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TELE-SAFE HOME SECURITY SYSTEM

Team # 9

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INTRODUCTION

MAIN GOAL AND MOTIVATION

The project team desired to innovate a home security system assembled using an embedded system with a microcontroller that would be:

- AFFORDABLE in order to appeal to the general public.
- RELIABLE in order to operate without failure.
- EFFECTIVE in order to provide a sense of security.

BACKGROUND

ISSUES & CONCERNS:

Why design a home security system when there are already a number of security products widely available? It seems EASIER to just pay for a professionally installed system.

SOLUTIONS:

Yes, there are some high-quality security systems already available on the market.

Yes, it is EASIER to just pay to have a professional company install your security system.

BACKGROUND, CONTINUED

HOWEVER:

- A majority of homeowners simply do not have sufficient funds to pay for a professionally installed security system.

- In addition to this, many homeowners may not feel the need to actually invest in a professionally installed security system.

- Many individuals who rent their homes, such as apartment owners, are usually not allowed to install permanent devices in their homes such as a professionally installed security system.

- Most inexpensive home security devices and components are nothing more than cheap and ineffective noise makers.

Product Requirements

<u>The Tele-Safe Home Security System consists of two visual components</u>:

1. The Arming Unit, or the black box, which is the “brain” of the system. This contains the microcontroller and the auto-dialer.
    - Figure 1 displays all of the components that are enclosed in the 12” x 3” x 8” black aluminum rectangular case.
    - Figures 2, 3, and 4 displays the microcontroller and the auto-dialer that are on a 1/8” x 3” x 12” black aluminum frame.
    - Two AC adapters are connected to the system that need to be plugged into an available AC outlet.
    - One analog phone line that is connected to the system will need to be connected to a standard analog phone jack.
2. Infrared Transmitter and Infrared Receiver:
    - Figure 5 shows one infrared transmitter is on a 2.2" x 1.6" circuit board and is enclosed in a 6” diameter flower pot. This will be powered by a regular 9 Volt DC battery.
    - Figure 6 shows one infrared receiver is on a 3.9" x 2.0" circuit board and is enclosed in a separate 6” diameter flower pot. This is connected to the Arming Unit.

- The estimated price for the Tele-Safe Home Security System on the market would be: **$60.00**

