NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

Power Electronic Alarm Systems

Graduation Project
EE-400

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ABSTRACT

Alarm systems are very important in property protection, and life preserving, they can prevent burglaries before they happen and even stop fires before they spread and burn every thing.

The security and reliability of the alarm system is very important, thus it must be secure enough so that it cannot be bypassed or tempered with.

This project begins by reporting the kind of sensors use in an alarm system, then the kind of alarm systems used.

Several new alarm system circuits have been designed and tested, they are inexpensive, easy to manufacture, place and use.

They can be used for preventing burglary, safe protection and detecting fire and smoke.

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Introduction

Alarm systems range from the simple alarm clock to sophisticated burglar alarms and national warning systems. They may be stand alone devices or be complete systems involving control centres to support the end user. An alarm system always has two functions. The first is to draw attention to the fact that something is happening and the second is to what is happening and consequently that certain actions have to take place. In many cases the signal also carries the messages for what has to be done. For example when the alarm clock or the telephone bell rings the response is obvious. The same is true for car horns. However it is more complicated when an alarm for a machine malfunction or for a national disaster alarm occurs, as a series of alternative procedures may have to be undertaken, some of them new and unpracticed. There are three categories of alarm system of which two have as a common denominator the fact that they generate signals in the immediate area of the user and that they only cover a small area i.e. personal alarms, impersonal alarms and disaster alarms which are intended to give warnings over large areas.

Personal alarms are for individual use and are found in everyday situations alarm clocks doorbells,telephone bells,timer signals, machinery warning or indicating signals. Impersonal alarm signals are intended for everyone who happens to be within the physical area of the alarm and are not intended for one specific person. Examples are horns of approaching vehicles,sirens or other signals from emergency vehicles; fire and emergency evacuation alarms. Disaster alarms are sent out by national or local authorities to indicate the presence or likely presence of a major incident that is likely to effect a wide geo-graphical area. The alarm signals for such incidents are often acoustic sirens or loudspeaker announcements from public services or verbal announcements on radio and television. Examples of this are poisonous discharges from industrial plants, large scale fires, such as forest fires and oil spillage warfare or terrorist activity.

CHAPTER ONE

INTRODUCTION TO ALARM SYSTEM

1.1. Introduction

The alarm system receives input from four sensors. Each sensor converts its reading into a 2 bits unsigned value, and sends it to the alarm system. The role of the alarm system is to select the highest value reading coming from the highest priority sensor. The block diagram of the circuit is show in Figure 1:

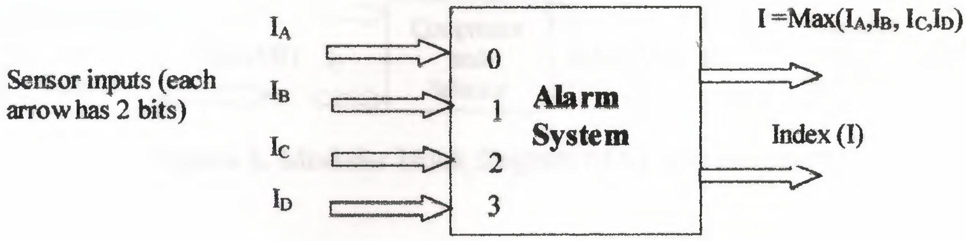

Figure 1: Block diagram of the Alarm System.

The sensor inputs are denoted with I_A To I_D. Each input and output arrow has 2 bits. The smallest value of a sensor input is 00, and the highest is 11. The index of each sensor is: index (I_A)= 0, index (I_B) = 1, index (I_C) = 2, index (I_D) = 3. The value of the index encodes the priority of the sensor: The highest priority sensor has index 3, and the lowest priority sensor has index 0. The first output - I - represent the maximum value reading between all four sensors. The second output - Index (I) - represents the index of the highest priority sensor that reads the maximum value. For example, if I_A= 00, I_B= 10, I_C=10, I_D= 01, the outputs should be: I = 10, and index (I) = 10. This means that the highest reading was 10, and the highest priority sensor with this reading was C (index (I_C=10)). A simple approach in designing the circuit for the alarm system is to decompose its task. For instance, in order to find the maximum value of the four inputs, you can compare them two by two: In the first stage, you compare I_A, and I_B, and find the maximum (M1).

In the second stage you find the maximum between M1 and I_C (= M2) and in the third stage, you compare M2 with I_D, and find the highest value (I):

$$M1 = \max(I_A, I_B)$$

$$M2 = \max(M1, I_C)$$

$$I = \max(M2, I_D)$$

Finally, you have to design only one circuit: the one that computes the maximum between two - 2bits - inputs. The same circuit will then be used in all three stages. The diagram of the decomposed alarm system circuit is shown in Figure 2.

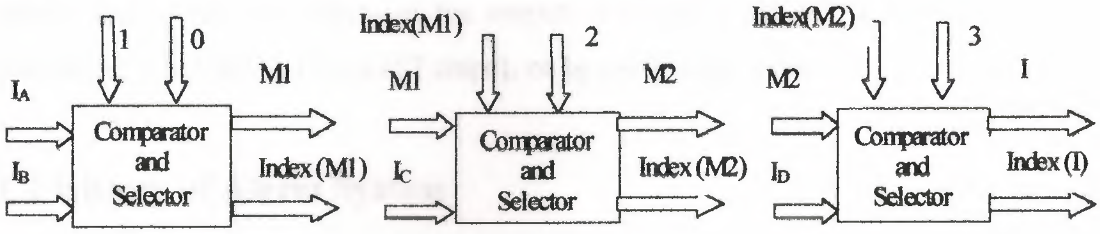

Figure 2. Modular block diagram of the alarm system

In Figure 2, you can observe that the three stages are all implemented using the same circuit (Comparator and Selector block). The circuit receives two magnitude inputs - each on 2 bits, and two index inputs - each on 2 bits. It outputs the highest magnitude input and its corresponding index (each of those on 2 bits). For example if the inputs into a Comparator and Selector circuit are: (magnitude inputs) 01 and 10, and (index inputs) 00 and 01, the circuit will output: 10 = max (01,10) and 01 = index (10).

The block diagram of one Comparator and Selector circuit.

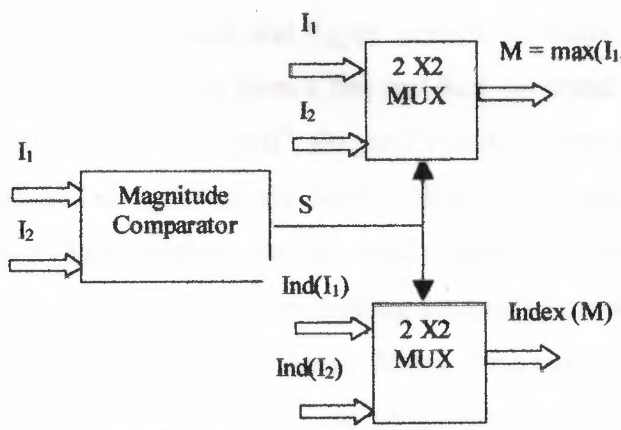

Figure 3: Block diagram of the Comparator and Selector circuit

The Comparator and Selector circuit is composed of three blocks: a magnitude comparator block, and two 2X2 multiplexes (MUX). The magnitude comparator circuit compares the two magnitude inputs (I_1 and I_2), and it outputs a selector signal (S): If $I_1 > I_2$, S = 0, otherwise S = 1. You can design the magnitude comparator circuit using Karnaugh maps. One 2X2 MUX selects the maximum magnitude input, and the other one, selects the index corresponding to that input. The index inputs are Ind (I_1) - index of I_1, and Ind (I_2) - index of I_2. A 2X2 MUX receives two inputs - each on 2 bits - and a selection signal - on 1 bit. Depending on the value of the selection signal (0, or 1) it selects one of the two inputs at the output. You can build a 2 X 2 MUX, either by combining 2 X 1 MUX (74LS157 chips), or by using logic gates.

