjusts the brightness of the room according to the intensity of the light. Common Anode Seven Segment Display is used to display the temperature of the room as measured by the LM35 sensor. The duty cycle of each load is displayed on the UART terminal along with the intensity of light and temperature as measured by LDR Sensor Module and LM35 Precision Centigrade Temperature Sensors respectively.

List of Components Used

Following is the list of equipment used in this project.

1. TIVA-C TM4C123GH6PM Launchpad
2. HC-05 Bluetooth Module
3. PC817 Optocoupler Chip
4. L289N Motor Driver Module
5. LM35 Temperature Sensor
6. LM393 Photosensitive LDR Module
7. Male to Male Jumpers
8. Male to Female Jumpers
9. 7805 Voltage Regulator
10. Common Anode Seven Segment Display
11. 2N3904 NPN Transistor
12. 9V DC Battery
13. DC Motor with fan
14. SMD Lights
15. Female Headers
16. Male Headers
17. Block Connectors
18. 12V 1A Supply Charger

Components Description

1. TIVA-C TM4C123GH6PM Launchpad

The board, includes a user-configurable TM4C123GH6PM micro-controller with 256 KB flash and 32 KB RAM as well as integrated circuit debug interface (ICDI). With appropriate software running on the host it is possible to connect to the TM4C123 (LM4F120) processor to download, execute and debug user code. There is a horizontal white line slightly above the midpoint. Below the line is the TM4C123GH6PM, crystal oscillators, user-accessible RGB LED, user-accessible pushbuttons and a reset push button. Above the line is the hardware debugger interface including a 3.3V voltage regulator and other components. The regulator converts the 5V supplied by the USB connection to 3.3V for the processors and also available at the board edge connectors.

All the pins of the Tiva C (Stellaris) Launchpad are brought out to well-labeled headers as we shall see the pin labels directly correspond to the logical names used throughout the documentation rather than the physical pins associated with the particular part/package used. This use of logical names is consistent across the family and greatly simplifies the task of designing portable software.

2. HC-05 Bluetooth Module

Pin Number	Pin Name	Description
1	Enable / Key	This pin is used to toggle between Data Mode (set low) and AT command mode (set high). By default it is in Data mode
2	Vcc	Powers the module. Connect to +5V Supply voltage
3	Ground	Ground pin of module, connect to system ground.
4	TX – Transmitter	Transmits Serial Data. Everything received via Bluetooth will be given out by this pin as serial data.

5	RX – Receiver	Receive Serial Data. Every serial data given to this pin will be broadcasted via Bluetooth
6	State	The state pin is connected to on board LED, it can be used as a feedback to check if Bluetooth is working properly.
7	LED	Indicates the status of Module • Blink once in 2 sec: Module has entered Command Mode • Repeated Blinking: Waiting for connection in Data Mode • Blink twice in 1 sec: Connection successful in Data Mode
8	Button	Used to control the Key/Enable pin to toggle between Data and command Mode

The **HC-05** is a popular module which can add two-way (full-duplex) wireless functionality to your projects. You can use this module to communicate between two microcontrollers like Arduino or communicate with any device with Bluetooth functionality like a Phone or Laptop. There are many android applications that are already available which makes this process a lot easier. The module communicates with the help of USART at 9600 baud rate hence it is easy to interface with any microcontroller that supports USART. We can also configure the default values of the module by using the command mode. So if you looking for a Wireless module that could transfer data from your computer or mobile phone to a microcontroller or vice versa then this module might be the right choice for you.

Input Voltage: 4V-6V

Current Consumption While Communication: 20mA

3. PC817 Optocoupler Chip

PC817 IC is an Opto-Coupler that includes a phototransistor and an IR diode. In various circuits, filters play a key role to remove the noise. When the circuit including resistor and capacitor always eliminates the noise from the incoming signal however the resistor & value capacitor frequently depends on the inward signal. This circuit is simply appropriate wherever the

incoming signal includes some data however when we need to transmit the signal from one element of the circuit to the other element although the signal includes noise.

