HOME SECURITY SENSOR SYSTEM USING
ATMEL AVR MICROCONTROLLER

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This project is submitted in partial fulfillment of
the requirements for the degree of Bachelor of Computer Science with Honours
(Network Computing)

Faculty of Computer Science and Information Technology
UNIVERSITI MALAYSIA SARAWAK
2006
ACKNOWLEDGEMENT

First and foremost, I would like to send my utmost gratitude to the Faculty of Computer Science and Information Technology, University Malaysia Sarawak for giving me an opportunity to do this final year project. I would also like to thank and acknowledge the contribution of my supervisor, Dr. Tan Chong Eng for guiding me through in this final year project. He has given full support and motivation for my final year project. And to Dr. Wang Yin Chai for being the coordinator of this final year project where he has also given guidance to us. I would like to thank my family for their encouragement and support. Lastly but not least, to everyone who has helped me in the final year project and bringing the best memories throughout the processes of completing project.
The AVR Flash Microcontroller based Home Security Sensor System is an automated home alarm system with built-in centralized security monitoring system prototyped using the Atmel STK500 starter kit. The system is able to monitor the house by displaying the information of the current condition of the house and trigger the alarm when the house is being broken in. The development of this home security sensor system involves both hardware and software components. The hardware interface is used to connect all the sensors in the model of the house together with a display panel. The hardware circuit design is built on the AT90S8515 microcontroller. The software program developed is used to control all the functions of the system and it is developed using the AVR studio. The AVR studio is a specific tool for Atmel based assembly program development and debugging. The Home Security Sensor System can be further extended to become more comprehensive in the future.
ABSTRAK

TABLE OF CONTENTS

ACKNOWLEDGEMENT ii
ABSTRACT iii
ABSTRAK iv
TABLE OF CONTENTS v
LIST OF FIGURES x
LIST OF TABLES xii

CHAPTER 1: AN OVERVIEW

1.0 Introduction 1
1.1 Problem Statement 2
1.2 Objective 3
1.3 Methodology 3
  1.3.1 Phase 1: Planning 3
  1.3.2 Phase 2: System Analysis 4
  1.3.3 Phase 3: System Design 4
1.3.4 Phase 4: System Implementation and Integration 5
  1.3.4.1 Stage 1: Hardware Implementation 5
  1.3.4.2 Stage 2: Software Implementation 5
  1.3.4.3 Stage 3: System Integration 5
1.3.5 Phase 5: System Testing and Evaluation 6

1.4 Scope of Project 6

1.5 Significance of Project 6

1.6 Expected Outcome 7

1.7 Summary 7

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction 8

2.1 Background Study 9

  2.1.1 The Operation of Security Alarm 9
  2.1.2 The Operation of Magnetic Sensor 10
  2.1.3 The Operation of Motion Detector 10
  2.1.4 The Operation of Vibration Detector 12
  2.1.5 How the Burglar Breaks into a House 12

2.2 Reviews on Existing Security System and Sensors 13

  2.2.1 NAPCO Gemini P816 Security Panel 13
  2.2.2 Home Alarm system 14
  2.2.3 48-Zone-Customizable Caddx Security System 16
  2.2.4 DDT-15 New Generation Professional Diffused Spectrum Analysis Detector with PIR & MW Dual-tech Novel 17
  2.2.5 Comparing the Features of the Existing Systems 19
2.3 Microcontroller