PRODUCT REQUIREMENTS, CONTINUED

Figure 1 Front view

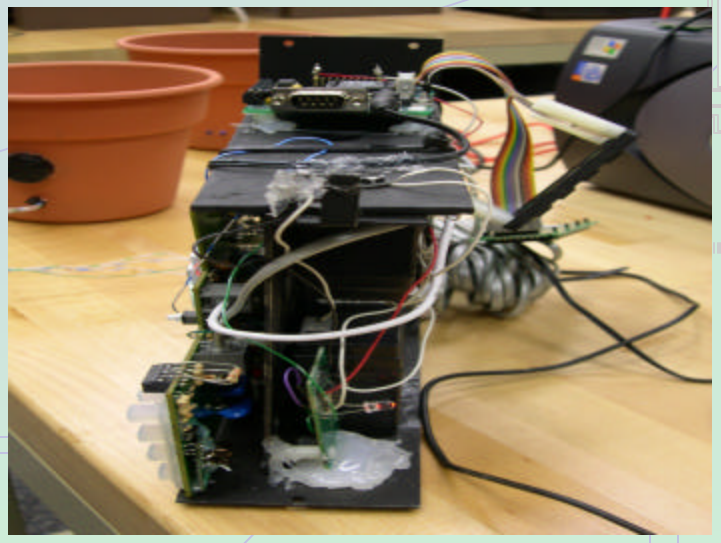


Figure 2 Internal side view

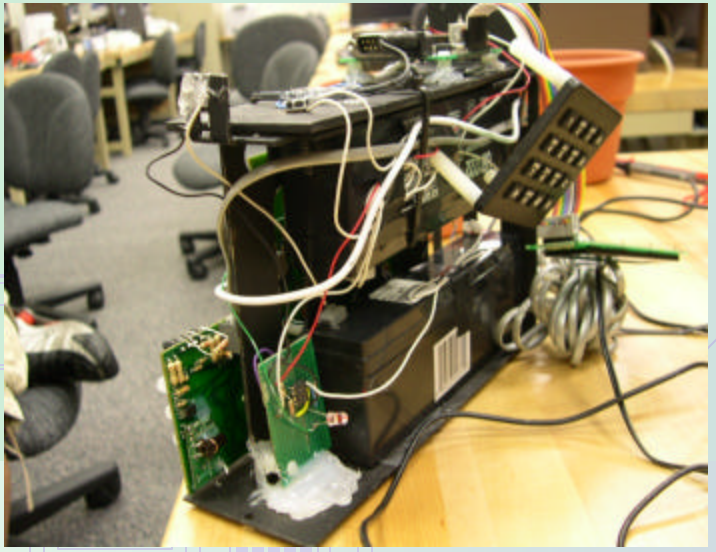


Figure 3 Internal rear view

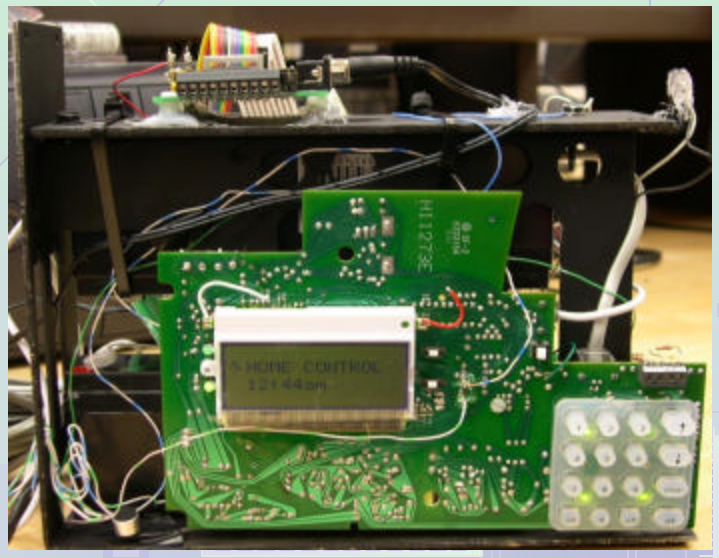


Figure 4 Internal side view

PRODUCT REQUIREMENTS, CONTINUED

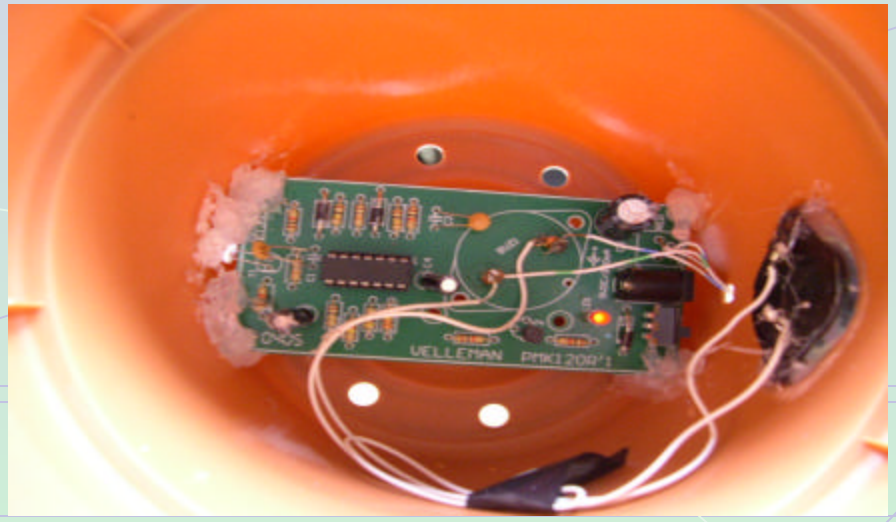


Figure 5 Top view of infrared transmitter

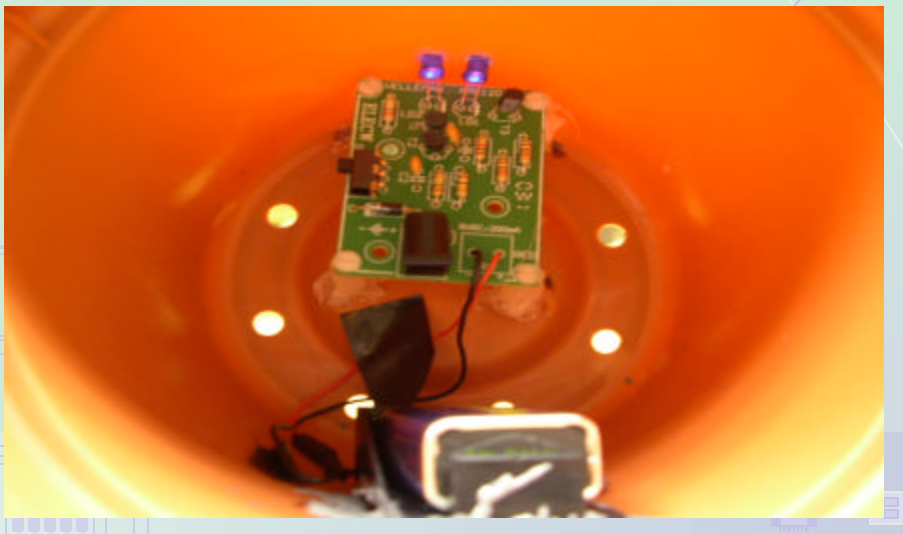


Figure 6 Top view of infrared receiver

DESIGN ALTERNATIVES

- The Project Team considered many different design alternatives for the Tele-Safe Home Security System. However, time and money constraints limited the choices.
- There are different types of sensors which are available that could have been used to trigger the system such as:
    - Infrared sensors
    - Heat sensors
    - Motion sensors
    - Magnetic sensors