Pin Number	Pin Name	Description
1	Anode	Anode pin of the IR LED. Connected to logic input
2	Cathode	Cathode pin of the IR LED. Connected to ground
3	Emitter	Emitter pin of transistor. Connected to Ground
4	Collector	Collector pin of the Transistor. Provides logical output

4. L289N Motor Driver Module

This **L298N Motor Driver Module** is a high power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. **L298N Module** can control up to 4 DC motors, or 2 DC motors with directional and speed control.

Pin Name	**Description**
IN1 & IN2	Motor A input pins. Used to control the spinning direction of Motor A
IN3 & IN4	Motor B input pins. Used to control the spinning direction of Motor B
ENA	Enables PWM signal for Motor A
ENB	Enables PWM signal for Motor B
OUT1 & OUT2	Output pins of Motor A
OUT3 & OUT4	Output pins of Motor B
12V	12V input from DC power Source

5V	Supplies power for the switching logic circuitry inside L298N IC
GND	Ground pin

5. LM35 Temperature Sensor

LM35 is a temperature measuring device having an analog output voltage proportional to the temperature. It provides output voltage in Centigrade (Celsius). It does not require any external calibration circuitry. The sensitivity of LM35 is 10 mV/degree Celsius. As temperature increases, output voltage also increases. E.g. 250 mV means 25°C.It is a 3-terminal sensor used to measure surrounding temperature ranging from -55 °C to 150 °C. LM35 gives temperature output which is more precise than thermistor output.

VCC: Supply Voltage (4V – 30V)

Out: It gives analog output voltage which is proportional to the temperature (in degree Celsius).

GND: Ground

6. LM393 Photosensitive LDR Module

The module is useful for detecting the presence of light. The module has two LEDs, one for power and one for output of the comparator. In this configuration, the circuit detects if the light exceeds a certain threshold.

7. 7805 Voltage Regulator

The LM7805 three terminal positive regulators is available in the TO-220 package with a fixed output voltage, making it useful in a wide range of applications. It employs internal current limiting, thermal shut down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, it can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

Voltage Output (V)(Min/Fixed)	**5**
Output Current	1 A
Output Type	Fixed

8. Common Anode Seven Segment Display

For common anode apply +5 volts to VCC pin in series to a 510 ohm-1k ohm resistor. This resistor is very important always include it otherwise your seven segment display will be damaged by over current. Note both the vcc pins are short so apply +5 volts on only one pin and leave other empty. Ground the dp (decimal/display point) pin if you want it to illuminate forever. If you to control dp (decimal/display point) led than connect it to some control system, microcontroller etc. In common Anode the Cathode (-) side of led's are connected to a,b,c,d,e,f,g pins of seven segment display.

9. 2N3905 PNP Transistor

Package	**TO-92-3**
Transistor Polarity	PNP
Maximum Collector Emitter Voltage	40 V
Maximum Collector Base Voltage	40 V
Minimum DC Current Gain	50 @ 10mA
Power Dissipation	625mW
Configuration	Single

Maximum Collector Emitter Saturation Voltage	0.4V @ 5mA @ 50mA
Number of Elements per Chip	1
Output Power	625mW
Product Type	Bipolar Small Signal
Maximum Emitter Base Voltage	5V

Working of the Model

We have used different modules working collectively to design this Smart Home Model

1. Timer module used to generate PWM (Pulse Width Modulated) Signals of specific duty cycle, which changed with Temperature & Intensity of Light as mentioned in the tables below. We used the module T0CCP0, T0CCP1, T1CCP0, T1CCP1 for this purpose with their respective outputs at PF0, PF1, PF2, and PF3. We used the 16-bit counter with the clock frequency of 100 kHz and Reload Value of 16000, providing an Interval of 0.5sec before the counter underflows since it is a down counter. To measure the Match Value, we have used the following formula

$$Match\ Value = Reload\ Value * ((100 - Duty\ Cycle) / 100)$$

For 0% Duty Cycle, Match Value isn't set equal to Reload Value. It is set some units less than the Reload Value i.e. 15999 in our case.

The following table defines duty cycles for different temperature readings.