2.3.1 Atmel AVR Microcontroller

2.3.2 Comparison of Microcontroller

2.4 Summary

CHAPTER 3: REQUIREMENT ANALYSIS AND SYSTEM DESIGN

3.0 Introduction

3.1 Requirement Analysis

3.1.1 Physical Hardware Requirement

3.1.1.1 Atmel AVR® STK500 Flash Microcontroller Starter Kit

3.1.1.1.1 STK500 Switches and LED

3.1.1.1.2 STK500 Port connection

3.1.1.1.3 STK500 Jumper

3.1.1.1.4 STK500 Target Socket Section

3.1.1.1.5 AT90S8515 Microcontroller

3.1.1.2 Sensors

3.1.1.2.1 Magnetic Sensor

3.1.1.2.2 Vibration Sensor

3.1.1.2.3 Passive Infrared Motion Sensor

3.1.1.3 Display Panel and Siren

3.1.1.3.1 Control Panel
3.1.1.3.2 Keypad

3.1.1.3.3 Siren

3.1.2 Communication Port Requirement Analysis

3.1.3 Software Requirement Analysis

3.2 System Design

3.2.1 Hardware Interface Design

3.2.1.1 Security Sensor System Circuit Design Layout

3.2.2 Security Sensor System Flow Chart

3.3 Summary

CHAPTER 4: IMPLEMENTATION AND TESTING

4.0 Introduction

4.1 Hardware Interface Implementation

4.1.1 Home Sensors Implementation

4.1.2 Display Panel Implementation

4.2 Software Implementation

4.3 Integration of the System

4.4 System Testing and Evaluation

4.5 Summary
CHAPTER 5: CONCLUSIONS AND FUTURE WORK

5.0 Introduction 56
5.1 Conclusions 56
5.2 Future Work 57

REFERENCES 58
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 2.1</td>
<td>The Magnetic sensor</td>
<td>10</td>
</tr>
<tr>
<td>Figure 2.2</td>
<td>Motion detector- Radar-based motion detectors</td>
<td>11</td>
</tr>
<tr>
<td>Figure 2.3</td>
<td>Vibration Sensor</td>
<td>12</td>
</tr>
<tr>
<td>Figure 2.4</td>
<td>How burglar breaks into the house</td>
<td>13</td>
</tr>
<tr>
<td>Figure 2.5</td>
<td>NAPCO Gemini P816 Security Panel</td>
<td>14</td>
</tr>
<tr>
<td>Figure 2.6</td>
<td>Home Alarm System</td>
<td>15</td>
</tr>
<tr>
<td>Figure 2.7</td>
<td>48-Zone-Customizable Caddx Security Systems</td>
<td>17</td>
</tr>
<tr>
<td>Figure 2.8</td>
<td>DDT-15 New Generation Professional Diffused Spectrum Analysis Detector with PIR &amp; MW Dual-tech Novel</td>
<td>18</td>
</tr>
<tr>
<td>Figure 2.9</td>
<td>Atmel AVR STK500 Programmers and Starter Kit</td>
<td>21</td>
</tr>
<tr>
<td>Figure 3.1</td>
<td>Physical Hardware Components That Required In This Security Sensor System</td>
<td>25</td>
</tr>
<tr>
<td>Figure 3.2</td>
<td>The connections to the STK500</td>
<td>25</td>
</tr>
<tr>
<td>Figure 3.3</td>
<td>The STK500 Starter Kit Schematic</td>
<td>26</td>
</tr>
<tr>
<td>Figure 3.4</td>
<td>The special Function and Status Indication LEDs</td>
<td>27</td>
</tr>
<tr>
<td>Figure 3.5</td>
<td>The STK500 Components</td>
<td>28</td>
</tr>
<tr>
<td>Figure 3.6</td>
<td>The LED and Switches Schematic</td>
<td>28</td>
</tr>
<tr>
<td>Figure 3.7</td>
<td>The General Pinout of I/O Port Headers</td>
<td>29</td>
</tr>
<tr>
<td>Figure 3.8</td>
<td>The I/O Ports Schematic</td>
<td>29</td>
</tr>
<tr>
<td>Figure 3.9</td>
<td>The default Jumpers Setting</td>
<td>30</td>
</tr>
<tr>
<td>Figure 3.10</td>
<td>The AT90S8515 AVR RISC Architecture</td>
<td>33</td>
</tr>
<tr>
<td>Figure 3.11</td>
<td>The AT90S8515 Data Block diagram</td>
<td>34</td>
</tr>
<tr>
<td>Figure 3.12</td>
<td>Memory Map</td>
<td>35</td>
</tr>
<tr>
<td>Figure 3.13</td>
<td>Pin Configurations</td>
<td>35</td>
</tr>
<tr>