- There are different methods that could have been used to connect the sensors to the system such as:
    - Wireless/Bluetooth
- There are different methods that could have been used to power the system such as:
    - One single source powering the whole system instead of multiple sources.
- The circuitry of the system could have been smaller and more compact.
- The casing for the system and the sensor could have been smaller and lighter – Perhaps a lighter material?
- To seal the case we could have used something else other than tape.

Design Specification

- **The Tele-Safe Home Security System uses Hardware and Software**

Hardware Block Diagram

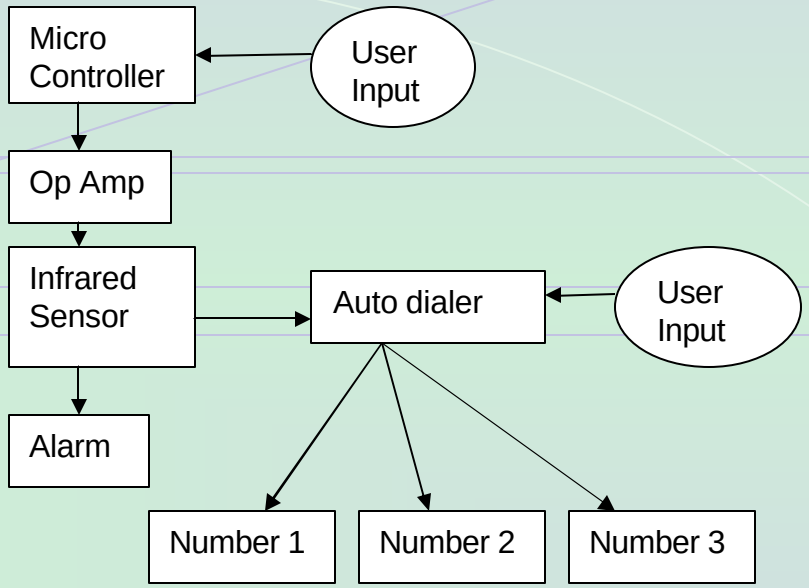


Figure 7 Hardware block diagram

Software Flowchart

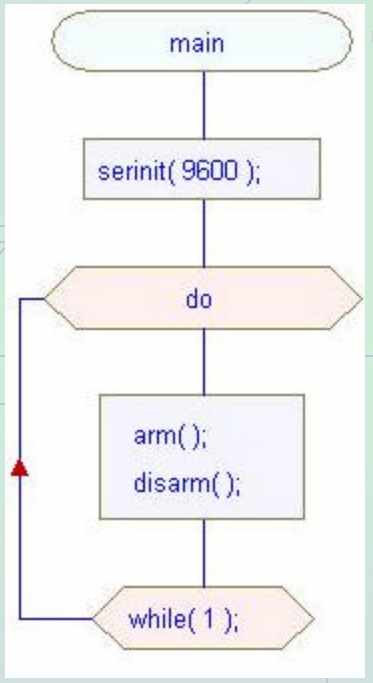


Figure 8 Flowchart

- **Performance Parameters**: From the time the sensor is triggered it takes between 18-20 seconds for the first phone number to be dialed.