Temperature	Duty Cycle of the Fan (%)	Match Value
≤ 10 °C	0	15999
> 10 °C and ≤ 13 °C	10	14400
> 13 °C and ≤ 16 °C	20	12800
> 16 °C and ≤ 19 °C	30	11200
> 19 °C and ≤ 22 °C	40	9600
> 22 °C and ≤ 25 °C	50	8000
> 25 °C and ≤ 30 °C	60	6400
> 30 °C and ≤ 35 °C	70	4800
> 35 °C and ≤ 40 °C	80	3200
> 40 °C and ≤ 45 °C	90	1600
> 45 °C	100	0

The following table defines duty cycles for different readings for light intensity.

Light Intensity	Duty Cycle of the Light (%)	Match Value
≤ 200	0	15999
> 200 and ≤ 500	10	14400
> 500 and ≤ 800	20	12800
> 800 and ≤ 1100	30	11200
> 1100 and ≤ 1400	40	9600
> 1400 and ≤ 1700	50	8000
> 1700 and ≤ 2000	60	6400
> 2000 and ≤ 2300	70	4800
> 2300 and ≤ 2600	80	3200
> 2600 and ≤ 2800	90	1600
> 2800	100	0

2. We used ADC Module 0 with sample sequencers 2 & 3 to input analogue values from the temperature sensor LM35 & LDR sensor Module respectively. GPIO Pins PE2 & PE1 were used for this purpose
3. UART Module 0 was used to display the following data on Putty Terminal which used PA0 & PA1 as their Tx & Rx pins with a baud rate of115200.
    - Current Temperature in Celsius
    - Intensity of Light in Lux
    - Duty Cycle for each Load separately
4. UART Module 4 was used for HC-05 Bluetooth Module to transmit & receive data via PD0 & PD1 as the Rx & Tx pins with a baud rate of 115200.

HC-05 Bluetooth Module	
Module Name	"AZIZ"
Password	1718
Baud Rate	115200

The following commands were used in our code.

Command	Action
'A'	Turn on Load A - Fan
'B'	Turn off Load A
'C'	Turn on Load B – Fan
'D'	Turn off Load B
'E'	Turn on Load C – Light
'F'	Turn off Load C
'G'	Turn on Load C – Light
'H'	Turn off Load C

5. To display the current temperature on the common anode seven-segment display, we used PB0-PB6 for the cathode connection for each segment. For connection to the common anode, PA2 & PA3 were used.