<td>Figure 3.14</td>
<td>Print screen of AVR studio</td>
<td>41</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------------------------</td>
<td>----</td>
</tr>
<tr>
<td>Figure 3.15</td>
<td>Logical Structure of the Security Sensor System</td>
<td>42</td>
</tr>
<tr>
<td>Figure 3.16</td>
<td>Display panel with LED connected to the Atmel STK500’s port B.</td>
<td>43</td>
</tr>
<tr>
<td>Figure 3.17</td>
<td>Home Security Sensor System design layout connected to the Atmel STK500’s port D.</td>
<td>44</td>
</tr>
<tr>
<td>Figure 3.18</td>
<td>Home Security Sensor System circuit design layout</td>
<td>45</td>
</tr>
<tr>
<td>Figure 3.19</td>
<td>Overall circuit layout of the home security sensor system</td>
<td>45</td>
</tr>
<tr>
<td>Figure 3.20</td>
<td>The Security Sensor System Flow Chart</td>
<td>46</td>
</tr>
<tr>
<td>Figure 4.1</td>
<td>A house model with switches (sensors)</td>
<td>49</td>
</tr>
<tr>
<td>Figure 4.2</td>
<td>The connection pins of each wire to 10-pin cable at port D</td>
<td>49</td>
</tr>
<tr>
<td>Figure 4.3</td>
<td>The 8-N-1 format</td>
<td>49</td>
</tr>
<tr>
<td>Figure 4.4</td>
<td>The connection of the house model to the STK500 starter kit through Port D</td>
<td>50</td>
</tr>
<tr>
<td>Figure 4.5</td>
<td>Display panel with LED</td>
<td>50</td>
</tr>
<tr>
<td>Figure 4.6</td>
<td>The connection pins of each wire to the 10-pin cable at port B</td>
<td>51</td>
</tr>
<tr>
<td>Figure 4.7</td>
<td>The connection of the display panel to the STK500 starter kit through Port B</td>
<td>51</td>
</tr>
<tr>
<td>Figure 4.8</td>
<td>Hardware connection of the system</td>
<td>54</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table 2.1</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Features of NAPCO Gemini P816 Security Panel</td>
<td>14</td>
</tr>
<tr>
<td>Table 2.2</td>
<td>Page Number</td>
</tr>
<tr>
<td>Features and benefits of Home Alarm System</td>
<td>15</td>
</tr>
<tr>
<td>Table 2.3</td>
<td>Page Number</td>
</tr>
<tr>
<td>Features of 48-Zone-Customizable Caddx Security System</td>
<td>17</td>
</tr>
<tr>
<td>Table 2.4</td>
<td>Page Number</td>
</tr>
<tr>
<td>Features of DDT-15 New Generation Professional Diffused Spectrum Analysis Detector with PIR &amp; MW Dual-tech Novel</td>
<td>18</td>
</tr>
<tr>
<td>Table 2.5</td>
<td>Page Number</td>
</tr>
<tr>
<td>Monitored alarm systems and alarm monitoring from national alarm companies compared</td>
<td>19</td>
</tr>
<tr>
<td>Table 2.6</td>
<td>Page Number</td>
</tr>
<tr>
<td>Features of Atmel AVR STK500</td>
<td>22</td>
</tr>
<tr>
<td>Table 2.7</td>
<td>Page Number</td>
</tr>
<tr>
<td>Microcontroller Comparisons</td>
<td>23</td>
</tr>
<tr>
<td>Table 3.1</td>
<td>Page Number</td>
</tr>
<tr>
<td>The description of jumpers</td>
<td>30</td>
</tr>
<tr>
<td>Table 3.2</td>
<td>Page Number</td>
</tr>
<tr>
<td>AVR Socket</td>
<td>31</td>
</tr>
<tr>
<td>Table 3.3</td>
<td>Page Number</td>
</tr>
<tr>
<td>The detail information about AT90S8515 features</td>
<td>32</td>
</tr>
<tr>
<td>Table 3.4</td>
<td>Page Number</td>
</tr>
<tr>
<td>Pin Description Summary</td>
<td>36</td>
</tr>
<tr>
<td>Table 4.1</td>
<td>Page Number</td>
</tr>
<tr>
<td>The Source code of the home security sensor system prototype</td>
<td>53</td>
</tr>
</tbody>
</table>
CHAPTER 1
AN OVERVIEW