1.2 History of Alarm System

If you see a word like burglar. That is underlined as in a link; just glide your mouse over the word to see the definition in the Glossary at the bottom of the screen. When human beings began building cities consisting of businesses and residences, it became necessary to protect the buildings from theft and fire. Until recently, the business was usually combined with the residence. The business was on the first floor and the residence was on the second floor. The resident extended family provided protection against burglars. Watchdogs and armed watchmen were often used to deter robbers and burglars. Sense of smell enabled the watchdog to detect an intruder and sound the alarm. A watchdog could also chase away or deter the intruder. Watchdogs are still used just about everywhere in the world as an alarm and protection “system”.

Lockable doors appeared in China and Egypt several thousand years ago. Watchdogs can also be trained to smell smoke from a fire and bark to sound the alarm. But you do not want to depend on “good ole Spot”, do you? Actually, your dog is still very useful. My faithful dog Bruno once saved my family's lives! The value of a good watchdog cannot be measured. Fire fighting was not really organized until the days of ancient Rome about 2000 years ago. Private fire-fighting companies came into existence several hundred years ago in Europe and the United States. You paid the monthly premium to the private fire company and if your house or business caught on fire, the company would put it out. if they could. Metropolitan police departments began to be organized about 200 years ago. It was necessary to personally go to the police or fire department for service. The private fire departments used tower-mounted bells and other signal devices to call the fire fighters to a fire. The use of pre-wired telegraph and telephone lines to residential and business locations made remote alarm monitoring possible. Edwin Holmes provided the first burglar alarm-monitoring center in 1858. The monitoring center evolved into Holmes Protection, Inc. The American District Telegraph Company (ADT) was formed in 1874. This company is now owned by TYCO International Limited and is now ADT Security Services. ADT Security Services operates several modern alarm monitoring centers, each of which handle thousands of alarms nationwide every day. Each Alarm Monitoring Center (ADT calls them Customer Monitoring Centers) also handle thousands of calls from customers who need help with their alarm systems or to set up service calls. Wired electric protection systems were well established in New York City by 1889. Manual fire alarm pull boxes were available along with burglar and hold up alarms. It was now possible to call for police and fire protection using Mr. Bell's telephone. The private fire companies were replaced by volunteer and municipal fire companies. In the meantime, criminals became more knowledgeable about the new electric alarm systems. They learned how to shunt the glass break tapes and the door sensors in use at the time. Alarm systems were armed and disarmed using a key lock located outside the business. This made it easy to defeat the alarm system by picking the lock. The arm/disarm key lock was moved inside the premises to prevent easy defeat. However, a time-delay circuit had to be added to allow entry and exit without setting off the alarms. In the last six years, some very fundamental changes have taken place with burglar and fire alarm systems.

Not so long ago, only high-risk businesses and wealthy homeowners could afford an alarm system which included central station monitoring. The purpose of this book is to answer all of your questions about burglar and fire alarm security systems for homes and businesses so that you can avoid expensive fines for false alarms levied by your local Police and Fire Departments. You will learn everything you need to use your burglar and fire alarm system effectively. You will learn all about the modern Alarm Monitoring Center, which has replaced the old-fashioned local Central Monitoring Facility in just the past six years. The modern Alarm Monitoring Center reduces the cost of reliable alarm monitoring and dispatch so that millions of homeowners can obtain the same level of security that was available to only the wealthy just a few years ago. Finally, you will learn to maintain your alarm system to avoid expensive repair bills and to avoid needless false alarms. The modern Alarm Monitoring Center could not even exist 10 years ago! Just imagine 32 servers handling a database of more than 2,000,000 burglar and fire alarm system users. Imagine the Alarm Monitoring Center with more than 200 emergency dispatch operators, customer service specialists and technical assistance specialists on duty helping thousands of customers every hour — 24 hours a day — 365 days a year! Each emergency dispatch operator may make 20,000 calls a year. Will you be ready when an Emergency Dispatch Operator calls you.

1.3 Essential Security Actions

The SANS Institute has organized a cooperative research initiative involving the people who protect the most often-attacked, high-profile computer systems in the United States. This project resulted in a consensus list of fundamental security actions that raise barriers to thwart those attacks that target repeatedly-exploited system vulnerabilities. Each security measure on this list has an implementation cost that is relatively low in comparison to its impact. These essential security actions establish a core that security-aware organizations implement to create a foundation for safe computing.
The consensus actions have three characteristics:

- Focus only on real threats rather than theoretical threats.
- They can be implemented quickly and inexpensively.
- They are proven and effective.

These actions are necessary for basic network security. Organizations that fail to take these actions, and are penetrated and/or used as launching platforms to attack others, may be considered negligent. Networks are like chains in which the system with the weakest security creates a threat to all other systems. It is becoming increasingly unacceptable to operate a networked computer without implementing at least the Level one security level. These core actions are not the complete answer for extremely high-risk situations such as funds transfer or processing critical national security data. However, even organizations that face those risks recognize that these core actions are an absolutely essential foundation for their more advanced security measures. Essential action lists there are three levels of security actions:

1.3.1 Level One-Security Actions

In Level one, security, system, and networking administrators make the computing environment less vulnerable by correcting flaws in the software installed on their computers and by implementing technical controls. Each action is usually authorized and controlled by a policy.

- 1.1 - Implement online warnings to inform each user of the rules for access to your organization's systems. Without such warnings, internal and external attackers can often avoid prosecution even if they are caught.
- 1.2 - Establish a protective net of filters to detect and eradicate viruses - covering workstations (PCs), servers, and gateways. Ensure that virus signatures are kept up-to-date.
- 1.3 - Make sure that back-ups are run regularly, that files can be restored from those backups, and that sysadmins have up-to-date skills needed to run special backups on all systems immediately in case an attack is detected. Without good backups, small security breaches can become calamities - both in terms of financial loss and time wasted.
- 1.4 - Enable logging for important system level events and for services and proxies, and set up a log archiving facility. Systems without effective logging are blind and make it difficult to learn what happened during an attack, or even whether an attack actually was successful.
- 1.5 - Perform system audits to learn who is using your system, to assess the existence of open ports for outsiders to use, and to review several other security-related factors about your system.
- 1.6 - Run password-cracking software to identify easy-to-guess passwords. * Weak passwords allow attackers to appear as "authorized" users. That allows them to test weaknesses until they find ways to take control of those systems.
- 1.7 - Install a firewall and enhance the firewall rule sets to block most sources of malicious traffic. Running a network system without a firewalls is equivalent to leaving the doors of your house unlocked in a dangerous neighborhood.
- 1.8 - Set access control lists (ACLs) on routers. *** Routers can provide an extra layer of protection.