Budget of the Project

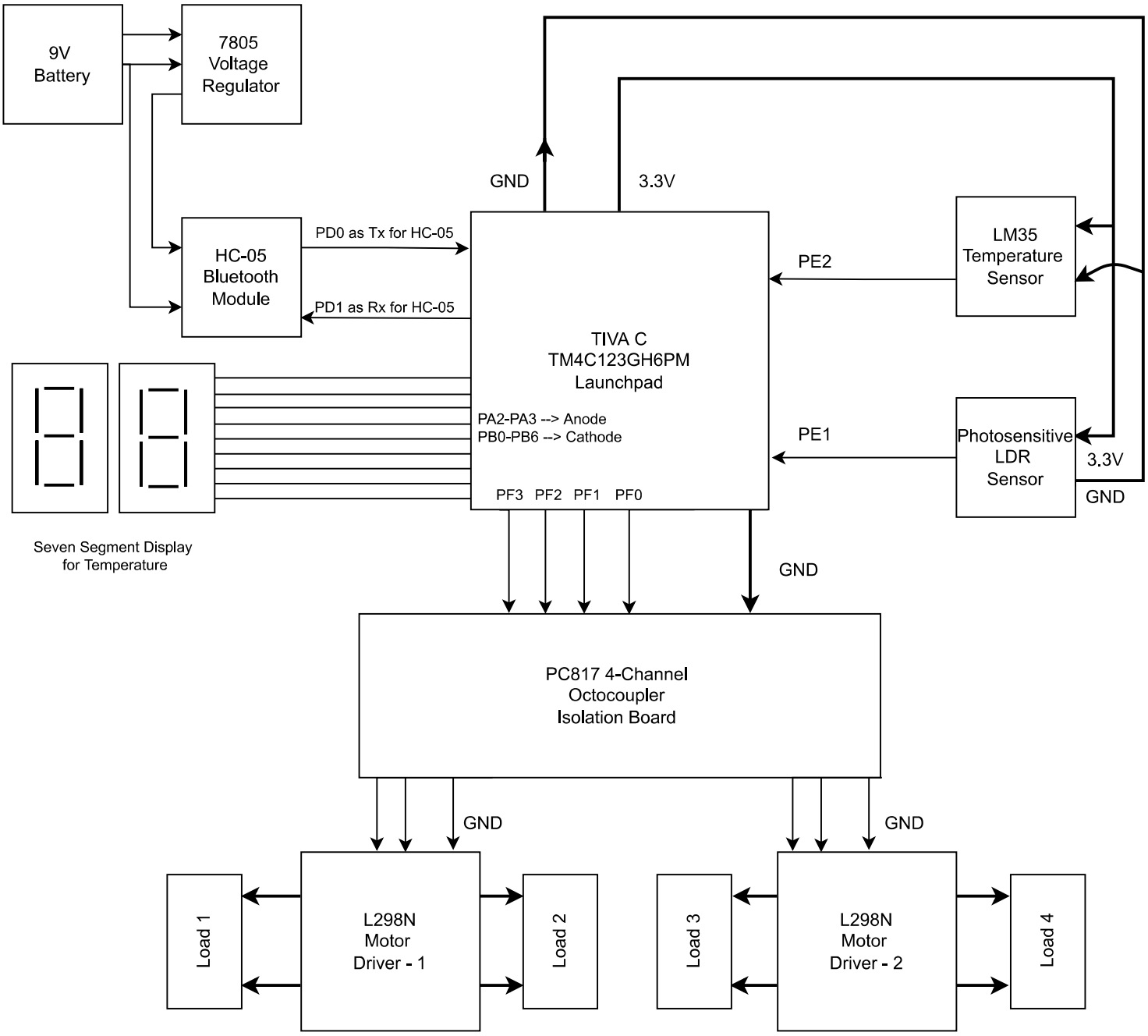
Product Name	Cost Per Unit	Quantity Used	Total Cost
TIVA-C TM4C123GH6PM Launchpad	6000	1	6000
HC-05 Bluetooth Module	600	1	600
PC817 Optocoupler Chip	5	4	20
L289N Motor Driver Module	320	2	640
LM35 Temperature Sensor	250	1	250
LM393 Photosensitive LDR Module	90	2	180
Male to Male Jumpers	100	2	200
Male to Female Jumpers	100	2	200
7805 Voltage Regulator	20	1	20
Common Anode Seven Segment Display	30	4	120
2N3905 NPN Transistor	10	5	50
9V DC Battery	70	12	840
DC Motor with fan	30	3	90
SMD Lights	140	2	280
Female Header	20	4	80
Male Header	10	1	10
Block Connectors	10	12	120
12V 1A Supply Charger	200	2	400
Total Cost of Components		Rs/-10,480	
Cost of PCB		Rs/-2000	
Miscellaneous Charges (Travelling, Material Used for Hardware Model, etc.)	➢ Rs/- 280 (x3) → Model Making Sheet ➢ Rs/- 40 (x5) → Glue Stick ➢ Rs/- 340 → Chart Paper ➢ Rs/- 400 → Wiring ➢ Rs/- 200 → Travelling **Total Price:** Rs/- 1980		
Total Cost		Rs/-14,460	