Design Specifications

The Tele-Safe Home Security System is comprised of 7 major components

- **Microcontroller**: The microcontroller provides an interface for the user and is connected to the op amp and used to power/arm the infrared sensors.
- **Op Amp**: The LS741 op amp circuit takes the voltage from the microcontroller and amplifies it to the proper level of 9 V.
- **Infrared Sensors**: The infrared sensors, when armed, produce an infrared barrier that monitors any user defined zone (i.e. door or window).
- **Auto Dialer**: When triggered by the infrared sensors, the auto-dialer dials the programmed number and plays a pre-recorded message once answered.
- **Alarm**: Once the infrared barrier has been breached, the alarm will sound.
- **Physical Enclosure**: This is the housing of the unit. Its function is to protect the inner components.
- **Graphical User Interface**: These provide instructions to the user for setup and functionality.

DESIGN DESCRIPTION

SO, HOW DOES THE TELE-SAFE HOME SECURITY SYSTEM WORK?

The four critical components of the project include:

- **The Atmel 89C51 Microcontroller.**

  Used to arm and disarm the operational amplifier.

- **The auto-dialer.**

  When triggered, a phone number is dialed.

- **The infrared motion detector.**

  Creates an infrared beam.

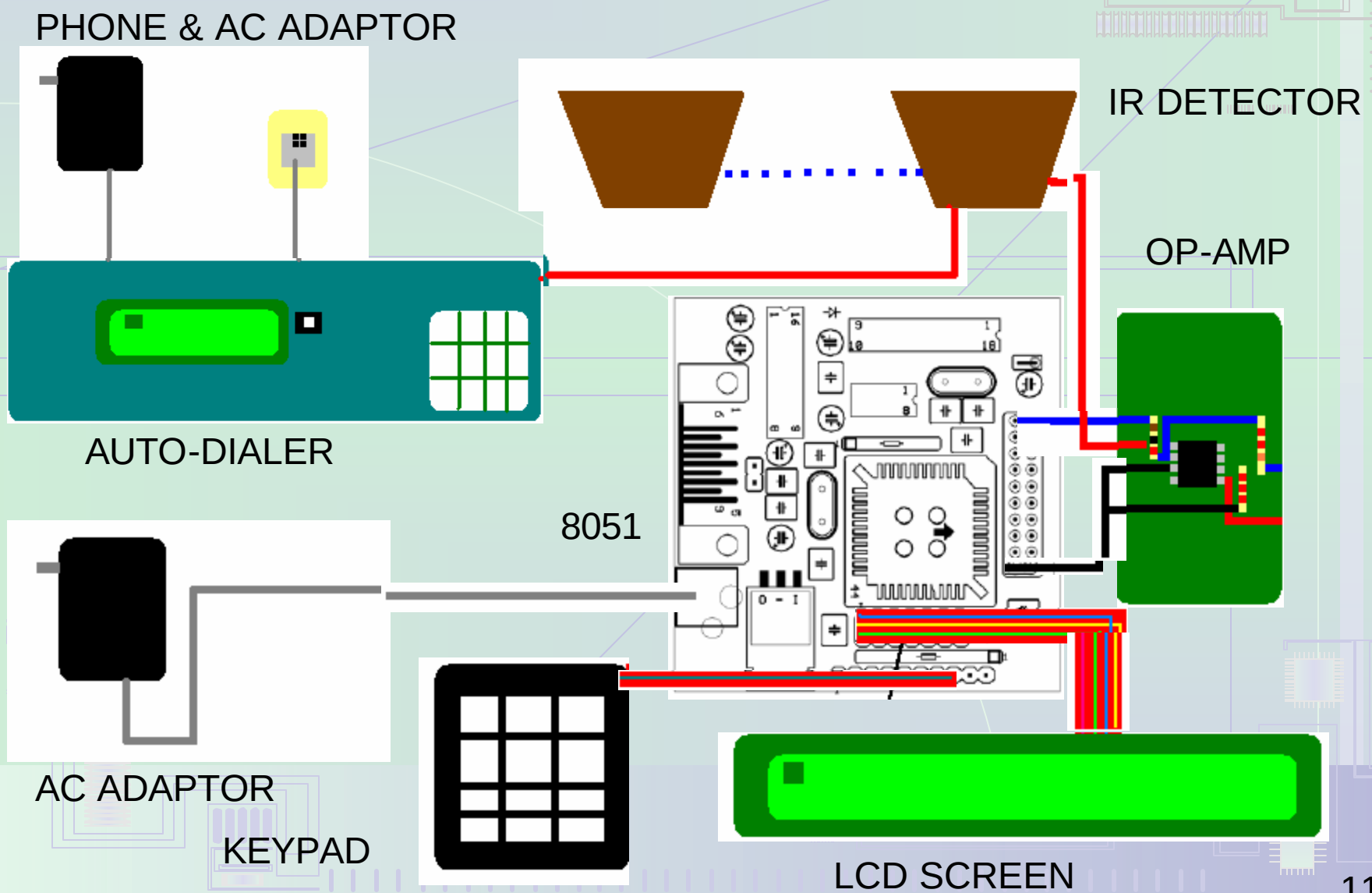
  Becomes triggered when the beam is broken.