- 1.9 - Scan the network to create and maintain a complete map of systems to which you are connected.
- 1.10 - Use network-based vulnerability scanners to look for any of the 22 Level One vulnerabilities and correct those that are found ** The Level One vulnerabilities have been developed in conjunction with the Common Vulnerabilities and Exposures project, a partnership of Government, industry and academia.
- 1.11 - Implement the latest applicable patches, remove or tighten unnecessary services, and tighten system settings on each host operating system (as described in SANS Step-by-Step guides).
- 1.12 - Establish a host-based perimeter.
- 1.13 - Implement a file integrity (cryptographic fingerprinting) system to ensure that you can tell which files were changed in an attack.
- 1.14 - Select an incident response team and establish the procedures to be used to respond to various types of attacks.

For many smaller organizations and for any organization whose business does not depend on the internet-based commerce or on the public trust, the actions of Level One may be sufficient if coupled with an ongoing monitoring system to ensure that new problems are uncovered and solved quickly. For most large organizations, however, and those for whom public trust means survival, higher levels of security action are required Each action on this list should be preceded by the creation of policies that authorize the action.

Several of the actions, and this one in particular, must be fully and carefully covered by policy and advanced knowledge and approval of senior management. In some organizations, cracking passwords without authorization is grounds for immediate dismissal and, if national security is involved, may be grounds for criminal prosecution. Level One vulnerabilities tested here are those that allow your systems to be penetrated or closed down by easy-to-find, easy-to-use attack programs available to any interested troublemaker. As you would expect, the list is continuously being updated.

1.3.2 Level Two Security Actions

Level Two actions move the focus from individual systems to the enterprise and raise the barriers to attackers even further, paying special attention to intrusion detection, finding and fixing unprotected "back doors" and ensuring that remote access points are well secured. Level two also focuses on threats from insiders and on improving monitoring on systems that contain the most critical information and support the most important business function. Organizations increase their security to Level Two in order to make a concerted effort to stay ahead of the attackers and especially to be prepared for insider attacks. Not every computer needs Level Two protection and one of the first tasks in Level Two is to identify the systems that need extra security.

- 2.1 - Identify the systems that must be protected for business to continue or trust to be maintained. These are called the "crown jewels." Many of the other actions tasks in Level Two apply primarily to those very important systems.
- 2.2 - Implement instrumentation (such as host-based intrusion detection and cryptographic file fingerprinting) for the crown jewels to enable immediate response to unauthorized access.
- 2.3 - Conduct a physical security assessment and correct insecure access and other physical security weaknesses.
- 2.4 - Implement intrusion detection sensors and analysis stations.
- 2.5 - Implement audited access only for crown jewels using one or more forms of encryption, certificates, or tokens.
- 2.6 - Assess and strengthen dial-in service configuration.
- 2.7 - Conduct a modem sweep to search for back doors.
- 2.8 - Search for and eradicate sniffer programs.
- 2.9 - Conduct a Level Two vulnerability scan, searching for additional vulnerabilities that have been exploited but are more rare and sophisticated than those in Level One.
- 2.10 - Correct the Level Two vulnerabilities that are found.

1.3.3 Level Three Security Actions

Security and system and network administrators can make a significant difference in improving security by implementing the actions of Level One and Level Two. However, their work can be partially or completely thwarted by security breaches caused by one or a combination of factors involving people who use those computers and networks. Level Three actions are designed to help reduce the chance that such security breaches will occur. Level Three actions are focused on overcoming organizational impediments to security and may be more difficult to implement than those in Level One and Level Two. There is an acute need for Level Three security actions. Banking executives and senior military officials with experience analyzing the causes of multiple successful attacks have demonstrated the strongest support for Level Three actions.

- 3.1 - Implement configuration management controls for the introduction of new systems to the network. (The "Occupancy Permit" program)
- 3.2 - Implement regular network mapping and scanning to ensure compliance with new system introduction controls.
- 3.3 - Implement a "Building Permit" program to reduce the chance that newly deployed applications will introduce unexpected vulnerabilities.
- 3.4 - Implement a "Drivers License" program and related security awareness education to help users know what to do in case they encounter a potential security breach and how users can avoid unsafe computing.
- 3.5 - Implement encryption, possibly as a virtual private network, to avoid disclosure of sensitive information traveling over the network.
- 3.6 - Tighten security of the web server
- 3.7 - Implement more sophisticated log file analysis

1.4 The Plan or the Action

Whenever any list of security actions is formulated, a question arises as to whether it would be wise to delay implementation until a full-scale risk assessment and security architecture are in place. A committee of the Security Council of the CIO Institute addressed that question directly in its August 30, Computer world article on "Computer Security's Top Three Questions." In that article, the Council, made up of Chief Information Security Officers from some of the largest organizations in the world, wrote, "Sophisticated security plans take a long time to evolve. Concerned organizations don't wait for a grand plan. Instead, as they identify internal and external threats and vulnerabilities, they recognize that they probably need to be safer than they are and they identify a set of basic controls and then systematically implement them. The basics are often the simplest and least expensive actions and offer substantial leverage for discouraging intruders". It is those simple and inexpensive actions that SANS sought to identify in its consensus project. We recognize that this is a living list and welcome the comments and suggestions from experts throughout the security community.

1.5 Fire Safety

You think it will never happen to you until it happens. Washington, D.C., homebuilder Tom Bozzuto woke up on a Saturday morning last July, ready to start his usual weekend routine when he looked out the window and saw that the entire side of his house was on fire.Bozzuto quickly roused his wife and dogs and got them out of the house. In a state of disbelief, he searched for the phone -- a portable that wasn't where it was supposed to be. Then he found his cell phone and called the fire department. His neighbor had already seen the fire and called them as had his security alarm company. Watching his house burn before his eyes, Bozzuto grabbed the fire extinguisher in his kitchen, but it was woefully inadequate to the blaze outside. As he contemplated getting a bigger one from the basement, the windows in the kitchen broke, and he was facing an advancing wall of thick, black smoke. Before he made a quick exit, he had the presence of mind to take his car keys so that he could move his cars out of the driveway to make way for the fire trucks.

