Project Description
The Mini-Storage Security System

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December 13 2002
Introduction

What would you do if you have a lot of stuff at home but lacking in space? Or you are in a transition of moving your home and need a temporary place for your furniture? Most people will try to rent a storage unit. But there is a potential problem of losing property; just using a padlock is not enough.

The project that I am proposing is a mini-storage security system. It will be a security system that monitors every storage unit and checks if there are any illegal entries. My demo will not only simulate the basic security functions, but also have additional security protections that other mini-storages on the market do not have, which are the additional unit security password and the unit alarm sensor.

General Description

Usually, the mini-stages on the market allow renters to choose a unique gate code to open the front gate, but the storage unit is only protected by a padlock. It is possible that someone can brake in without passing the front gate and just cut the padlock off. In order to provide extra protections, besides the gate code, additional security functions are necessary.

Each storage unit will have an alarm sensor installed. If the unit door is opened without passing the password check, the alarm will be activated. Also, each unit will have a secondary unit password associated with the front gate, which means the users has to enter both the gate code and
the unit password correctly to unlock their units. This secondary password prevents the possibilities of code guessing by intruders.

Besides the three security functions, the system will also admits multiple entries, which means that when there is one user in the area, the following users can enter the area without causing any system conflicts. In addition, this security system also provides flexibility and expansibility by separating the system into a central unit and several remote units. Because the total number of remote units is not fixed, storage owners can simply choose how many storage units they want to be in their storage area. Please refer to Figure 1 for the product sketch.

Figure 1: Product Sketch
**Hardware Description**

The mini-storage security system can be broken down into two parts: The central unit and the remote unit. Please refer to Figure 2 for the system block diagram.

![System Block Diagram](image)

**Figure 2: System Block Diagram**

The central unit is the Motorola MC68HC912B32 microcontroller. This processor contains 32K bytes flash EEPROM, 768 bytes byte-erasable EEPROM and 1k byte RAM. The 1K byte RAM will be used for storing temporary variables. The 768 bytes EEPROM will be allocated as a database for both the gate code and the unit password. The 32k bytes flash EEPROM will be used for the main system program. The 68HC12 contains the synchronous serial peripheral interface (SPI) and the serial communications interface (SCI). The SCI is connected to a PC terminal monitor, which allows technicians or software programmers to read the data from each storage...
A universal asynchronous receiver transmitter (UART) chip is connected to SPI. This chip converts SPI to SCI. The reason of using a converting chip is because the 1-wire line driver of the remote units requires a connection to the SCI, but the SCI of 68HC12 has already been used for a terminal monitor. The 68HC12 uses all general-purpose I/O pins of port A and three of port DLC to connect to the LCD display. A sixteen button standard keypad is connected to the 68HC12 through all pins of port B. In addition, a reset circuitry is connected to the reset pin of the microcontroller in order to protect the system under the low voltage situation. Finally a 16MHz crystal is used to drive the timing for the 68HC12. Please refer to Figure 3 for the functional block diagram for all connections.

Figure 3: Functional Block Diagram
Every remote storage unit has a 1-wire memory chip, a detector and a LED. The memory chip has its own registration number to provide a guaranteed unique identity for traceability. The detector is a switch to indicate whether the unit door is opened or closed. The LED indicates the status of this unit: Armed, Disarmed or Alarm. The memory chip communicates to the microcontroller via a 1-wire bus. The microcontroller accumulates the level of a port on each memory chip and compares with the password database to see if there are any illegal entries.

The power for this project will be a regular wall adapter 120VAC / 5VDC – 1.5A regulated. This power supply should drive enough power for the central unit and the remote units.

**Software Description**

The C program language and assembly language using a cooperative real time kernel will be used for this project. The program will include the following module: a main module, a LCD module, a keypad module, a remote unit module and a terminal module.

**Main module**

This module will have a basic time slice function which will allow the microcontroller to perform multitask. Moreover, it will compare the input to the gate code and the password database, and also accumulates data received from the remote units.

**LCD module**

The previous projects’ module will be reused. This module contains functions that controls the
Keypad module

The previous projects’ module will be reused. This module contains function that reads the keypad input.

Remote unit module

This module gathers the pin level from the remote units, one at a time. Also, it transmits data from the central unit to the LED for correct signal display. In addition, this module also calculates the CRC (Cyclic Redundancy Checks) to make sure the serial number is read correctly. Moreover, this module will perform communication between the microcontroller and the UART chip, the UART chip and the 1-wire line driver, the 1-wire line driver and the remote units.

Terminal module

This module will allow reading the unit level through the terminal monitor program. In addition, this module will allow editing to the password database.

User Interface Description

The user interface has two portions: Main User Interface and Terminal User Interface.

Main user interface

The basic user interface is a two line by sixteen characters LCD module and a sixteen button numeric keypad. The LCD will display the password request, and the login information. The
keypad will be used for entering the gate code and the unit password. The “Alarm off” button will be used to turn off alarm and rest the system to its stand by mode. The security system can be divided into several states. Please refer to Figure 4 for the state diagram.

