Embedded Systems 2020

Final Projects

Deliverables

For each group the following deliverables are requested:

- Source code with comments (submitted on github)
- Project Description Document:
    - Solution
    - Design Choices
    - Hardware Architecture
    - Software Architecture
    - Software Interfaces
    - Software Protocols
- Short presentation (max 10 slides)
    - Project
    - Hardware schema and connections
    - Software architectures
    - Protocols and interfaces
- Short video (max 5 minutes)
    - The video must contain the name of the class [Embedded Systems 2019/2020 – Computer Engineering - University of Salerno]
    - Subtitles explaining the projects
    - No speech

Home Security System

Realize an embedded system to protect your home from undesired intrusions. The home security system is required to manage two different kind of intrusion detection sensors: **area,** used to detect people or animals moving inside an area, and **barrier,** to detect intruders crossing a virtual line.

Commands are provided to the system through an alphanumeric keypad (see the command format below).

The system can be activated or deactivated by the user. When the system is not active all the sensors are turned off. When the system boots, it is not active.

The system can be partially active, meaning that only one of the sensors is active. In this case the user selects which sensor to be activated. Only active sensors can trigger alarms.

Hereinafter, we will name the alarms on the base of the sensor has fired it, thus: Area alarm and Barrier Alarm.

An active sensor is alarmed, so it fires an alarm, when its signal is high for at least 1 second.

A sensor can be delayed. Alarms on delayed sensors are not immediately fired as soon as the sensor is alarmed, but the sensor must remain alarmed for a longer time, provided by the user in the configuration. Different sensors can have different delay. The maximum delay is 60 seconds.

When an alarm is fired, the system emits a sound. A different sound is emitted for each one of the following events:

- Area alarm
- Barrier alarm
- Both the sensors are alarmed

When at least one of the sensors is alarmed, the system is alarmed. The sound is emitted as soon as the system is alarmed. The system stops to be alarmed until the user explicitly closes the alarm though a command.

A sensor can be in one of the following states:

- Inactive
- Active
- Alarmed
- Delayed

The system has a basic configuration. When it boots, it expects to get a new configuration. If the configuration is not provided within 30 seconds, the system will start using the basic configuration.

The user pin and all the configurations regarding the sensors are provided to the system when it is configured.

The user pin must be composed of 4 numbers.

Except for the transmission of the configuration at boot time, each command sent to the system must be started using the user pin. If the pin sent does not match the one provided in the configuration, the command is rejected.

[Extra Requirement] The configuration is stored in an external memory. The system starts with a basic configuration stored inside the memory. In order to change the configuration, the user has to send the pin and then send the new configuration.

Alarm and System Activation/Deactivation

To activate an alarm or the whole system the user performs the following procedure:

- Press the button #
- Insert the user pin followed by:
    - A: area alarm
    - B: barrier alarm
    - C: both the alarms
    - D: the system
- Press button #

To deactivate an alarm or the whole system the user performs the following procedure:

- Press the button #
- Insert the user pin followed by:
    - A: area alarm
    - B: barrier alarm
    - C: both the alarms
    - D: the system
- Press button *

The system confirms the operation through a short sound using the buzzer.

Deactivating the system means deactivate the sensors also.

System Log

Every 10 seconds the system sends a status through the UART interface. The message is structured as follows:

[DATE TIME] Status

The status is composed of the status of each sensor, e.g.

[12-10-2020 10:20:10] Area Active – Barrier Active

[12-10-2020 10:20:20] Area Alarmed – Barrier Active

Together with the periodic status message, a log message is sent when one of the following events happens:

- System Boot
- System Configuration Loaded / Rejected
- Wrong user pin inserted
- Command rejected
- Command accepted

System Configuration

The configuration is composed of:

- USER PIN [4 numbers]
- Alarm delay for each sensor (in seconds) [Max 30 seconds]
- Alarm duration (in seconds) [Max 60 seconds]
- Current Date and Time

If the configuration is not provided within 30 seconds after the boot, the system will boot using a default configuration:

- USER PIN: 0000
- Alarm Delay: 0 seconds
- Alarm Duration: 5 seconds
- Date and Time is unchanged

[Extra Requirement] If the system has a configuration stored in the external memory, this configuration will be considered as the actual configuration to be loaded at boot time. If a new configuration is provided the current user pin must be provided right after the configuration data. If the user pin does not match the last pin the new configuration is rejected and the one stored in the memory is loaded.

If a sensor is configured to have 0 seconds of delay it is not delayed.

It is not possible to send the configuration after the boot.

System Global Status

The system shows its global status using the user led:

- After the boot, the system turns on the user led.
- While the system is active, the user led is blinked periodically.
- If the system is not active, the led is on.

Summary

In brief, realize a home security system having the following features:

- Two different kind of alarms: AREA and BARRIER
- Activate/Deactivate both or a single alarm
- Drive a buzzer for notifications and alarms (different sound for different alarm)
- Close an active alarm
- Activate/Deactivate the system
- Delayed alarms
- User pin to activate/deactivate the system and the alarms
- Log through the UART
- [EXTRA] Store the configuration in an external memory

The system requires the following components:

- Passive infrared sensor (PIR) to monitor an area
- Laser and photoresistor as barrier sensor

- Active buzzer for notification
- UART Interface for configurations and logging
- Real-Time clock over I2C to get time
- Numeric keypad
- [EXTRA] I2C nonvolatile memory