In the one and a half hours it took for the fire department to put out the blaze, Bozzuto and his wife reconstructed how the fire started and how it went on for so long before they became aware of it. The night before, they sat on their rear deck to enjoy a rare, pleasant July evening and a nice break from Washington's notorious summertime humidity. As Bozzuto was getting a couple of drinks, his wife Barbara lit two candles that sat on a dish inside a wicker basket. The candles were old and their flame so low, he didn't notice them. After his wife went to bed, he stayed up reading and smoking a cigar, which he carefully extinguished in a bucket. Not realizing that the candles were lit, he didn't put them out. Eventually the candles burned down. The wicker basket they sat in caught fire; sparks then ignited several other wicker baskets on the deck. These in turn ignited the redwood siding on the house. Because the Bozzutos' modern Frank

Lloyd Wright-styled house had huge windows of tempered glass, the heat of the fire did not cause them to crack. No smoke entered the house, so the smoke alarms did not go off. Bozzuto and his wife are now rebuilding and refurnishing. It is not the house building project that either ever imagined they would be undertaking. They are not locked into a fire-proof-at-any-price mentality, but the fire did influence a few of their decisions. Their rebuilt house will have sprinklers. Their bedroom will have a window that is large enough to make a quick exit should the need ever arise. Their balcony off the bedroom will feature a fold-up ladder that can be opened for a quick exit off the other side of the house if need be (they had purchased it for their old house but had never gotten around to installing it). Beyond these basics, however, Bozzuto said he and his wife were carefully picking and choosing as they would with any new house, considering their lifestyle and adding needed space for household activities, in this case an exercise room and a fourth bedroom for visiting children and future grandchildren. Nonetheless, as Bozzuto can attest, the unimaginable really does happen and he offered this advice to homeowners:

1. Make sure that an emergency vehicle can find your house. In Bozzuto's case, his house number was a cute little sign on a tree and the fire department trucks did not have a global positioning satellite receiver, otherwise known as a GPS. These make finding an address much easier because you type in an address and it gives directions. It took the fire department twenty minutes to find his house; precious time was lost, and the fire damage that much greater.
2. When you buy a homeowner's policy for fire protection, you will almost certainly be offered coverage for your household contents. The quick rule of thumb that most people use is "the replacement value of your contents should be about fifty percent of the replacement value of your house," but Bozzuto said this won't be enough. His insurance company gave them one hundred percent of what they told their insurance company their household contents were worth, but this turned out to be about fifty percent less than their true value. His wife's jewelry was insured separately, but they never thought to insure each one of their extensive collection of paintings and prints. Nor did they ever think about the replacement cost when they purchased shoes and other clothing items. "Go and look at your own closet and start adding up all the money you spent for everything in it. You'll be surprised," he said.

3. Unless you marry someone with a near photographic memory, you should film your contents (Bozzuto did not but he had the good fortune to marry someone with terrific recall). You own many more belongings than you realize -- his wife typed up 47 pages of household inventory items.
4. When you have a fire and smoke spreads rapidly, you will have people approaching you very soon afterwards to clean your stuff. Think twice before you give them anything. In a dazed state, the Bozzutos sent off large quantities of clothing that weren't salvageable. Moreover, at least one-half of the clothing were items that they no longer wore -- like his old army uniform -- , but had kept for sentimental reasons. Bozzuto said the smell of smoke is "pervasive" and the chemicals used to clean the clothes could not remove it. None of the fabric-covered furniture was salvageable either, despite the cleaning service's best efforts, so the Bozzutos had to throw all of it away.
5. Many people think insurance companies are adversarial when resolving claims, but the Bozzutos' insurance company was not adversarial at all. The firm didn't argue with $40 or $50 for a silk tie or $39 for an iron. Where he had problems was with his art collection. The insurance company understandably wanted documentation for $1,300 paintings by lesser-known Washington area artists. If you have anything unusual, document its value.
6. Have your house rebuilt by a firm that specializes in fire restoration. Though Bozzuto is a builder himself, his firm does not have the experience to tackle a job of this specialized nature. As they go about rebuilding, Bozzuto has remained resolutely philosophical. "When all of your possessions are destroyed, you can't quickly replace what it took you 30 years to accumulate. You happened to see a painting you liked a lot. It captured your heart so you bought it. You bought a book you saw reviewed -- you lived with it for a month. You don't just lose your possessions, you lose memories, and that's tough. But you get caught up in the day to day minutiae of things like 'can I get a sweater I like as much as the one I lost?' that help you get through this."

CHAPTER TWO

SENSORS USED IN ALARMS

2.1 Light Sensors

Light sensors are the most common sensors used in small robotics, along with touch sensors. They're cheap, easy to wire, and can be used to produce an interesting set of behaviors. Small robots are fascinating to watch even while performing the simplest of tasks such as following a line or seeking bright light, both of which can use light sensors to good effect.

Two types of light sensors are common: photo resistors and phototransistors. Photo resistors, available from Radio Shack as "CDS Photocells," are cheaper but in our experience less responsive. That is, their range of values typically isn't as large as that for phototransistors. Radio Shack carries two phototransistors: "Phototransistors" and "Infrared Detector." We use generic phototransistors as well as infrared detectors in the lab. Somewhat obviously, the infrared detectors are geared towards detecting infrared light, mostly through the use of a case that is opaque to visible light but does not inhibit infrared light. The same effect can be achieved by carefully shielding a normal phototransistor with the magnetic material from a floppy disk, which is also opaque to visible light but does not inhibit infrared light. In practice what this means is that the IR detector seems to not respond to fluorescent lights as the phototransistor and photo resistor do, but they behave similarly with other light sources such as lamps with normal light bulbs, LEDs, and IR LEDs. Wiring light sensors is extremely straightforward and easy, part of their popularity. The layout of the Handy Board sensor port is depicted to the right. Header pins matching these ports can be bought from JameCo Electronics as part #68339. Simply snap off a row of four pins and pull one of the middle pins out of the plastic with pliers. The Handy Board ports are designed this way to help prevent sensors from being plugged in the wrong way. When using a photo resistor such as a CDS cell, simply connect one lead to the HB sensor input pin and the other lead to the ground pin. For phototransistors, the cathode (the lead on the flat side of the case) should be wired to the sensor input pin and the anode to the ground pins on the sensor port. That's all that needs to be done except for hot gluing or employing all the connections to reduce wear and tear on the joints.

The sensor can be sampled using the standard analog () function. We do not have our light sensors mounted to any particular LEGO piece; instead they're just taped or bound into place as needed. One common method is to build a LEGO box around the sensor in order to shield it from ambient light and to provide a useable LEGO interface. One subtle advantage of the box is that as long as the sensors are placed at similar locations within their respective boxes, they will receive very close to the same amount of light when placed under similar conditions. This is not so easy to achieve when jury-rigging a shield together out of paper and electrical tape. Keeping the amount of light blocked by different shields very close helps simplify control software, reducing the need to calibrate each sensor for normal values. This assembly can be seen on one of the photo or robots. Also, the particular IR detector which we use, Dig Key part #160-1031-ND, as well as the detectors available from Radio Shack are well suited to being inserted into a Technique hole, they fit quite snugly. A (reflected) light sensor consists of an infrared LED that emits (invisible) light, and a photodiode that measures the amount of reflected light. Both are enclosed in the tiny black box. Plug the light sensors into the analog inputs of the Handy Board (numbered 6)