1.0 Introduction

In this fast and rapid growth of information technology era, most of the people nowadays can live in comfort zone. People can get whatever they want easily and go wherever they want.

The criminal rate is increasing day by day. Robbery, burglary, and rape are happening everywhere. People are afraid of walking alone, living in frighten, no peace in their heart when they go out or traveling, and hence people reduce their outdoor activities. From a survey that done by the National Crime Prevent Council (NCPC), most of the people feel safe when they are in the house, in workplace and in the community [NCPC, 2001]. Most of the people nowadays are preferred to stay at home. Since Internet is widely used and everywhere, by having Internet at home, people think that they do no need to go out to socialize with other people.

Crime rates continue to increase nationwide. Mark Jarrett from British Gas Home Security said that the crime statistic shows that 18.2% of the households with no security system were burgled compared to there was only 0.7% out of 2% household with high level of security system being entered [Centrica, 2004]. Some people may believe that locking all the doors and windows, using hardwood or metal for outside doors and door frame and so on
will make the house a safer place. In reality, these are still not safe enough! Burglars still can break into the house.

The National Crime Prevent Council (NCPC) suggests the homeowner to install an alarm system for summoning emergency help [NCPC, 2001]. When the house is broken in, the alarm system will be triggered and alert the homeowner or neighbours. Therefore, homeowner or neighbours can take necessary reactions.

Even though, a security system cannot give 100% guarantee that the house is safe, but at least it managed to reduce the crime rate.

1.1 Problem statement

Due to the increase in crime rate, most of the houses today are lacking of a security system to protect the home. A good lock for doors and windows is just not enough. The National Crime Prevent Council (NCPC) suggests the homeowner to install the alarm system [NCPC, 2002].

A security systems that only trigger the alarm is just not good enough, it only can get attention from the homeowner and neighbours. Sometimes it may scare the burglar, but most of the time they will not afraid of the alarm.

Most of the homeowners would like to know the current state of their house even before the alarm system is triggered. The lack of features such as monitoring in an automated alarm system, will never give a total peace of mind to the home owners.
1.2 Objective

The purpose of this project is to develop a security sensor system for smart home.

The project aims to:

i. Create an automated home alarm system with monitoring feature built-in based on the Atmel AVR STK500 starter kit.

ii. Create an alarm system that is able to monitor the house by displaying or providing the information of the current condition of the house (centralized security monitoring system).

iii. Create an alarm system that is able to trigger the alarm and send a signal to homeowner when the security system has been triggered or detecting moving objects like human in the house.

1.3 Methodology

In order to complete this project, several phases are needed. This project starts with planning the system. Then, analysis and design of the system. Finally, it is implemented and tested.

1.3.1 Phase 1: Planning

In this phase, feasibility study will be conducted. It involves identifying the project goals, objectives, problems, project contributions, and system requirements.

The methods to be adopted by the security sensor system in the planning phase are:
• Literature reviews on the existing security systems and study their background to understand more about the security sensor features and functionality.

• Exploration on how the Atmel AVR STK500 microcontroller works and understands the AVR studio by testing some of the example assembly programs.