Figure 4: Main User Interface State Diagram

**Stand by:** This is the state while the system is waiting for user’s input. At this state, the front gate is closed. Three possible situations can occur. First of all, if a user enters a gate code, the system will search its database to check the existence of the gate code; if yes, the system will go to Unit
Password Request state. Secondly, if the gate code does not exist, the system will return to the Stand by Mode state. Finally, if an armed unit is opened, the system will go to the Alarm state.

**Unit Password Request:** This state will ask for user’s unit password. There are four possibilities. Firstly, if the unit password matches the gate code and the unit is armed (user is trying to enter the storage area), the system will go to the “Disarm Matched Unit” state. Secondly, if the unit password matches the gate code, the unit is disarmed, and the unit door is closed (user is trying to leave the storage area), the system will go to the “Arm Matched Unit” state. Thirdly, if the unit password matched the gate code, the unit is disarmed, but the unit door is opened (user is trying to leave the storage area but forgot to close his door), the LCD will display “unit door is opened” and the system will go to the “Stand by” state. Finally, if the unit password does not match to the gate code, then the LCD will display “invalid password” and the system will go back to the “Stand by” state.

**Disarm Matched Unit:** This state disarms the corresponding storage unit, and then the system will move to the “Open Front Gate” state.

**Arm Matched Unit:** This state arms the corresponding storage unit, and then the system will move to the “Open Front Gate” state.

**Open Front Gate:** Open front gate for 60 seconds, which is enough for user to drive through the front gate. After 60 seconds, the system will go back to the “Stand by” state. In addition, if an
armed unit is opened during this state, the system will go to the “Alarm” state.

**Alarm:** The alarm will be activated until the “Alarm off” button is pressed, and then the system will go back to the “Stand by” state. This demo will simulate the security alarm by flashing the unit LED in high frequency.

**Terminal User Interface**

The terminal user interface contains the functions and commands of reading the unit data and changing both the gate code and unit password.

**display:** This command will display the total number of units and the current status of every unit on the terminal monitor. Please refer to Figure 5 for the sample display.

```
> display
> Total Units: 6
> Unit 1: Armed    Unit 2: Armed    Unit 3: Disarmed    Unit 4: Armed
> Unit 5: Armed    Unit 6: Disarmed

> display
```

**Figure 5: Unit Status Display**

**codechange:** This command will allow changing to the gate code and the unit password. Please refer to Figure 6 for the sample interface.
Development Plan

I have no experience with the 1-wire device therefore I will start gathering all components and studying them during the winter quarter. I will attend the ETEC 454 class to learn about C language for embedded system. Also, I am expecting to finish the hardware portion at the end of the winter quarter. I will start writing software while the ETEC 454 class begins therefore I can apply what I learned right away. The final product should be expected to complete by three weeks before the end of spring quarter.

Winter Quarter

Week 1: Borrow 68HC12 from Professor Morton.

Week 2: Study DS2406, DS2480B and MAX3100.

Week 3: Continue study DS2406, DS2480B and MAX3100.

Week 4: Continue study DS2406, DS2480B and MAX3100.

Week 5: Continue study DS2406, DS2480B and MAX3100.
Week 6: Start building a test circuit.

Week 7: Test the circuit and start writing codes.

Week 8: Concentrate in DS2406 functions, such as channel access and ROM function.

Week 9: Continue writing codes.

Week 10: Continue writing codes.

Week 11: Continue writing codes.

Spring Quarter

Week 1: Continue writing codes.

Week 2: Continue writing codes.

Week 3: Continue writing codes.

Week 4: Continue writing codes.

Week 5: Test project.

Week 6: Test project.

Week 7: Expect finishing all codes.

Week 8: Setup the hardware for demonstration.

Week 9: Final test of project.

Week 10: Project demonstration.

Hardware and Software Development
In order to accomplish all the tasks, proper tools, such as the oscilloscope, the logic analyzer, and the digital multimeter, etc, are required. The ETEC department’s laboratory provides access to these utilities for construction and testing of hardware. This project will be a prototype using the 68HC12 evaluation board.

The ETEC 340 computers contain all the software I need, such as C, Assembly, Introl code, and P-Spice, etc. Therefore, I will spend most of time on writing codes in this lab.

**Demonstration**

For demonstration, I will build total of twenty simulated storage units. All the gate codes and the unit passwords will be pre-written into the ROM. Therefore, during the demonstration, all the listed functions can be tested. Also, the terminal functions, unit status information and code changing, can be tested.

**Electrical Specification**

- **System Requirement**
  - SCI to PC Baud Rate: 9600 bps.
  - Maximum distance: 600 meters.
  - Maximum 6 numbers gate code and 6 numbers unit password to each unit.

- **Power Requirement**
  - 120VAC / 5VDC @ 1.5A
- Maximum power dissipation 7.5W

• Operating Environment
  - -40 to +85 degree

• PCB Size Limit
  - Central Unit: 8 x 8 x 2 inches
  - Remote Unit: 1.5 x 1.5 x 1 inches

### Preliminary Part List

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Total: $5.84