Real-Time Embedded System & MicroCnt Des

NANENG 410

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SECURITY SYSTEM

(Final report)

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Introduction

In this project, we're making an advanced Security System by blending motion and sound sensors with the Tiva C Series microcontroller platform and Bluetooth module.

In order to implement a security system, we use sound sensors along with passive motion sensors such as PIR (Passive Infrared) sensors, which measure variations in infrared energy released by surrounding objects. These sensors alert the user to detected events immediately by activating the system's outputs, which include an LCD display and a buzzer. To ensure timely alerts even when the user is away from the immediate neighborhood, we also integrate a Bluetooth module into the system, allowing it to send safety warnings and notifications to the user's smartphone or other devices.

In this phase we will implement the hardware of the system using the TIVA-C chip with the implemented code to work with all the conditions of the system.

Block diagram

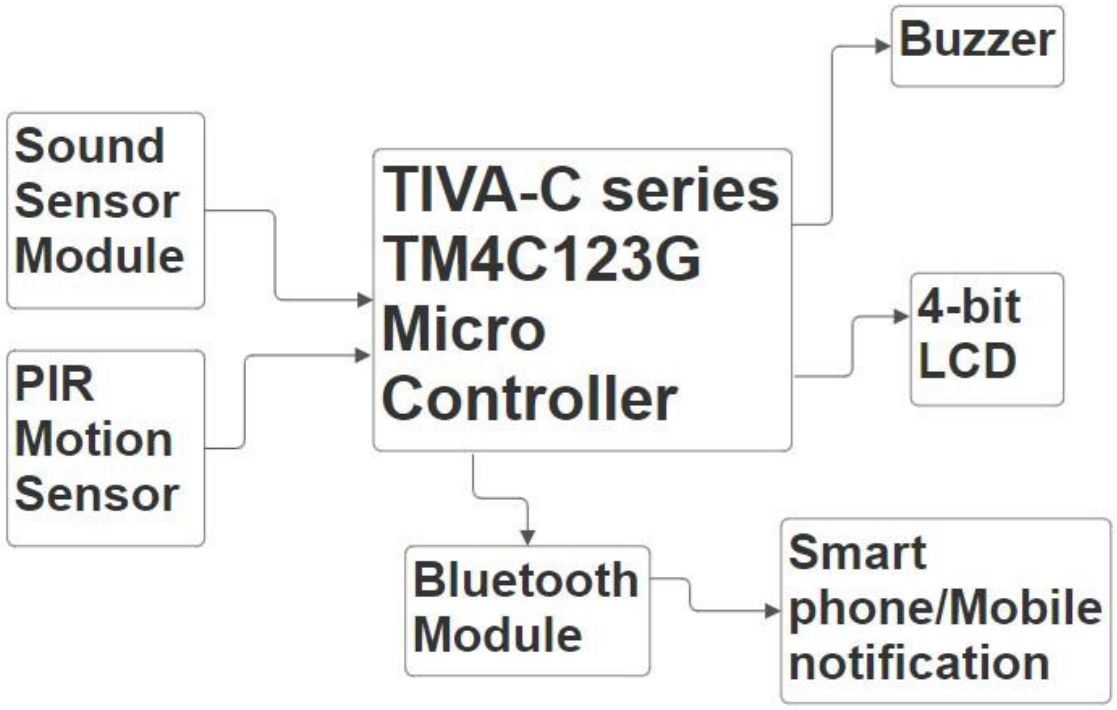

Figure 1 Block diagram.

Schematic diagram

The schematic in figure 2 and 3 is made using Fritzing software.

