Introduction to Embedded Systems

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GPS Tracking Systems

TEAM 23

Members of TEAM

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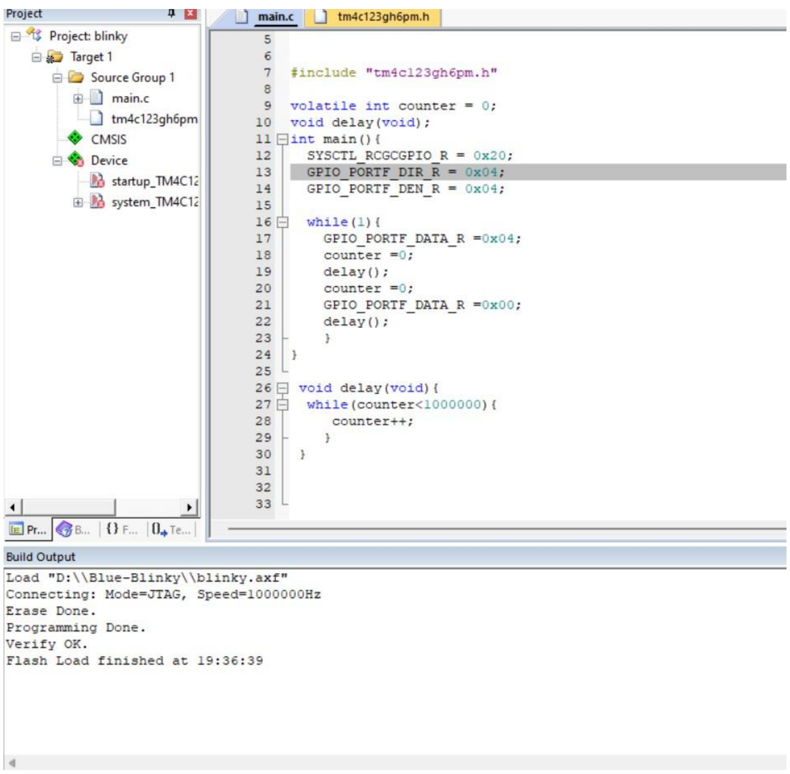
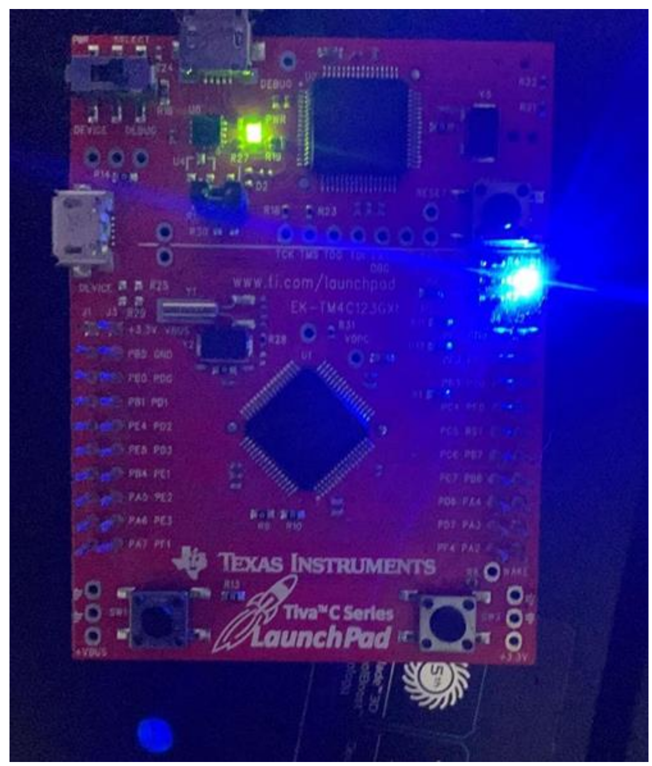
1. Project Outline:

In this project, our task involves developing a GPS Tracking System using embedded C programming. The system operates by continuously gathering real-time positional coordinates while a microcontroller, specifically the TM4C123G Launchpad, is in motion from power-on until it reaches its destination. The collected data is then efficiently transferred to a personal computer where it is visualized on a map application. Throughout the following pages, we will provide a brief guide detailing the entire process.