Tasks Performed by Each Group Member

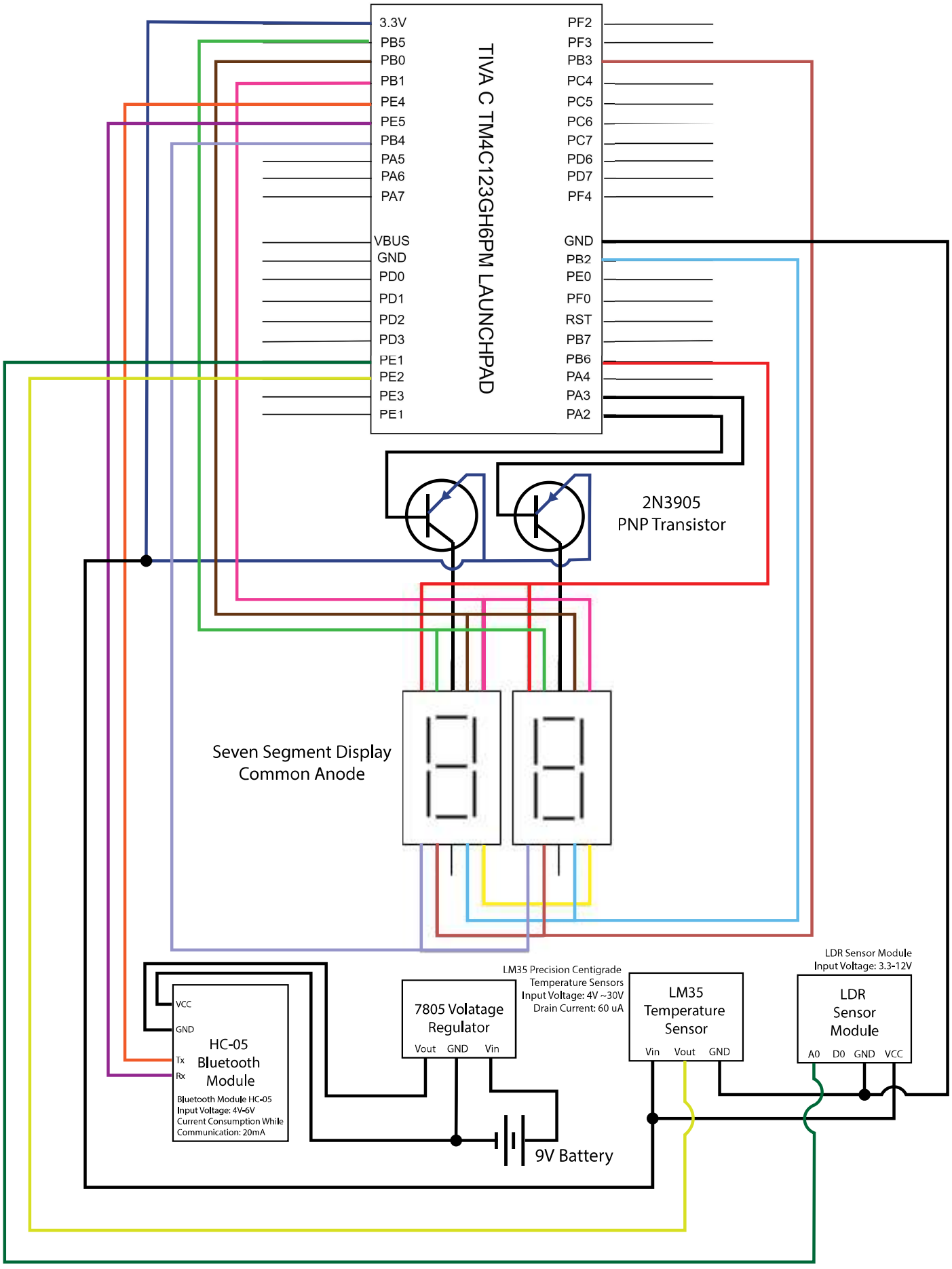
While each member participated equally in all domains of the project, the following tasks mentioned w.r.t each member are the ones where they lead the team and contributed to the team in their own manner.

Members Name	Tasks Performed
Arooj Fatima	1. Working out minor details & specifications for the hardware demonstration 2. Designing *block diagram* & *circuit diagram* using Draw.io & Illustrator 3. UART Interfacing with TIVA-C Launchpad for HC-05 Bluetooth Module 4. Designing the GUI for Controlling the loads via Bluetooth App on our mobile phone
Aziz Haider	1. Finalizing the *components to be used* in the projects 2. Configurations on TIVA-C Launchpad 3. Analog Interfacing with TIVA-C Launchpad 4. Interfacing L298N Motor Driver Module with TIVA-C Launchpad by electrically isolating the two circuits using PC817 Optocouplers
Subhan Mansoor	1. Finalizing the circuit for PCB 2. *PCB Design* on Altium Designer Software 3. Soldering of the PCB 4. Worked out the home model used for hardware demonstration