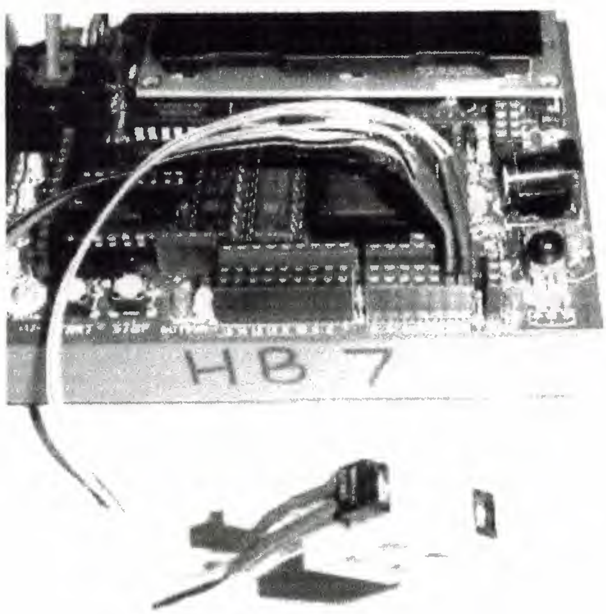

Figure 1: Light Sensors

The values returned by the light sensors can be observed by turning the Handy Board's user knob past option.

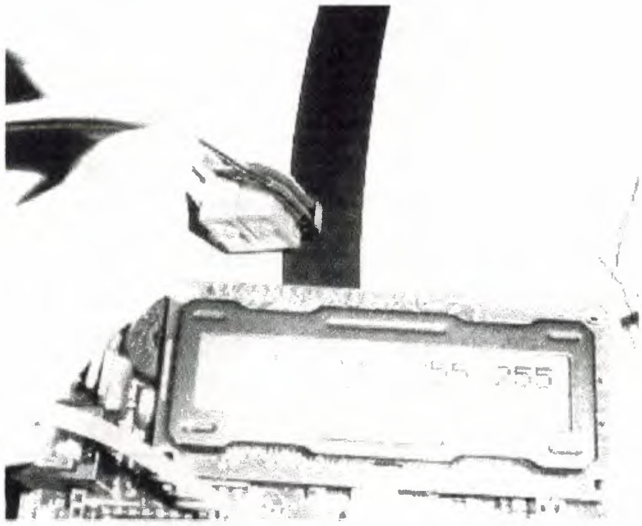

Figure 2: Light Sensors

2.1.2 Measurements of the Light Sensors

Table 1: Measurements from ambient light sensor

	Angle (in degrees)				
Distance	0	22.5	45	90	180
20	268	240	225	221	221
40	267	265	222	221	221
60	266	245	221	220	221
80	264	228	221	221	221
100	261	232	221	221	221
120	250	224	221	221	221
140	241	233	221	221	221
160	236	223	220	220	220
180	231	222	220	220	220
200	229	222	221	220	220

Table 2: A graph of the sensor readings from ambient light sensor

	Angle (in degrees)				
Distance	0	22.5	45	90	180
20	267	242	210	208	209
40	267	213	209	209	209
60	264	211	209	209	209
80	250	214	209	209	209
100	228	212	209	209	209
120	222	211	209	209	209
140	218	210	209	209	209
160	216	210	209	209	209
180	215	209	209	209	208
200	214	209	209	209	209

2.1.3. Ambient Light Sensors

I have made a simple mathematical model of the LEGO MINDSTORM ambient light sensors, as the robot will depend on continuous readings . From experiments I found that the following simple mathematical function is a close approximation:
[-255,255]

$$v_{temp} = v_{\max} - \frac{d_{light}}{10} - |a_{light}|$$

Where $v = \max(v_{\min}, v_{temp})$ is the value of the sensor, is a temporary variable,

v_{temp} is a function returning the greater number of a and b ,

$\max(a, b)$ is the maximum value of the sensor, $v_{\max}$ is the minimum value of the sensor,

$v_{\min}$ is the distance to the light source,

d_{light} is the angle to the light.

2.2. A Sound Sensor

2.2.1 A Sound Sensor

This was our first project, to test our knowledge of the electronics of the RCX and to get a feeling of how to put the components into a lego brick. For convenience we used standard components and no smd-components. We designed it straight forward and of course this leads almost exact to the design of Michael Gasperi. His design was also published (without reference) in a Dutch magazine, Elektuur july/august 2000, schematic 30. Of course this is not a clean electronic design, but more "getting maximum functionalty from a minimal number of components". We have tried to optimize the design (see schematic below), which resulted in the following differences with respect to the design of Michael Gasperi:

- we used an electret microphone, which is much smaller and has a higher sensitivity
- the power supply capacitor C3 is much smaller, even with 1uF the sensor works perfect
- we saved 1 diode, by combining the creation of the positive power supply and generating the output signal
- we amplified the signal extra with U1B (5*), one of the resistors R6 or R7 is mounted in way it can easily be changed
- we increased the value of R8, saving a lot of energy (minus 5 mA).

This sensor uses less than 1.5 mA of current, which can even be reduced by a factor 2 by using a TLC272 (CMOS opamp) instead of the LM358. The RC-time of C2/R5 seems to be optimal, we've tried other values but they performed worse. Increasing R8 from 1 kOhm to 10 kOhm gives a great reduction of power needs. This is quit simpel to understand, if you assume that most of the time there is no sound, then output 7 of U1 will be 0 Volt. The RCX drives its terminals 97% of the time (hard) to +8 Volt. So the power consumption of R8 will be roughly 8 Volt / R8, which in the case of 1 kOhm is 8 mA. There is a little drawback, the effective signal range is only 2.5V ... 5V, instead of 0.5 V ... 5V. Because the amplifier isn't linear at all, and even has a memory effect, the decreased range doesn't affect the performance of the cirquit. Combining the positive power supply and the signal generation, results in a power supply for the opamp which is 0.7 Volt less than normally.

This is no problem because the pumps will work correctly down to 3 Volt; it will even save some (very little) current. This is a circuit for a Sound Sensor. A crystal microphone provides the sound input to an amplifier, peak detector, and buffer that drives the RCX input. The RCX is configured to think it has a Light sensor on its input. When no sound is present the Light value is around 96, but when loud noises are present, the Light value will drop momentarily to a value proportional the sound. A loud clap near the microphone is usually read as a value below 75. Everything but the microphone is available from Radio Shack, but there is a way around that described below. This is a circuit for a Sound Sensor. A crystal microphone provides the sound input to an amplifier, peak detector, and buffer that drives the RCX input. The RCX is configured to think it has a Light sensor on its input. When no sound is present the Light value is around 96, but when loud noises are present, the Light value will drop momentarily to a value proportional the sound. A loud clap near the microphone is usually read as a value below 75. Everything but the microphone is available from Radio Shack, but there is a way around that described below.