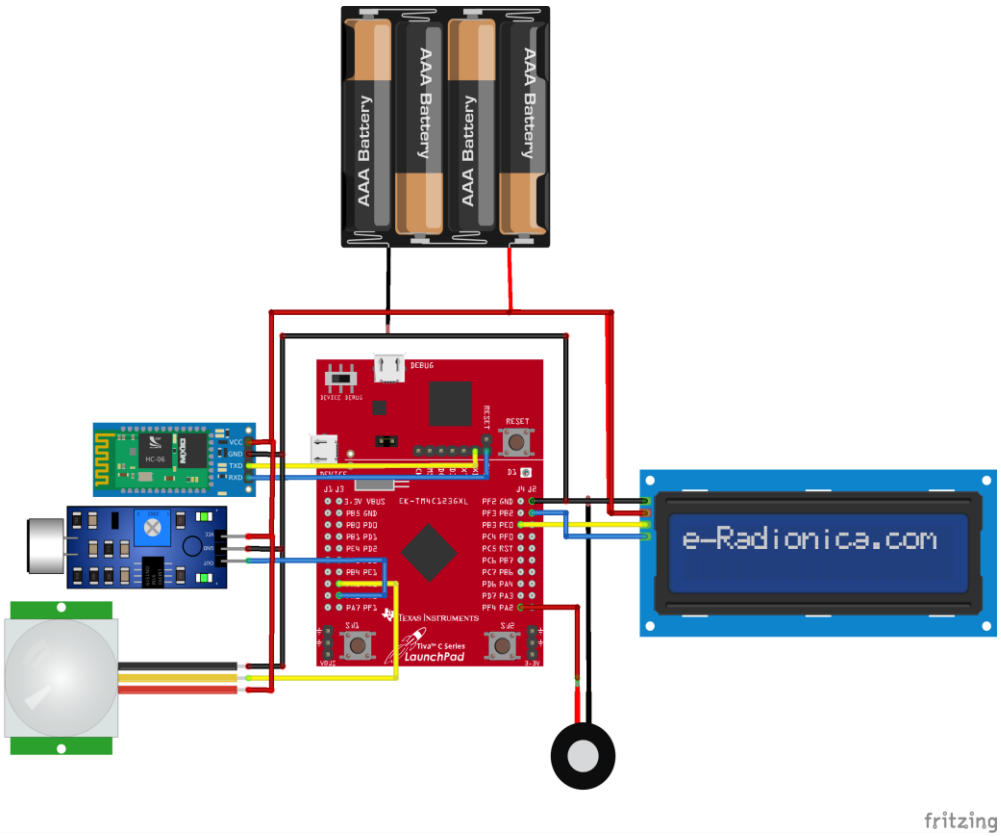

Figure 2 Breadboard connections diagram.

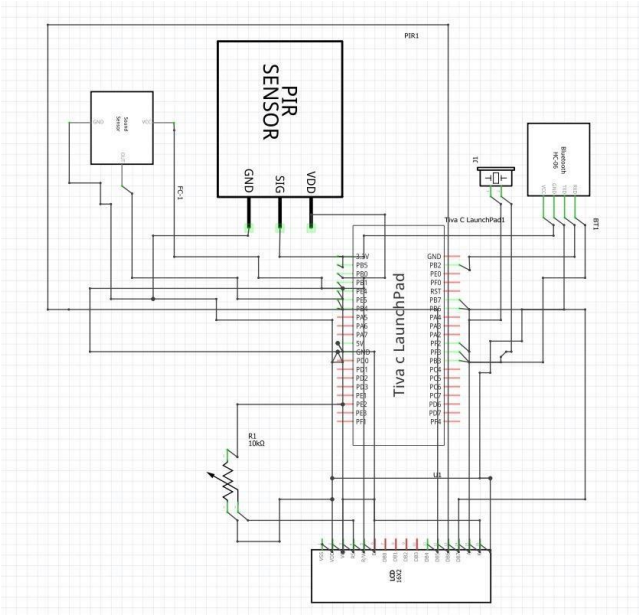

Figure 3 Schematic connections diagram.

Description

In this phase, we incorporate the TM4C123G microcontroller into our security system to manage both the motion and sound sensors. This microcontroller allows us to create smart algorithms that can detect potential threats accurately as our system can swiftly identify any suspicious activity in the area it monitors, ensuring a rapid response to keep you safe.