1.3.2 Phase 2: System Analysis

In this system analysis phase, analyze and specify system requirements, finalize systems objectives, and define system functionality will be done. The information gather in phase 1 during the feasibility studies will be used to further define the system goals and functions.

The methods to be adopted by the security sensor system for this phase 2 are:

• Analyzing the existing security systems and comparison among the systems which similar to the proposed security sensor system.

• Performing search for appropriate hardware required by the system.

• Analyzing of hardware and software requirements for the system such as sensor circuits and assembly language to use.

1.3.3 Phase 3: System Design

At this phase, a detailed implementation plan will be developed, revise cost estimation, and produces the Systems Design Specifications.

The methods to be adopted by the security sensor system for this design phase are:
• Design and propose a standalone security system specifically for home use.

• Sensor circuit design

• Design the logical flow of the system.

1.3.4 Phase 4: System Implementation and Integration

In this phase, the security sensor system will be divided into three stages. Therefore, developer can be more focus on a small module and become more effective compare to doing the whole system at once. Besides that, it also helps to refine the vital components of the system that needs more time to develop.

1.3.4.1 Stage 1: Hardware Implementation

• Implementing, setup and configuring all the sensors and come out with a functional prototype. This prototype will be developed based on the sensor circuits’ design that was defined in the previous phase.

1.3.4.2 Stage 2: Software Implementation

• Program will be developed to implement all the applications that have been proposed for the security system by using assembly language.

1.3.4.3 Stage 3: System Integration

• Integrating the hardware and software systems to produce the final system.

• Solve the system errors or hardware errors once integrate.
1.3.5 Phase 5: System Testing and Evaluation

After the system is completely built functionality and usability testing will be carried out. Feedbacks gather from the tests will be used to further improve the final system. Documenting process will also be carried out in line with the testing and evaluation.

1.4 Scope of Project

This prototype system is designed only for home use. The security sensors will be implemented by homeowner in their house. This system only includes the basic security applications implemented using the Atmel AVR STK500 microcontroller. This system not only can trigger the alarm when the security is breach, but also capable of performing centralized security monitoring under normal home conditions.

1.5 Significance of Project

The significance of this project is to provide a solution to the problem faced by the homeowner which is the security of their house. By implementing this security system in the house, users are able to check their house condition from time to time. They can monitor their home from a centralized location where they will know exactly which part of the house has been broken in. This will give them additional information to plan for the actions required to counter the break-in.
1.6 Expected Outcome

When this working prototype of security system is fully developed, it will be able to trigger the alarm and alert the user at the centralized control panel when the sensor is triggered. This system can also alert the user when the motion sensor detects any moving object. Users can know their house conditions through the centralized control panel.

1.7 Summary

Chapter 1 gives an idea about the importance of having a security system at home. The problem statements, objectives, methodology, and expected outcome are discussed as well in this chapter.
CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

Statistic showed that burglars attack homes without electronic security three times more often than homes with a system [TCPALM Network]. Therefore, knowing how to choose a good or suitable security system for home is important.

A good system covers the entire perimeter of your home and at least one internal trap [TCPALM Network]. The size and layout of the home must be taken into consideration when designing the overall system. The alarm system should be loud and clearly heard [Vivian Capel, 1997] but also easy to use. The system chosen must also reliable and less false alarms happen. In the Metropolitan Police area no less than 98% of the call-outs are for false alarms. So, it is a waste of time and resources [Vivian Capel, 1997].

Basic elements of a standard system includes: a keypad, control panel, a siren, an inside motion detector and door contacts [TCPALM Network]. And it must be linked to a central monitoring station. Additional protection should be added to meet the individual needs of the property being protected.
2.1 Background Study

Before go into the detail of the current technologies, an overview of the security alarm and sensors will be discussed in this chapter to further the understanding of the techniques used in the similar system.