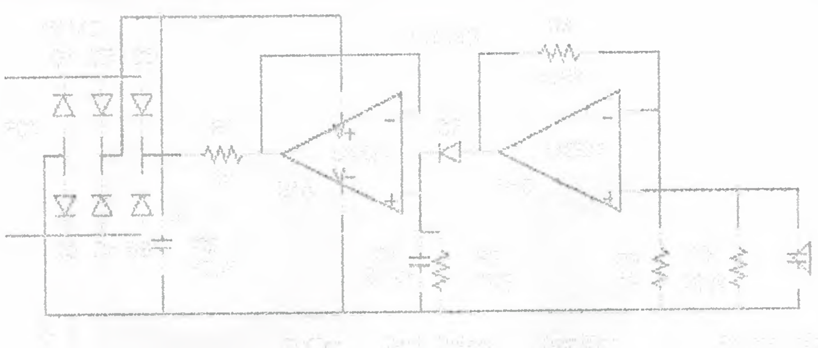

Figure 3

If you really want to build it right away, the earphone from a crystal (sometimes spelled Xtal) radio kit works almost as good as a microphone. Radio Shack sells a crystal radio kit for about $7. NOTE: This is NOT the same as the earphone that comes with pocket radios. The photo below shows a typical crystal earphone.

They are usually a color that, in less politically correct times, was called flesh. They also usually have a long ear tube that you might want to cut off.

Figure 4

Here are some photos of my finished Sound Sensor. It was made by cutting away all but the sides of two 2x4 blocks and hollowing out the insides of a third. The stack was glued together with liquid plastic cement. A bottom was made with a 2X4 plate but the sensor is shown without the bottom in the lower right. It also uses a new microphone I found in the mouser catalog (25LM025). It seems to be very sensitive and I was able to simplify the circuit design. The mice is held to the front of the stack with double face foam tape.

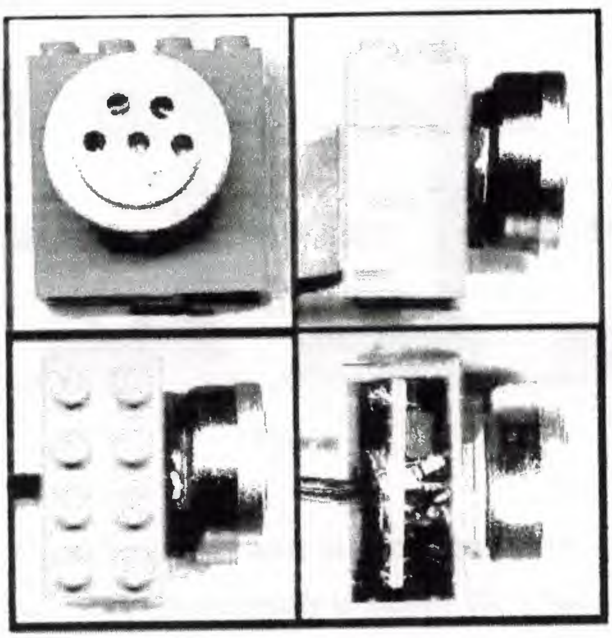

Figure 5

Here is a Clapper type controller example using only RCX code. The algorithm was taken from a Mind Storms member upload called "der Uber-Tank." His member name is OROBORUS and he used flashes of light not sound to control a vehicle.

Depending on how many times you clap within 2 seconds it does three different things. The RCX watches the Sound sensor (Light) and whenever the value drops below 91 it counts up. The exact threshold value will depend on how sensitive your circuit is. As soon at the counter hits 1 the other 4 stacks are started. The first will reset the counter in 2.1 seconds. The other three only wait 2 seconds and check the counter value for 2, 3 or 4. Two claps make the 2-Beep, three is the 3-Beep and four is the 4-Beep. A slightly more complex .PRG version is available for download Mobile robots will probably need to listen, move a while, stop and listen again. The motors make a lot of vibration that can be picked up and misinterpreted as clapping

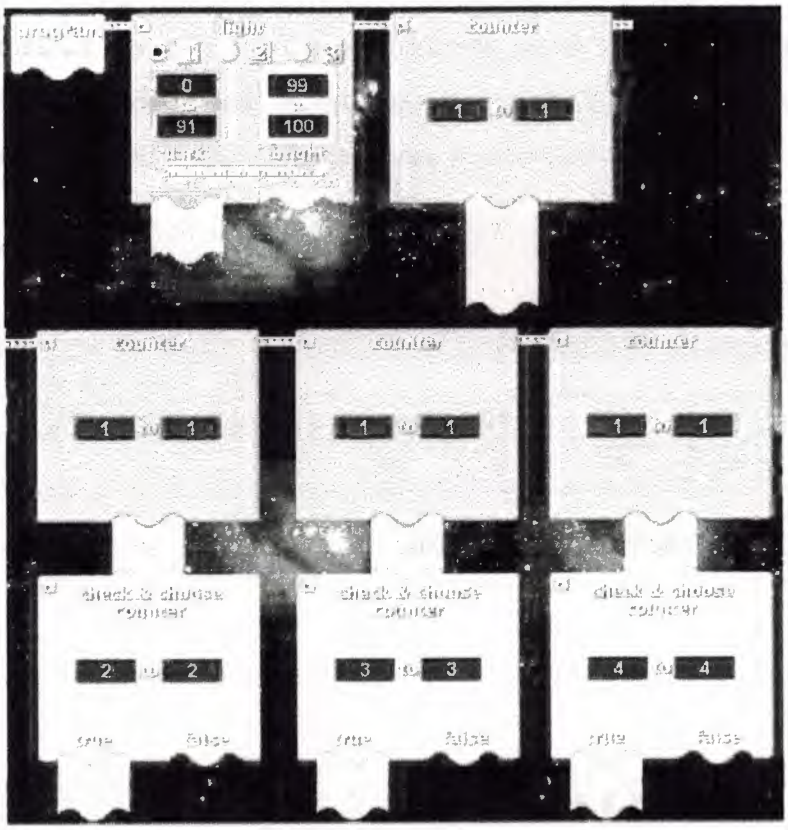

Figure 6

DrDAQs internal microphone can be used in two ways, firstly to display and record sound level (sound level meter) and secondly to display the actual sound waveform. The sound level channel works over the 55dB to 100dB range (approximately from quiet conversation to a loud motorcycle). The human ear does does not respond equally to all frequencies (it peaks at about 3kHz which corresponds to a baby crying).

To allow for this non linearity, sound level has been 'A-Law' weighted to approximately match the response of the human ear. Typical uses for this channel include:

1. monitoring ambient noise levels in the class room (do they increase when the teacher is absent?)
2. monitoring traffic noise
3. showing how sound level decays with distance
4. recording the 'dawn chorus'

Unlike many data loggers, DrDAQ can take readings very quickly (up to 15,000 per second). This means that it is capable of displaying sound waveforms both in the time domain (oscilloscope view) and in the frequency domain (audio spectrum analyzer view). The waveform below shows the response to someone whistling at 1kHz.