We also added a simple LCD display with I2C module that connects to the TM4C123G, showing alerts directly in your system. When a threat is detected, the microcontroller sends a message to the display, giving you immediate visual warnings.

As shown in figure 4,5 using the microcontroller's connectivity options with the Bluetooth module, the system sends alerts to your phone. This way, you get notified instantly, ensuring you stay informed and can act quickly to address any security concerns. Otherwise, the LCD display “safe “and send to the Phone that the system is safe.

As concluded from our test for the system that will be shown clearly in the attached videos, that the system responds to any mechanical activity around even it’s motion or sound by turning on the buzzer, turning on the police-like warning LEDs, sending warning messages to the mobile interface and display a visible warning message in the LCD screen.

Otherwise, when the system doesn’t observe any sound or motion around it, it stays showing the safe message on the LCD and on the mobile application connected to it without any operation of the buzzer or the LEDs.

RTOS Tasks

This project is divided into 4 tasks with different priorities:

- Sensing task (highest priority):

  This task has the highest priority of (4) including motion and sound sensors with ensured continuous operation in an infinite for loop.

  If the condition of motion sensor or sound sensor is true, the tasks of the URT, LCD AND Buzzer will be given 0x01 values, if false these tasks will take 0x00.

- LED and Buzzer task:
  This task responds to notifications from the Sensing Task to activate/deactivate the LEDs and buzzer. when it receives a 0x01, it activates the buzzer and blinks the LEDs. If it receives a 0x00, it turns them off.
  Blocking: This task waits indefinitely for notifications with xTaskNotifyWait ().
- LCD Task:
  It displays messages on the LCD based on sensor status. As it displays "WARNING" when notified of a sensor trigger (0x01) and "SAFE" when sensors are clear (0x00). After displaying the message, the LCD is cleared, and then the task waits for 500 milliseconds before checking for new notifications.

- UART Task (lowest priority):
  It sends messages via UART to an external system or computer reflecting the sensor status.
  It sends a "WARNING" message if it receives a 0x01, and a "SAFE" message for a 0x00.
  Like the LED/Buzzer Task, it waits indefinitely for notifications, acting only when a notification is received. This task's activity is solely dependent on the sensing task's alerts.

Delays and Task Execution

- Sensor Polling: Every 100 ms in the Sensing Task.
- LCD Update Delay: 500 ms delay in the LCD Task to ensure message visibility.
- Indefinite Blocking: LED/Buzzer and UART tasks wait indefinitely for notifications, making them responsive without unnecessary CPU use.