Block Diagram

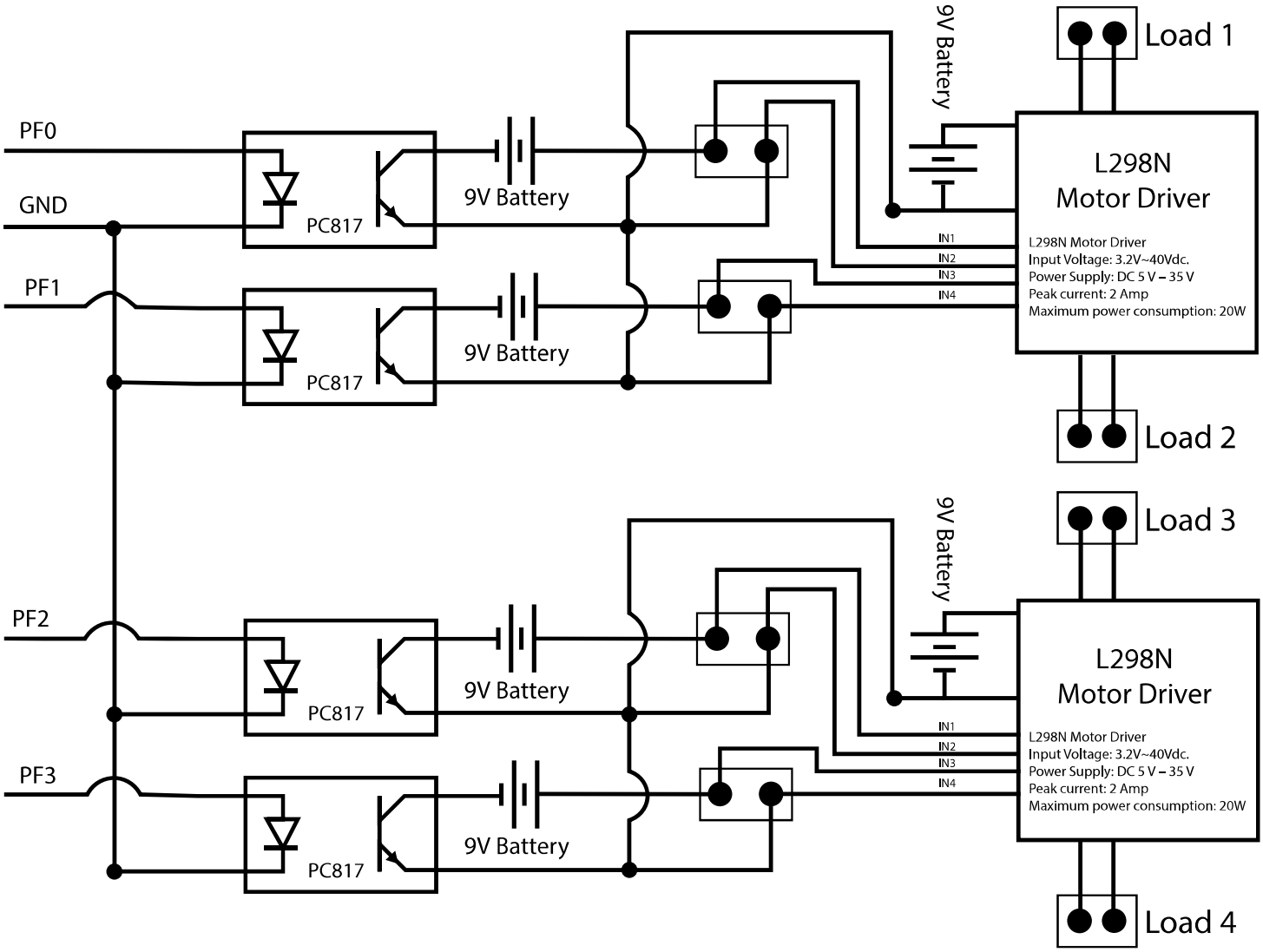


Circuit Diagram

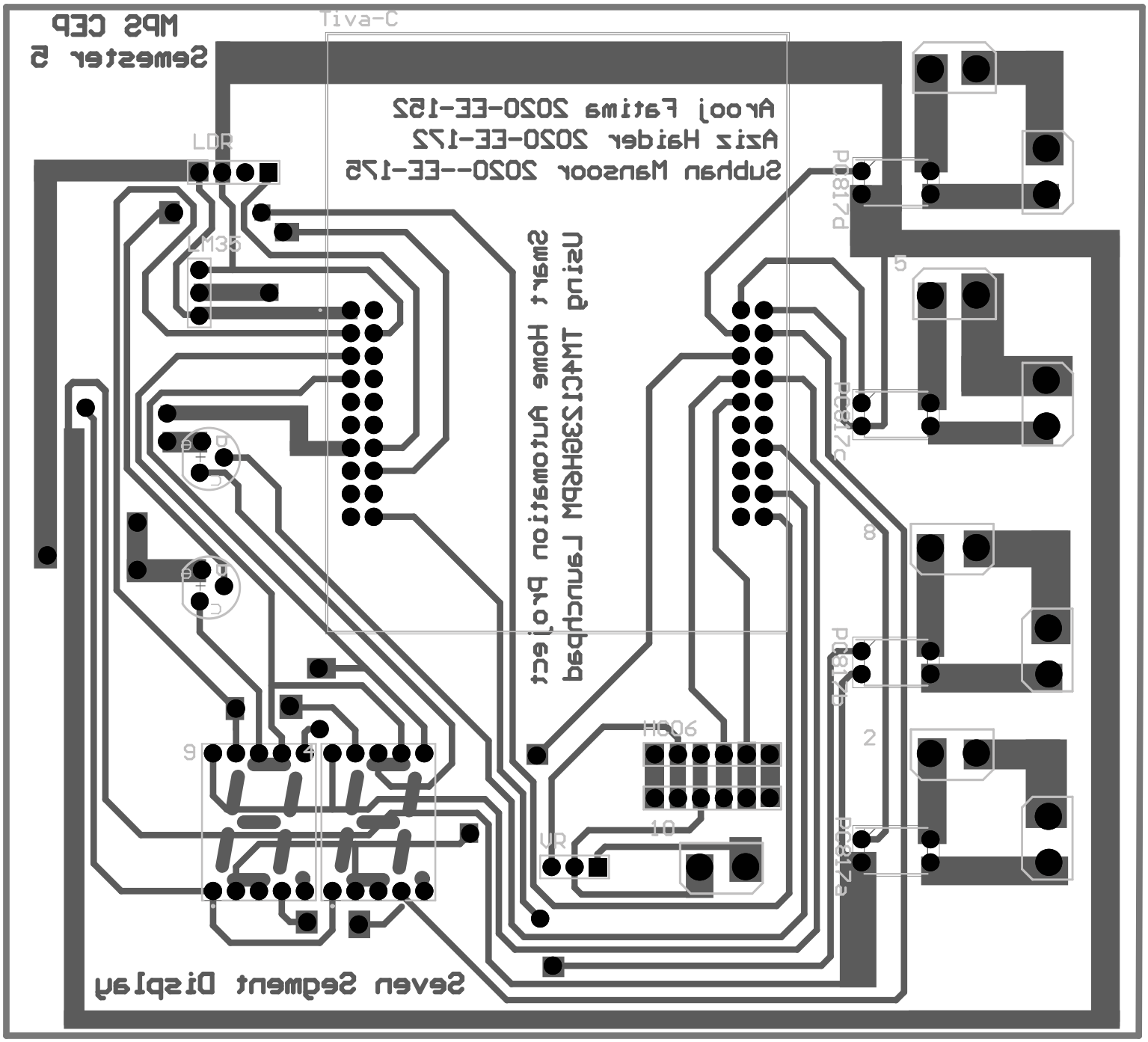


*Different colors are used to differentiate different wires and avoid confusion and messy connections

Connection with L98N Motor Driver



PCB Design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Smart Home Automation Project
Using TM4C123GH6PM Launchpad
LDR
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