2.2.2.SampleWaveform

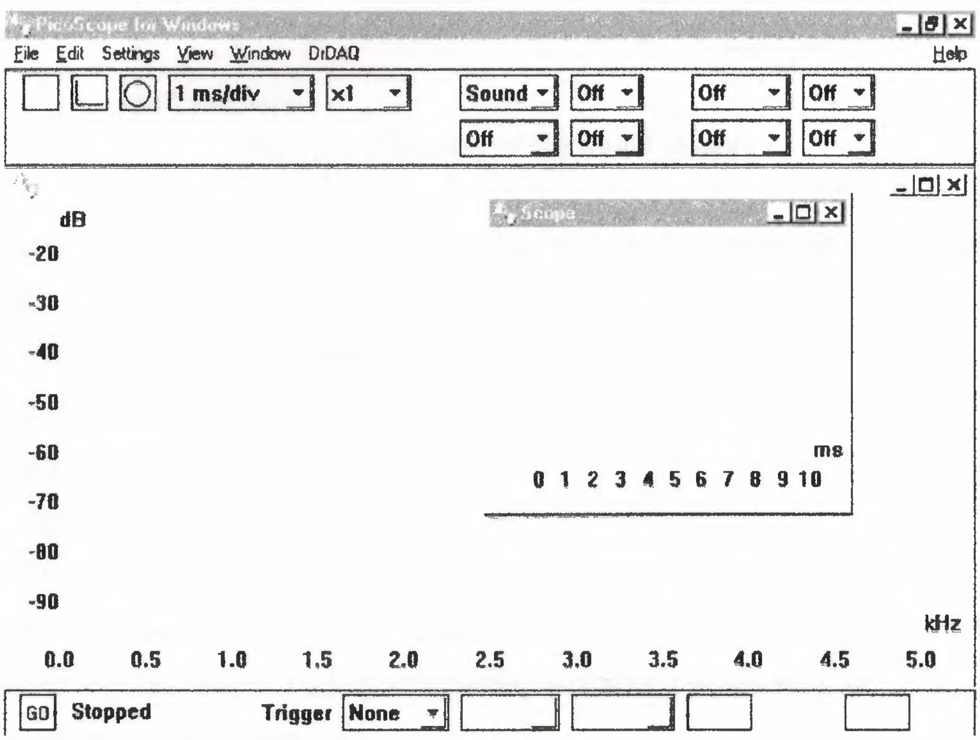

Figure 7

2.2.3. Short description

The sound sensor is a microphone with an internal amplifier. The sensor measures variations in pressure (of the air).Because of the high sensitivity, the sensor is very much suited to detect pressure pulses. This offers one to measure the speed of sound from a bouncing ball. Within a certain range, the sensor can also be used for dB-measurements. One can do this in one of the following ways:

1. to determine the average amplitude (rms) and to calculate the decibelvalue;
2. to measure the output of the sensor via a rectifying circuit and to calibrate the readings in decibel.

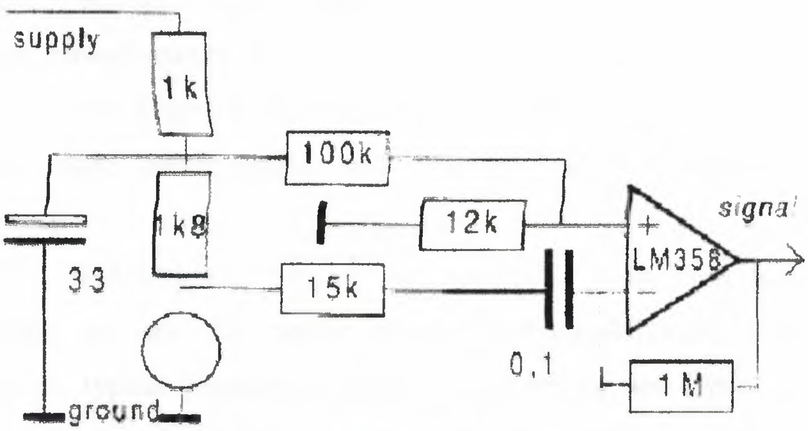

Figure 1: Circuitry of the sound sensor

The sound sensor is delivered with a BT-plug and can be connected to the following interfaces:

1. UIA/UIB through Measuring Console (via 0520 adapter)
2. CoachLab
3. CoachLab II
4. *SMI (via 0520 adapter)*
5. Texas Instruments CBL™ data-logger.

There is an adapter (art. 0520) to connect sensors with BT-plugs to 4-mm inputs. Suggestion for experiments Variety of activities with sound waves such as:

- Demonstration of wave patterns.
- Measurements of frequency and amplitude of sound (also for a tuning fork).
- Comparison of the waveforms of different instruments.
- Beat patterns.
- Measure the speed of sound.

2.2.4.Calibration

The sound pressure in mPa has been calculated from the measurement in decibel (dB-A) by means of a calibrated decibel-meter. The source of sound is a noise generator (white noise) in combination with band-pass filter (1000 Hz). The calculation can also be done via a multimeter, which measures the effective equivalent of the dc-voltage.

2.2.5. Sound Level Meters and Noise Dosimeters

Sound level meters and noise dosimeters are used in many kinds of sound and noise analysis including industrial safety, traffic and transportation noise quantification, and scientific noise measurement. They are frequently hand-held and battery-powered. Sound level meters measure real-time sound and can have functions such as signal analysis, noise dose measurement, and different time and frequency weighting. Sound level meters are used for measuring Sound Pressure Level (SPL) and different weightings such as A-weighted SPL, C-weighted SPL, Sound Exposure Level, etc. Noise dosimeters are used for specific measurement capability for defined industrial safety criteria. A typical measure is sound exposure for an 8-hour period. These instruments can be found either individually or as one unit that covers capabilities of both products. Two critical specifications for sound level meters and noise dosimeters are frequency range and sound level range. Frequency Range is the range of frequencies for which the meter maintains a constant sensitivity within defined boundaries. Functionally, this is the operational range of the meter. Sound level range is limited on the low end by the inherent noise of the acoustic system and on the high end by the maximum soundpressure level. Many sound level measurement modes are available for these devices. Flat or unweighted SPL measures the straight physical quantity with no weighting. A-weighting is a frequency domain weighting based on human hearing response. This filters out low frequency sound to approximate the response of the human ear. C-weighting filters less low frequency sound than A-weighting, providing a closer representation of acoustic energy across all frequencies. A-weighted sound exposure level measurement is used for short or one-time sounds as the equivalent 1-second level. Equivalent continuous SPL is the noise level of a continuous steady sound whose time-averaged power equals that of the fluctuating noise under measurement.

Percentile SPL measures the percentage of time during a given measurement period that the instantaneous measurement exceeds a given value.

Some typical features for sound level meters and noise dosimeters include ratings for outdoor use and auxiliary outputs for measurement with other instruments. These devices can also have human and hand-arm vibration measurement for industrial, environmental or occupational vibration such as power tools, nearby trains, etc.data storage and spectrum or frequency analysis are also available. Control panel options include analog, digital front panel or computer control. Typical machine interfaces are parallel and serial, although other possibilities, such as RF transmission, may be available. Displays on these instruments can be local analog or digital readouts or else can be read through a host computer or video display terminal.