Timing diagram

Hardware System Test

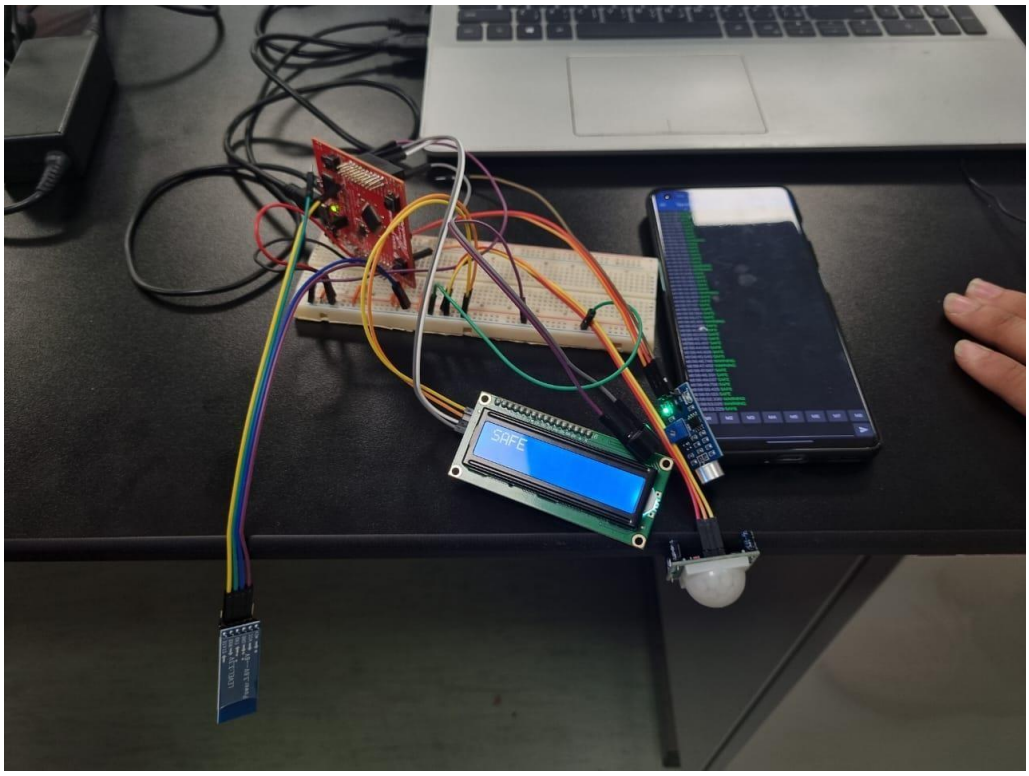

Figure 4 safe test of the system

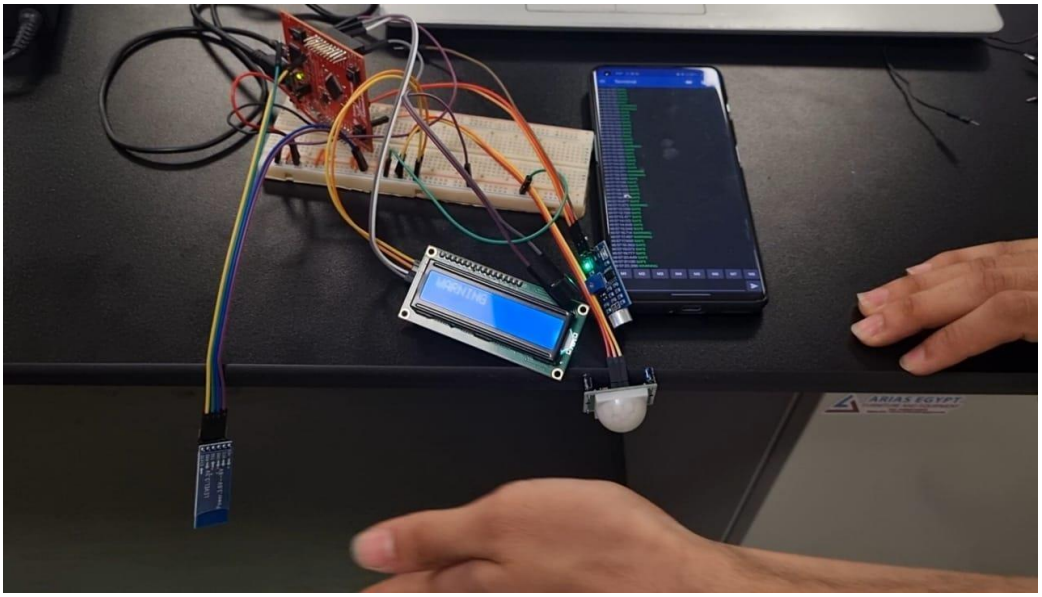

Figure 5 Warning test of the system

**The running test of the system is attached.

**project files are attached

References

Muneer, S., Wu, W., Ahmed, F., Ahmed, & Microcontrollers Lab. (2020, December 8). *LCD interfacing with TM4C123 Tiva Launchpad - Keil uvision*. Microcontrollers Lab. https://microcontrollerslab.com/16x2-lcd-interfacing-with-tm4c123-tiva-launchpad-keiluvision/

N. Khera and A. Verma, "Development of an intelligent system for bank security," 2014 5th International Conference - Confluence The Next Generation Information Technology Summit (Confluence), Noida, India, 2014, pp. 319-322, doi:10.1109/CONFLUENCE.2014.6949339