Western Washington University
Engineering Technology 471

Senior Project Description
Web-Enabled Access Control System

Daniel Droker
Branden Le

Prepared for Todd Morton

December 12, 2001
Introduction

In today’s society, security has become extremely important. Many schools, businesses, government agencies, and private citizens need new ways to monitor and protect their personnel and properties from intruders. The Web Enabled Access Control System will provide a useful solution for small-scale security needs. The system will provide security and accountability for a single door, with oversight both on site and remotely. Access through the door is limited to authorized users, and all events are logged both locally and to a Web site. The system will operate unobtrusively and will have the versatility to meet the needs of a variety of users. The cost will be relatively low, similar to that of systems offering less functionality.

Hardware Description

For complete system diagram, refer to Figure 1, page 14. The major components utilized appear in Table 1, page 13.

Web Interface

The Web-enable Ethernet Entrance Control Monitor will be implemented using the HelloDevice 1100 Ethernet board with Digital I/O. The HelloDevice will be connected directly to Port P of the M68HC12 and a standard Ethernet connection to form a complete Web enabled system. Using its TTL inputs (pins 0-7), the HelloDevice interfaces with the M68HC12 through Port P (PP7-PP0). Limited two-way communication will be made possible through two lines carrying signals from the HelloDevice to the HC12. These will facilitate remote unlocking and resetting of the system. The HelloDevice 1100 Ethernet board provides an ideal platform for this project because it has 512Kb Flash for Web resource files and application storage, an Ethernet controller, and 16 contact points of digital input and output for interfacing with other devices.
Given these specifications, the HelloDevice is affordable at $136 (board only), compared to other similar Ethernet evaluation boards.

**Access Control**

The access control system hardware will center around the Motorola 68HC912B32 single-chip microcontroller. This unit was selected because of its capabilities and our familiarity with it. The user interface will consist of an LCD, numeric keypad, magnetic card reader and piezo buzzer. The LCD will be a two line by 16 character unit that will display prompts, user inputs, and the activity log. The numeric keypad will be used for entering PINs and authorized user data. The magnetic card reader will be used to authenticate users. The buzzer will sound if the door is left open longer than a specified amount of time and, if desired, if unauthorized entrances are detected.

Detection hardware will consist of magnetic door sensors. Four magnetic sensors will indicate the status of the controlled door, two other doors, and the system enclosure. If time allows, hardware will be added to the doorknob to sense it being turned from the inside in order to distinguish between exits and forced entries.

The opening of the door is controlled with a fail-secure electric strike; that is, it will remained locked with no power applied. This is paired with a doorknob and lockset in storeroom configuration, always unlocked on the inside, always locked on the outside and openable with a key. This will allow those on the inside to exit without hindrance and will allow the door to be opened with a key if necessary. A driver chip will interface the electric strike with the microcontroller.
A real time clock with a built in battery back-up and four kilobytes of internal memory will be utilized. This will provide an accurate time-stamp for log events and non-volatile memory for authorized user records and the activity log.

For demonstration, the two microcontrollers will reside in a plastic enclosure affixed to a model door and frame, whose activity will be controlled and monitored. Additional sensors will be affixed to simulated entrances. See product sketch in Figure 2, page 15.

Software Description

Web Interface

The system software will require the use of HTML, C, and Java languages. Java applets will be written to perform remote I/O control of the HelloDevice on the Internet. HTML Web pages will serve as the backbone of the user interface.
Figure 3, above, shows the simplified software structure for the Web-enable Ethernet Entrance Control Monitor using the HelloDevice. The software structure is broken up into five different modules: Communication Protocol, Security, Application, Displays, and a Date and Time module. The following descriptions explain the function of each module:

**Communication Protocol Module** In order to perform remote I/O control on the Internet, the Internet socket interface should be implanted on the user PC for Internet communication with the HelloDevice. The Communication Protocol can be implemented with a C language-based socket program or a Java applet running on the Web page.

**Security Module** The security module restricts unauthorized users from accessing the system. Upon receiving a request from a web browser, this module will prompt the user to enter a username and a password.

**Application Module** The application module will monitor people entering and leaving the controlled area, system status, and access doors that have been left opened. This is accomplished by continuously (60 ms resolution) monitoring the inputs from the access control unit.

**Displays Module** The displays module contains all the HTML documents necessary for Web pages. The HelloDevice will transfer the HTML documents to the user’s Web browser. The Web browser then interprets the HTML documents and displays the documents as Web pages.
**Date and Time Module**  The date and time module displays the current date and time (synchronized to the user’s machine.)  This can be implemented using a Java applet running on the Web page.

**Access Control**

Software will be written in C and assembly language.  The uC/OS pre-emptive task scheduler will be used. Software modules will include display, real-time-clock, keypad, card reader, lock, and sensor operations.

**Display Module** The display module will control the user prompts and information displayed on the LCD.

**Real Time Clock Module**  The real time clock module will retrieve time information from the clock and handle the storage and retrieval of user information and log activity.

**Keypad Module**  The keypad module will monitor the keypad for button presses and debounce the buttons.

**Card Reader Module**  The card reader module will monitor the reader for card swipes and interpret the data on the card.