2. Project in Action (Screenshots):

This screenshot was captured real-time, as we tested our board and a startercode for the LED:





3. Source Code:

Entire project source code can be found on our team's GitHub repo:
https://github.com/Omar-26/GPS_Tracking_System.git

The tree structure of our repo is explained briefly on this page:

- **Application Layer (APP)**: This is the layer where the primary sequence of the software resides. It is specific to the software in use.
- **Hardware Abstraction Layer (HAL)**: This layer offers a high-level interaction with the hardware. It enhances the portability of the application code, allowing the same code to function with various hardware by merely using a different HAL implementation.
- **Microcontroller Abstraction Layer (MCAL)**: This layer is responsible for managing the microcontroller hardware. It encompasses our primary drivers, such as GPIOs, communication interfaces (SPI, I2C, UART), ADCs, and so on.
- **Library (LIB)**: This includes third-party or proprietary libraries that the project may rely on. These libraries offer a range of functions and utilities that are not specific to the hardware or the application but are utilized by them. Examples include data structures, mathematical functions, or communication protocols.

- ## Link of video:
  https://youtu.be/8cY5F0Gdrfo?si=t2VoWmTAcOozdW1D

- ## Description:
  The system obtains GPS data via the UART interface by utilizing a specialized GPS module. This module sends NMEA sentences, standardized text messages containing diverse GPS information. Specifically, the system focuses on extracting latitude and longitude coordinates from the "$GPRMC" sentence.

- ## GPS module pins:

1. VCC → +3.3 V
2. GND → GND
3. RXD → PB1(UART1 TX)
4. TXD → PB0 (UART1 RX)

- ## ST 7735 1.8" TFT:

  1. VCC → +3.3 V
  2. GND → GND
  3. CS → PA3 (SSI0_CS)
  4. RESET → PA7
  5. A0 → PA6
  6. SDA → PA5 (SSI0_MOSI)
  7. SCK → PA2 (SSI0_SCK)
  8. LED → +3.3 V

- ## Configuration:

  1. UART0 Initialization
  2. UART1 Initialization
  3. Systick Initialization
  4. EEPROM Initialization
  5. Interrupt Initialization

6. System control Initialization
7. GPIO Initialization
8. SSI Initialization
9. ST7735 Initialization
10. RGB Initialization
11. SW Initialization
12. SysCtr Initialization

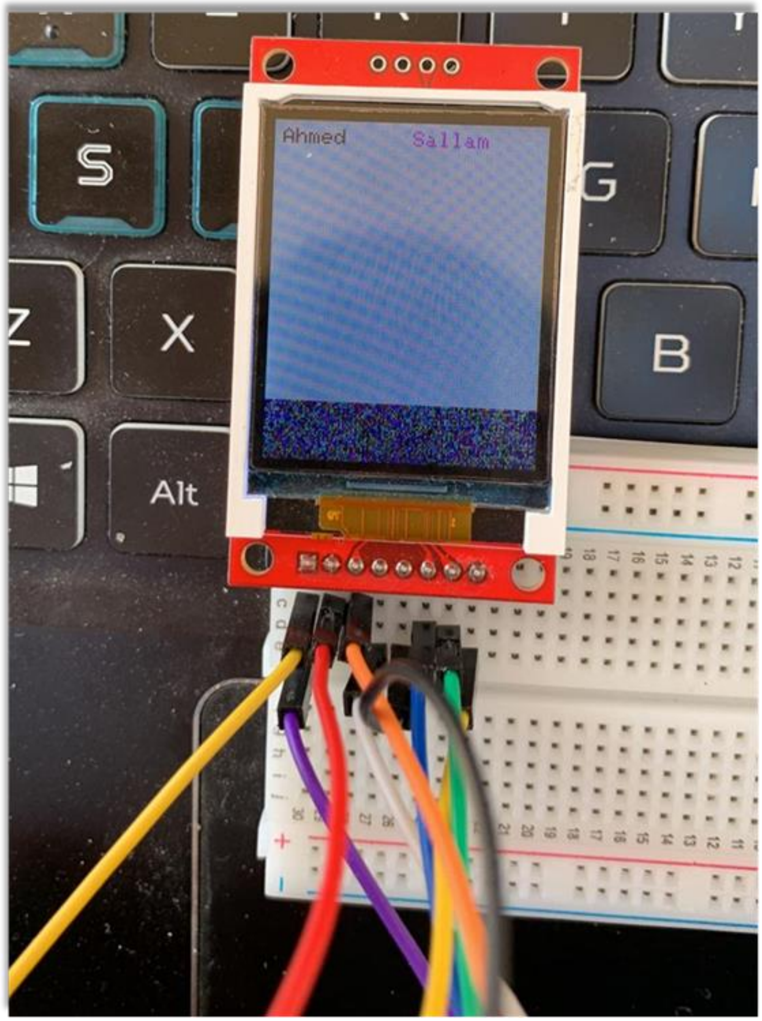
- ## System functionalities:

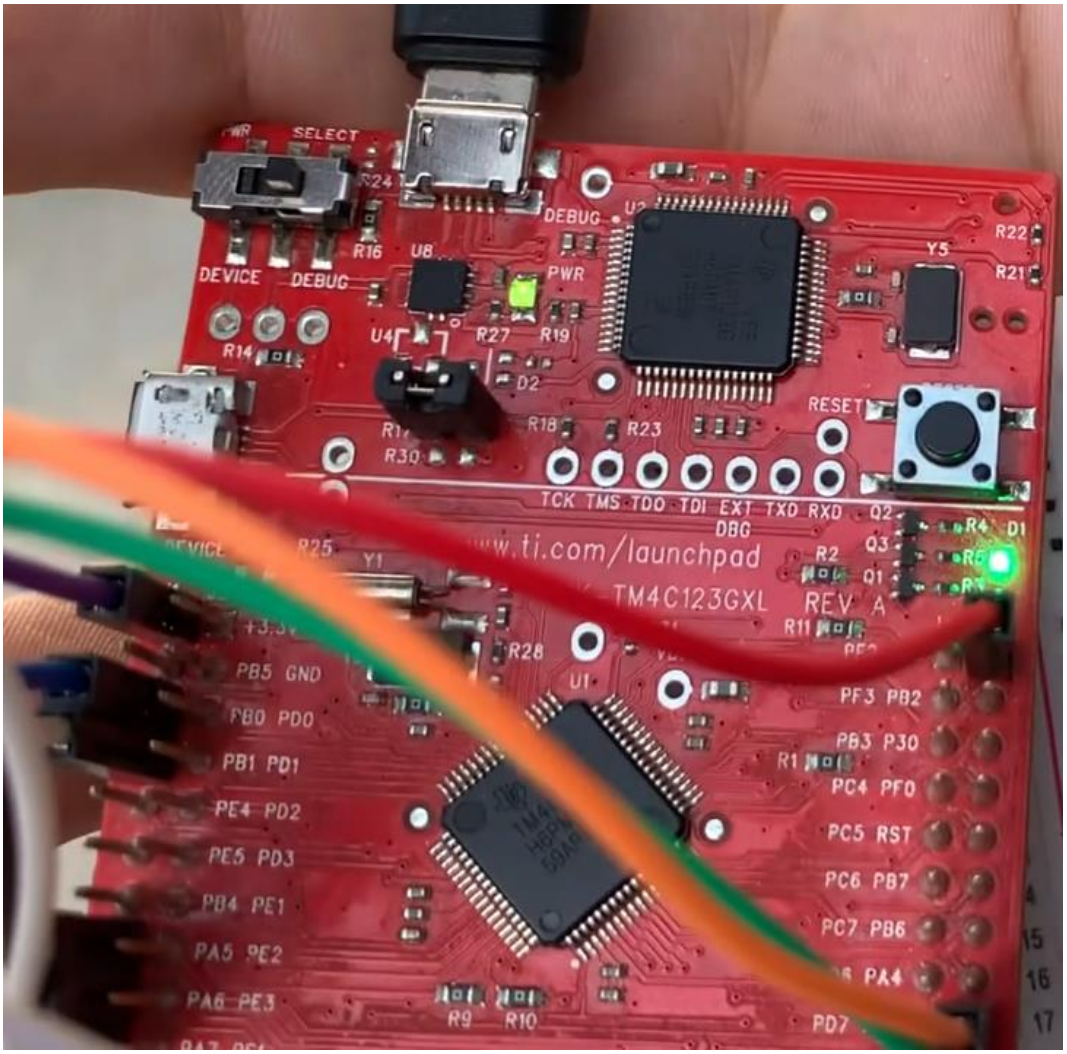
1. GPS module sends location data via UART.
2. TFT displays total distance covered in Realtime.
3. LED notifies when 100m mark is reached.
4. LED notifies when data is saved on the EEPROM.
5. Location data is saved on the EEPROM.
6. Location data is sent from the EEPROM to the pc via UART.
7. Location data is then displayed on the world-map using an in-house python application.