- **The operational amplifier.**

  Provides the required voltage to the infrared motion detector when armed.

DESIGN DESCRIPTION, CONTINUED

BLOCK DIAGRAM OF THE TELE-SAFE HOME SECURITY SYSTEM



DESIGN DESCRIPTION, CONTINUED

TEST ANALYSIS & VERIFICATION:

Maximum Power Consumption

Microcontroller 6 V @ .5 A (Provided by an AC adaptor)

Auto-Dialer 8 V @ .4 A (Provided by an AC adaptor)

Total Voltage = 14 V Total Current = .9 A

Power in Watts = Voltage in Volts X Current in Amps

12.6 W = 14 V X .9 A

One Kilowatt-Hour (kWh) = (Watts X Hour of Use) / 1000 Watts

.0126 kWh = (12. 6 W X 1 Hour) / 1000 W

Cost Per Hour of Use = (Kilowatt-Hour) X (Price of Electricity per kWh)

.1323 Cents Per Hour of Use = (.0126 kWh) X (10.5 Cents per kWh)

NOTE: 10.5 Cents is the current Reliant Energy residential KWh price around the University of Houston.

DESIGN DESCRIPTION, CONTINUED

Heat Generation

- The internal components of the main unit (Black Box) remained at room temperature over the course of three days of constant use.

- A change in the internal temperature of the system was very minimal. (Less than two degrees Fahrenheit)

CONSTRUCTION DETAILS

- **Materials Needed**:
  - 8051 Microcontroller with keypad and LCD
  - Infrared Sensor Kit
  - Small PCB Board
  - Batteries (two 12 Volt and one 9 Volt)
  - Auto Dialer
  - Alarm
  - Enclosures (for Infrared and Main Components)
  - Wires (Electrical and Phone/Power)
  - Soldering Iron
  - Solder
  - Components
  - Hot Glue
  - JB Weld
  - Zip Ties
  - Pliers/Wire Strippers
  - Screwdriver
  - Computer
  - Software (Micro IDE and MultiSim)
  - Serial Cable

CONSTRUCTION DETAILS, CONTINUED

Hardware Construction Procedure:

- The microcontroller and auto-dialer came pre-assembled. Therefore, no construction was required for these units.
- The Infrared Sensor kit was purchased from EPO. This required soldering the components and wire to assemble. No software was required to design the layout of the circuit board.
- The op-amp was constructed on plain PCB board using MultiSim to design the schematic.