**Lock Module**  The lock module will activate the electric strike for a specified period of time.
Sensor Module  The sensor module will monitor the magnetic sensors for door openings.

User Interface

Web Interface

The user will access the Ethernet Entrance Control Monitor (HelloDevice) with a Web browser, by placing the device’s IP address in the address bar of the Web browser. After connection is established, the device will prompt the user to enter a username and password, as shown in Figure 4 below. If access is authorized, the HelloDevice redirects the user to the protected Web page (Main page) of the system. As these usernames and passwords must be pre-programmed into the system, the device will have several built in that the supervisor can use and distribute as desired.

** Authorized Personnel Only! **

**Username:** hello2  
**Password:** *******

Figure 4  Username and Password
Ethernet Entrance Control Monitor

Sat Nov 24
19:30:45

Alarm Status for ET340

System Status: **ARMED**

Main Door: **CLOSED**

Emergency Exit: **CLOSED**

Back Door: **CLOSED**

**CURRENT PERSONNEL IN ROOM (ID#):**

ID# 02
ID# 05
ID# 03
ID# 09
ID # 15

**CLICK HERE TO VIEW PERSONNEL INFO**
Figure 5  System’s Main Web page

Figure 5 shows the proposed system’s main Web page. This page is configured for ET340; however, it can be easily reconfigured to a more generic diagram to meet all users’ needs. This page will provide the user with real time system status, doors positions, and a list of current personnel in the room. The user can also select the ‘VIEW PERSONNEL INFO’ link to view the information corresponding with the personnel ID numbers listed on this page. Buttons on the Web page will allow authorized users to remotely unlock the door and reset the system.

Access Control

The user interface of the access control unit will consist of the LCD, numeric keypad, and magnetic card reader, as shown in Figure 6, page 16. Several buttons on the keypad will have a secondary function, printed on the keypad. The action of these multi-use buttons will be determined by the context in which they are pressed. The user interface will behave as shown in the state diagram of Figure 7, page 16.

The reset state of the LCD will display the message “Slide Card Or Enter PIN”. When a user is authenticated, the display will read “Door Open”, and if the user is authorized to view the event log or program users, a menu of the permissible activities will be presented. The arrow buttons are used to scroll through the menu options and the number buttons are used to select the desired option. If no activity is detected within five seconds, the system will assume that user wishes only to enter and will return to the reset state.
If users choose to view the log of events, it will be displayed one line at a time and can be scrolled through in the same manner as the menu. The exit button is used to cease viewing the log. The authorized user list is added to and deleted from by choosing the appropriate menu options. Prompts on the LCD ask for each piece of information required to add a new user. Editing of previous entries will not be provided for. This is reasonable because of the small time required to delete and re-enter a user with new data. If time permits after required functions are finished, editing will be added as a new feature.

Any key presses that do not apply in the current context will be ignored and the system state and display will remain unchanged.

**Development plan**

Since the Motorola M68HC12 board and the HelloDevice 1100 Ethernet board are currently available for use, I am expecting the hardware portion of the project to be completed by the second week of spring quarter 2002. At this point software design will start, and final software integration, revision, and testing are expected to complete by the middle of spring quarter. The following schedule shows the tasks to be accomplished, starting from winter quarter through spring quarter of 2002:

**Winter Quarter**

**Week 1:** Obtain references necessary for creating simple Web pages using HTML and Java applets. Complete construction of model door. Become familiar with real time clock operation.

**Week 2:** Become familiar with the HelloDevice operation. Become familiar with control of LCD

**Week 3:** Create simple Web pages using HTML and Java applets. Become familiar with keypad and magnetic card reader.
Week 4: Upload Web pages to HelloDevice and verify functionality. Become familiar with outputs required for HelloDevice from HC12.

Week 5: Create Web pages for use in this project.

Week 6: Learn to create simple Java applets.

Week 7: Create Java applets to monitor I/O of HelloDevice.

Week 8: Become familiar with the HC12 operation.

Week 9: Become familiar with the ‘C’ programming language.

Week 10: Start putting together hardware.

Spring Quarter

Week 1: Continue hardware construction. Write keypad and lock modules

Week 2: Finish hardware construction. Write real time clock module.

Week 3: Develop software. Write LCD and sensor modules.

Week 4: Continue software development.

Week 5: Project Design review.

Week 6: Final software integration, revision & testing.

Week 7: Continue software revisions & testing.

Week 8: Code review & preparation for demonstration.

Week 9: Project Demonstration.

Hardware development

In order to accomplish the tasks listed in the schedule, special hardware development tools are required. These tools include the oscilloscope, logic analyzer, digital multimeter, and solderless breadboard. These development tools are available in the Engineering department’s laboratory areas for construction and testing of circuits as necessary to accomplish this project.
Development software

Since the system software will require the use of HTML, C, and Java languages, the development software for this project is extensive. C language will be written using the Introl-CODE Development System for the M68HC12. For remote I/O control of the HelloDevice on the Internet, Java applets are required. Java applets will be written with Forte for Java and the Java™ 2 Platform, Standard Edition v1.3.1_01. To serve Web pages, HTML will be written with a text editor such as Notepad or TextPad, and stored in the HelloDevice Flash memory, using the HelloDevice Utility software.