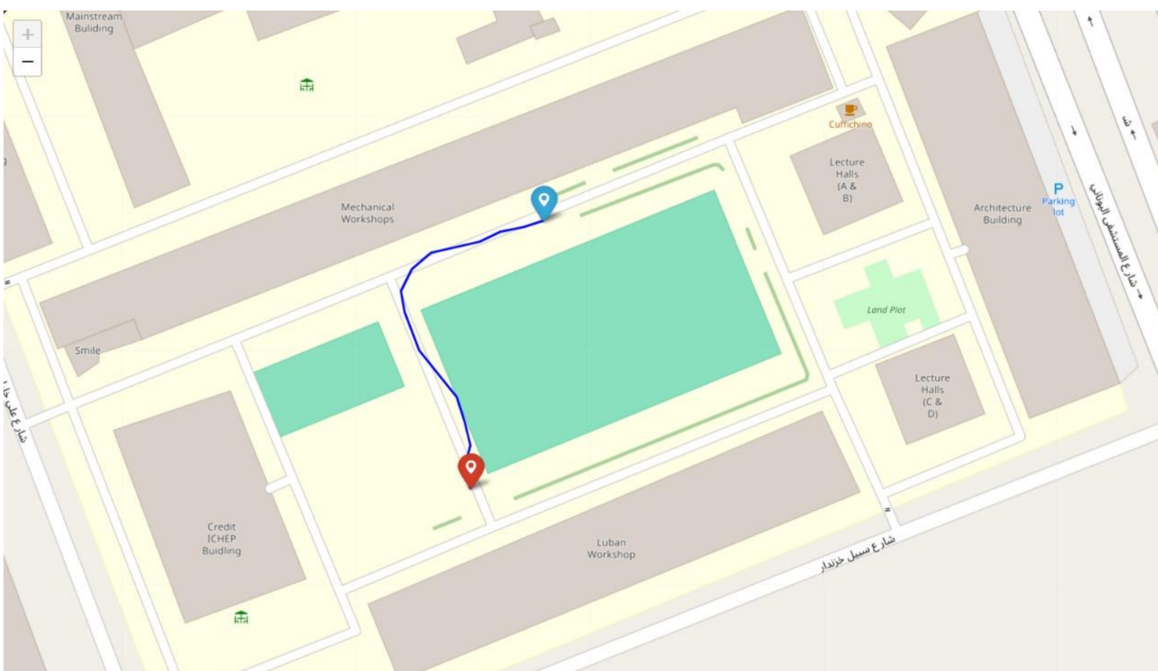
- ## Used drivers in the project:

1. GPIO
2. UART
3. SPI
4. TFT
5. EEPROM
6. Sys_Tick

- **Project in action:**




PWR
SELECT
DEVICE
DEBUG
RESET
TCK TMS TDO TDI EXT TXD RXD
DBG
TM4C123GXL
REV A
PB5 GND
PB0 PD0
PB1 PD1
PE4 PD2
PE5 PD3
PB4 PE1
PA5 PE2
PA6 PE3
PF3 PB2
PB3 P30
PC4 PF0
PC5 RST
PC6 PB7
PC7 PB6
PD7


Mainstream Buliding
Mechanical Workshops
Cuffichino
Lecture Halls (A & B)
Architecture Building
Parking lot
Land Plot
Lecture Halls (C & D)
Smile
Credit [CHEP Buidling
Luban Workshop
شارع سبيل خزندار

- ## Conclusion and Future Work:

This project effectively showcased the integration of a GPS module with a microcontroller to monitor real-time positional coordinates. It proficiently collected and stored data, interfaced with a PC, and displayed the trajectory on a map. The collaborative efforts of the team ensured the accomplishment of project objectives, guaranteeing precise GPS data acquisition, distance computation, and real-time tracking.
For future endeavors, the system could be enhanced by:

1. Enhancing Power Efficiency: Implementing low-power modes for the microcontroller to prolong battery life during extended usage.
2. Advanced Data Visualization: Incorporating more sophisticated mapping and data visualization tools to offer comprehensive insights.
3. Real-time Data Transmission: Enabling live data transmission over the internet for remote tracking and monitoring purposes.

These enhancements would bolster the system's resilience and versatility in diverse real-world scenarios. The knowledge acquired from this project establishes a solid groundwork for future advancements in embedded GPS tracking systems.