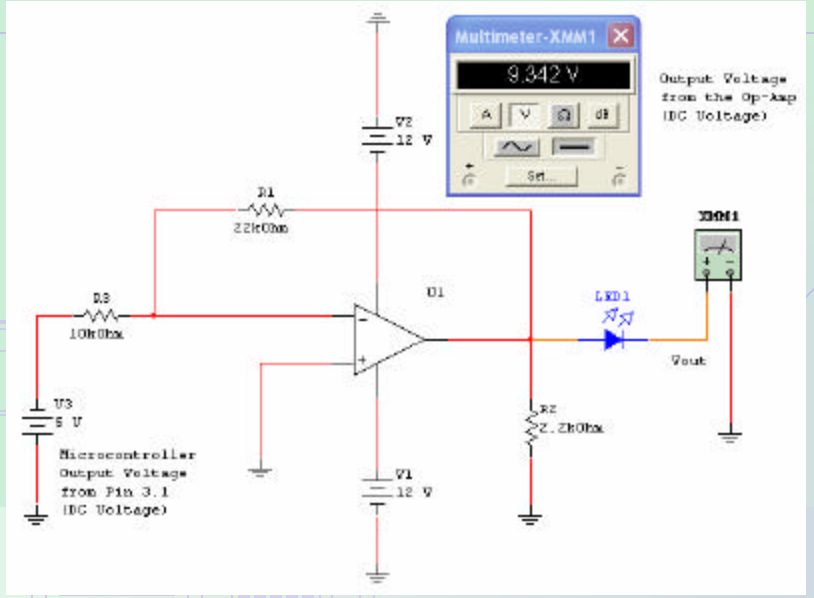


Figure 9 Op-amp circuit schematic

After all components are assembled, everything is placed in the enclosure.

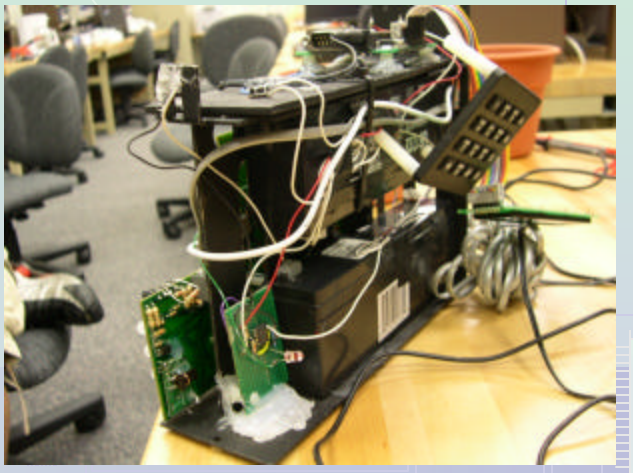


Figure 10 Uncovered case

CONSTRUCTION DETAILS, CONTINUED

SOFTWARE PROCEDURE:

- The program was written in ‘C’ programming language using Micro-IDE under the Micro C 8051-8052 and debugged with the MINI-MAX/51-C Debugger within the programming environment.

- After the code was written, it was compiled, linked, and downloaded into the ATMEL 89C51 microcontroller via the serial connection between the computer and microcontroller.

Cost Analysis

The team project cost analysis is composed of several different categories that we have listed below:

- **Cost of parts used in the project.** (Including tools and parts from the senior project inventory)
- **Laboratory resources.** (Usage of laboratory equipment)
- **Salaries of team members for the completion of the project**.
- **EPO credit used for the project**.

COST ANALYSIS CONTINUED

During the process of building the Tele-Safe Home Security System, the team used the listed materials and parts for the completion of this project in Table 1.

Figure 11 Layout

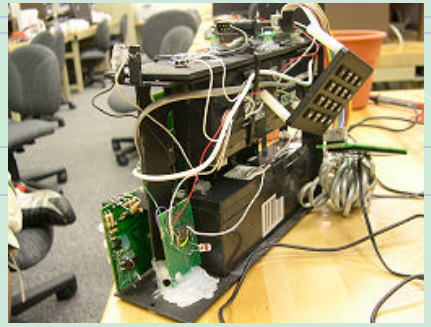


Figure 12 Internal case

Figure 13 Sensors

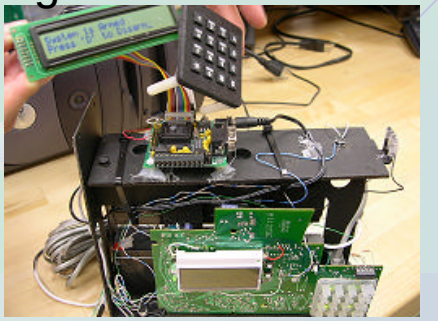


Figure 14 Testing

Parts	Cost
8051 Microcontroller (Figure 14)	*$150.00*
Motion Detector (Figure 11)	*$13.53*
Phone Line	*User Provided*
LCD Display (Figure 14)	*$21.59*
Keypad (Figure 12)	*$21.59*
Automated Dialer	*$6.49*
Breadboard's	*$12.88*
Plant Pots & Casing (Figure 13)	*$9.13*
Circuitry Testing Materials (for products liability)	*$10.82*
Batteries	*$24.72*
Tools (hot glue, spray paint, tape, etc…)	*$19.20*
Other Circuitry Kits	*$49.74*
Senior Project Inventory Parts (Op-Amp etc …)	*Free*
Miscellaneous	*$17.03*
Total=	*$356.72*

Table 1

COST ANALYSIS, CONTINUED

Laboratory Resources

The team calculations for the laboratory resources stand at an hourly rate of $2.30 per person. Using this hourly rate, the team then multiplied the hours invested in the laboratory to obtain a usage charge per person of $384.10. This gives a total charge of $1,536.40 for the resources during the entire construction process of the Tele-Safe Home Security System. These figures are shown in Table 2 .