These software development tools are currently available or can be downloaded from the Internet to a PC or the lab computer for use in this project. The Introl-CODE Development System is available in the ET340 lab for writing C codes. HTML documents can also be written using the computers in ET340 lab. Forte for Java and the Java™ 2 Platform can be downloaded from Sun Microsystems Web site for free.

Demonstration

For demonstration, the HelloDevice will be a standalone prototype. The device will be contained in the same enclosure as the M68HC12 board, LCD module, and the magnetic keypad. Since the M68HC12 board and the HelloDevice belong to the Engineering Department, no permanent connections will be made between the HC12 and the HelloDevice. Jumper wires will be used to interface the HelloDevice with the HC12 for demonstration purposes.

Electrical Specifications

- Sampling Rates:
  - Web interface sampling of access control activity: 60 ms
  - Access control sampling of door sensors, keypad, and card reader: <= 50ms
• Power requirements:
  - 120VAC in / 5VDC @1.5A out table-top power supply for microcontrollers and peripherals
  - 120VAC in / 12VDC @1A out table-top power supply for electric strike
  - Maximum power dissipation, microcontrollers and peripherals: 3 W
  - Maximum power dissipation, electric strike: 10.8 W
  - Total maximum power dissipation: 13.8 W

• Operating Environment:
  - Operating Humidity: 0 - 95%
  - Operating Temperature: 0 - 40 Degrees Centigrade
Sena Technologies
HelloDevice 1100

Motorola
MC68HC912B32

10 Base-T Filter
Ethernet Controller (10 Base-T)
Microprocessor
Flash Memory 512Kb
16 Point TTL I/O

Sena Technologies
HelloDevice 1100

Motorola
MC68HC912B32

10 Base-T Filter
Ethernet Controller (10 Base-T)
Microprocessor
Flash Memory 512Kb
16 Point TTL I/O

10 Base-T Filter
Ethernet Controller (10 Base-T)
Microprocessor
Flash Memory 512Kb
16 Point TTL I/O

LCD
Real Time Clock

Port B
PB6-PB0

Numeric Keypad

Piezo Buzzer

Magnetic Sensors (4)

Magnetic Card Reader

Lock Driver

Electric Strike

Gnd

Reset

Extal Xtal

16MHz Crystal

Switching Power Supply
115VAC in
+5VDC @ 1.5A
+12VDC @ 1A
<table>
<thead>
<tr>
<th>Description</th>
<th>Source</th>
<th>Cost $</th>
<th>Current (max)</th>
<th>Lead Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>HelloDevice</td>
<td>Monterey Tools</td>
<td>136.00</td>
<td>200 mA</td>
<td>On Hand</td>
</tr>
<tr>
<td>Various Resistors</td>
<td>ET 340</td>
<td>1.28</td>
<td>12 mA</td>
<td>On Hand</td>
</tr>
<tr>
<td>RJ45 Ethernet Cable (25’)</td>
<td>Walmart</td>
<td>12.95</td>
<td>---</td>
<td>On Hand</td>
</tr>
<tr>
<td>Microprocessor</td>
<td>Todd Morton</td>
<td>17.02</td>
<td>225 mA</td>
<td>On Hand</td>
</tr>
<tr>
<td>16 MHz Crystal</td>
<td>Allied</td>
<td>0.78</td>
<td>---</td>
<td>1 Week</td>
</tr>
<tr>
<td>LCD Module</td>
<td>Todd Morton</td>
<td>35.00</td>
<td>20 mA</td>
<td>On Hand</td>
</tr>
<tr>
<td>Real Time Clock with 4k RAM</td>
<td>Allied</td>
<td>8.95</td>
<td>250 mA</td>
<td>8 Weeks</td>
</tr>
<tr>
<td>Enclosure</td>
<td>Jameco</td>
<td>2.15</td>
<td>---</td>
<td>1 Week</td>
</tr>
<tr>
<td>Numeric Keypad</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piezo Buzzer</td>
<td>Jameco</td>
<td>0.06</td>
<td>10 mA</td>
<td>1 Week</td>
</tr>
<tr>
<td>Magnetic Door Sensors (4)</td>
<td>Smart Home</td>
<td>10.80</td>
<td>200 mA</td>
<td>1 Week</td>
</tr>
<tr>
<td>Power Supply</td>
<td>Jameco</td>
<td>9.95</td>
<td>---</td>
<td>1 Week</td>
</tr>
<tr>
<td>5 Volt Regulator</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric Strike</td>
<td>Smart Home</td>
<td>21.95</td>
<td>900 mA</td>
<td>Have Part</td>
</tr>
<tr>
<td>Driver</td>
<td>Jim Shepard</td>
<td>0.59</td>
<td>25 mA</td>
<td>Have Part</td>
</tr>
<tr>
<td>Card Reader</td>
<td>eBay</td>
<td>8.00</td>
<td>7 mA</td>
<td>Have Part</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>270.63</td>
<td>&lt;600 mA + 900 mA</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 - Preliminary Parts List