2.1.1 The Operation of Security Alarm

Most of the security alarm systems or burglar alarms are simple electric circuit built into an entry way. In any circuit, electricity only flow when giving the path between two points of opposite charge. In order to turn on the electric current, it needs to close the circuit by a using switch. In order to turn off the electricity, it needs to open the circuit.

In the security alarm system, a switch detects the act of intrusion. For example, open or close the door and window. In a closed-circuit system, the electric circuit is closed when the door or window is closed. This means that as long as the door is closed, electricity can flow from one end of the circuit to the other. But if somebody opens the door, the circuit is opened, and electricity cannot flow. This triggers the alarm. While in an open-circuit system, opening the door closes the circuit, and electricity begins to flow. In this system, the alarm is triggered when the circuit is completed.

The modern alarm system insert a control box inside their system in order to prevent burglar closes the door after triggering the alarm and turn off the alarm. This control box has its own power supply even though it hooked on the alarm circuit. It monitors the circuits and sounds the alarm when they are closed or opened. When the alarm is triggered, the control
box will not cut off until someone has enters a correct security code at the connected keypad.

[HowStuffWorks]

2.1.2 The Operation of Magnetic Sensor

Magnetic sensor works closely related to security alarm system. When the door or window is closed, the magnet pulls the metal switch closed so the circuit is complete. When you move the magnet by opening the door or window, the spring snaps the switch back into the open position. This cuts off the current and closes the relay, then sounding the alarm. Figure 2.1 shows examples of magnetic sensor. [HowStuffWorks]

![Closed-Circuit Magnetic Sensor](image)

Figure 2.1 The Magnetic sensor

2.1.3 The Operation of Motion Detector

There are several different sorts of detectors. Radar-based motion detector sends out bursts of microwave radio energy (or ultrasonic sound waves), and then waits for the reflected energy to bounce back. If there is nobody in front of the door, the radio energy will bounce back in the same pattern. But if somebody enters the area, the reflection pattern is disturbed.
When this happens, the sensor sends a signal and the door opens. In a security system, the sensor sends an alarm signal when the reflection pattern in a room is disturbed as shown in Figure 2.2. [HowStuffWorks]

<table>
<thead>
<tr>
<th>The motion detector emits radio energy into a room and monitors the reflection pattern.</th>
<th>If somebody disturbs the reflection pattern, the motion detector sends an alarm signal to the control box.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 2.2 Motion detector- Radar-based motion detectors</td>
<td></td>
</tr>
</tbody>
</table>

Another type of motion detector is photo-sensor motion detector. There are two types of components: focused light (laser beam) and light sensor. Normally, the light sensor will be used for home. When somebody walks between the light source and the sensor, the path of the beam is blocked briefly. The sensor registers a drop in light levels and sends a signal to the control box. [HowStuffWorks]

Passive infrared (PIR) motion detectors are more advanced than others. These sensors sense the infrared energy emitted by an intruder's body heat. When an intruder walks into the field of view of the detector, the sensor detects a sharp increase in infrared energy. PIR detectors are designed to trigger the alarm only when infrared energy levels change very rapidly. [HowStuffWorks]
2.1.4 The Operation of Vibration Detector

These devices consist of a leaf spring suspended at its top and having a weight fixed to its free end. At the free end is a contact that mates with another which is fixed to the case. The pressure between the contacts, which are normally closed, is adjusted by a set-screw which thereby sets the sensitivity of the device. Any vibration or movement will cause the contacts to part, this will initiate an alarm. Figure 2.3 shows the components of a vibration sensor [Vivian Capel, 1997]

![Vibration Sensor Diagram](image)

Figure 2.3 Vibration Sensor

2.1.5 How the Burglar Breaks into a House

According to the National Crime Prevention Center, there are several ways for a burglar to break into the house for example through a door, window, garage, basement and so on. According to the statistic done by the National Crime Prevention Center, 34% of the burglary is through the front door; followed by 23% through the first floor windows and 22% is broken in through the back door as shown in Figure 2.4. From the survey, it can be