Laboratory Resources	
Lab Fees/Person	$97.00
Team Lab Use	$388.00
Lab Hours Used	42
Hourly Rate/Person	$2.30
Hours for Project/Person	167
Total Hours Invested by Group	668
Charge Lab Usage/Person	$384.10
Team Lab Usage Charge	**$1,536.40**

Table 2 Lab resources

Salaries

The base dream salary that the team set for this project is $20 per hour. As of January, 2004, the average salary for a general technology major in the Houston Area is $17.00 per hour. The break-down of the team's salaries are on Table 3 .

	Hourly Rate		Hours Worked	Labor Cost
Jason Hoover	$20.00	2.5	167	$8,350.00
Nathan Hunter	$20.00	2.5	167	$8,350.00
Daniel Pineda	$20.00	2.5	167	$8,350.00
Bo Yi	$20.00	2.5	167	$8,350.00
		Total=	**668**	**$33,400.00**

Table 3 Hourly pay

COST ANALYSIS CONTINUED

The total cost of the Tele-Safe Home Security System is $35,293.12 . This sum includes every aspect needed to accomplish this project, as is displayed in Table 4 .

PRODUCT COSTS	
Salaries	$33,400.00
Cost of Parts	$164.65
(not including the EPO parts used)	
Lab Resources	$1,536.40
EPO Resources Used	$192.07
Total=	$35,293.12

Table 4 Table of product costs

Figure 15 Completed Product

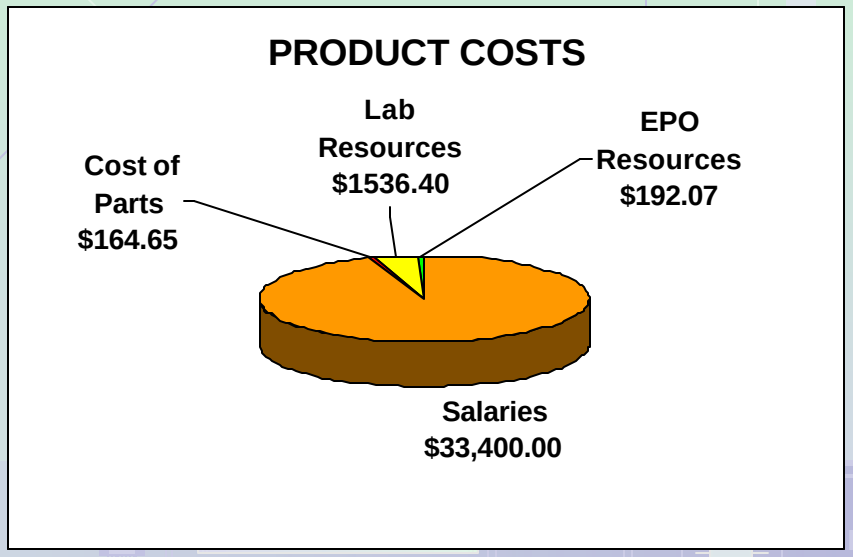


Figure 16 Pie chart of costs

CONCLUSION

It is clear that the team goals have been reached. The team has created a functional home security system that is able to dial out to a preprogrammed analog phone number when the infrared motion detector of the system is triggered. The Tele-Safe Home Security System is a great device that will provide a sense of security for any homeowner.

Needless to say, the team members already see some changes that could improve the system. For example, the next project upgrade should require only one AC adapter to power all of the components of the system. This is an attainable goal that can be reached after prototyping is complete.

Improvements such as this will improve the Tele-Safe Home Security System prototype. However, as of now, the team members are happy to show you the capabilities of this system in the following video clip.

Thank You Very Much for Your Time and Attention.

Questions & Comments?

USER INTSTRUCTIONS
&
PROJECT DEMONSTRATION