2.3 SMOKE SENSORS

2.3.1 SMOKE SENSORS

Smoke sensors include spot-type smoke detectors, projected-beam detectors, and air sampling type detectors. Effective placement for these smoke sensors requires consideration of the type of smoke to be detected and the effects ambient conditions, such as air velocity, ceiling height, ceiling construction, room temperature, and humidity, have on fire-plume development, smoke spread and ceiling jet flow (i.e., fire dynamics). Smoke sensors should be spaced in accordance with the manufacturer's recommendations and NFPA 72 requirements, with the design goal, such as early warning, in mind. Non-smooth ceiling applications differ from smooth ceiling applications because the non-smooth ceiling limits the horizontal travel path of smoke and increases the transport time for smoke to reach the smoke sensor. Examples of non-smooth ceilings include solid-joist construction, beam construction, sloped ceilings, peaked ceilings, and shed type ceilings. The most common no smooth ceilings are beam construction and solid joist construction. Beam construction is defined by NFPA 72 as construction with solid structural or nonstructural members projecting more than 4 in. down from the ceiling surface that are spaced more than 3 ft on center. Solid-joist construction is defined as construction with solid structural or nonstructural members projecting more than 4 in. down from the ceiling surface that are spaced 3 ft or less on center. The critical number to remember for smoke sensor placement requirements in beam construction is 12. If the beam depth exceeds 12 in. or if the beam ceiling height is greater than 12 ft, a spot-type smoke sensor should be placed in each beam pocket. Additionally, the spot type smoke sensors may be placed on either the ceiling or the bottom of the beams for beams over 12 in. in depth. Spot-type smoke sensors should be placed on the bottom of the joists for solid-joist construction. Projected beam smoke detectors can be used on no smooth Ceilings as long as no obstruction hinders the light beam reaching the projected beam receiver.

2.3.2. DUCT SMOKE SENSORS

Smoke sensors are installed in ducted HVAC systems to limit the spread of smoke through a duct system and detect filter or system motor fires. The mechanical codes and NFPA 90A prescribe where and when duct smoke detectors are required. These codes typically require duct smoke detectors on any supply-air fan greater than 2,000 cfm and on return-air fans greater than 15,000 cfm; however, some variation in requirements does exist between the various standards. Duct smoke detectors should be listed for use in air velocities, temperatures, and humidity ranges expected in the ductwork during the air-handling system operation. The Heat sensors include spot-type fixed temperature heat detectors, spot-type rate-of-rise heat detectors, rate-compensated heat detectors, spot-type combination rate-of-rise or rate compensated and fixed temperature heat detectors, linear heat detectors, and pneumatic rate-of-rise tubing. Like smoke sensors, effective placement of heat sensors must consider the effects that ceiling height, ceiling construction and HVAC systems have on fire plume development and ceiling jet flow. They should also be spaced in accordance with the manufacturer's recommendations and NFPA 72 requirements with the design duct smoke detectors must be installed in such a way as to obtain a representative sample across the entire width of the duct air stream. Some duct smoke detector installations involve rigidly mounting the duct smoke detector on the inside wall of the duct with or without a sensing element protruding across the duct width, or, more commonly, on the outside of the duct with rigidly mounted sampling tubes traversing the duct. The sampling tubes should be installed so that the inlet holes in the sampling tube face upstream toward the airflow, while the return tube should be oriented downstream of airflow. It projects more than 18 in. below the ceiling and are more than 8 ft on center, each bay formed by the beams should be

treated as a separate area for heat-detector spacing. This means that one or more spot-type heat detectors would be required in each bay.
Spot-type heat detectors should be mounted on the bottom of the joists in solid-joist construction. Flame sensors include ultraviolet (UV) detectors, infrared (IR) detectors, and combination UV/IR detectors. Their application is usually for specific areas or hazards that require early warning of fires at the insipient is common to find the sampling tube installed backward. To be effective and obtain a representative air sample, duct smoke detectors should be located to avoid dead air space or turbulent airflows. This can be accomplished by placing duct smoke detectors between six and 10 duct-equivalent diameters from inlets, bend, or sharp turns. Too often, duct detectors are installed incorrectly, making them ineffective and unreliable (Photo A). Also, duct detectors must be accessible for maintenance purposes. This requires access doors or panels be provided in the ductwork.

2.3.3 Fire and Smoke Dampers

Fire and smoke dampers are installed to protect openings in fire- or smoke-rated assemblies, as well as to segregate fire and smoke zones. A fire damper is a mechanical device used to resist the passage of flame or interrupt migratory airflow and consists of a heat-actuated fusible link that will close a fire rated shutter when actuated. A smoke damper is an electro-mechanical device used to resist the passage of air or smoke and consists of operable vanes that open and close upon a programmed electrical signal. A fire/smoke damper combines the features of a fire damper with a smoke damper and consists of fire-rated operable vanes that will close upon either a programmed electrical signal or actuation of a fusible link. The locations and sequencing of fire and smoke dampers are prescribed by building codes, mechanical codes and NFPA 90A, 92A, and 92B. The selection, placement and installation of fire and smoke dampers must be closely coordinated with the mechanical, electrical, fire alarm and controls contractors to assure proper operation. The same dampers used for smoke control may be allowed to serve as air supply control dampers; however, the operation of their life-safety function should not be overridden for building management air conditioning functions. Smoke dampers require power to operate and should be installed in close proximity to a power circuit. Additionally, because smoke dampers are a life safety device used to control the spread of smoke, they must be connected to an emergency power circuit.

Sequencing of dampers is critical to life-safety operations and should be reviewed prior to and during AHJ acceptance testing to ensure system integrity.

2.3.4 Smoke Eater

Smoke Eater is an autonomous robot that randomly searches for fires and the extinguishes them once they are found. Smoke Eater is equipped with a UV detector, IR detectors, bump switches, CdS cells, and a water pump to accomplish his goal. To implement Smoke Eater's flame etection heavier, I used an ultra- violet detector. This allows Smoke Eater to detect a wavelength of light that is only characteristic of fires. The UV detector has a 40range of detection. It can detect flames up to ten feet. Once it has detected a flame it stops and sprays the fire with water provided by the water pump. Smoke Eater must roam through a building with unknown obstacles, which he must avoid. IR detectors and IR emitters implement his obstacle avoidance. The IR detectors read the signal sent out by the emitters if there is an object in front of the sensors. The stronger the signal the closer the object is. Once there is an object detected Smoke Eater Turns away in a direction that is free of obstacles. There are also bump switches circling Smoke Eater. These are in case the IR sensors fail. This may seem redundant but a good system has redundancy built into it. Just like the IR sensors when an object is detected then Smoke Eater turns in a direction, which is clear of objects. By integrating all these sensors with The Motorola 68HC11 I was able to build an autonomous robot that would roam a building, search for fires and extinguish them. Smoke Eater is designed to use Motorola's 68HC11 microprocessor on a MTJPRO11 board designed by Macaronis. Included in my robot are four IR emitters and five detectors for proximity detection and avoidance, ten bump switches for collision avoidance, a UV Tron made by Hamamatsu for flame detection and a DC water pump and reservoir to extinguish the fire. It will also have two CdS photo resistor cells to detect for a white ring on the ground known as "Home Base" in the fire-fighting robot contest. Smoke Eater will be driven by two hacked Futaba servos. There will also be another servo to move the nozzle of the extinguisher up and down the fire to eliminate any inaccuracy in the extinguisher.

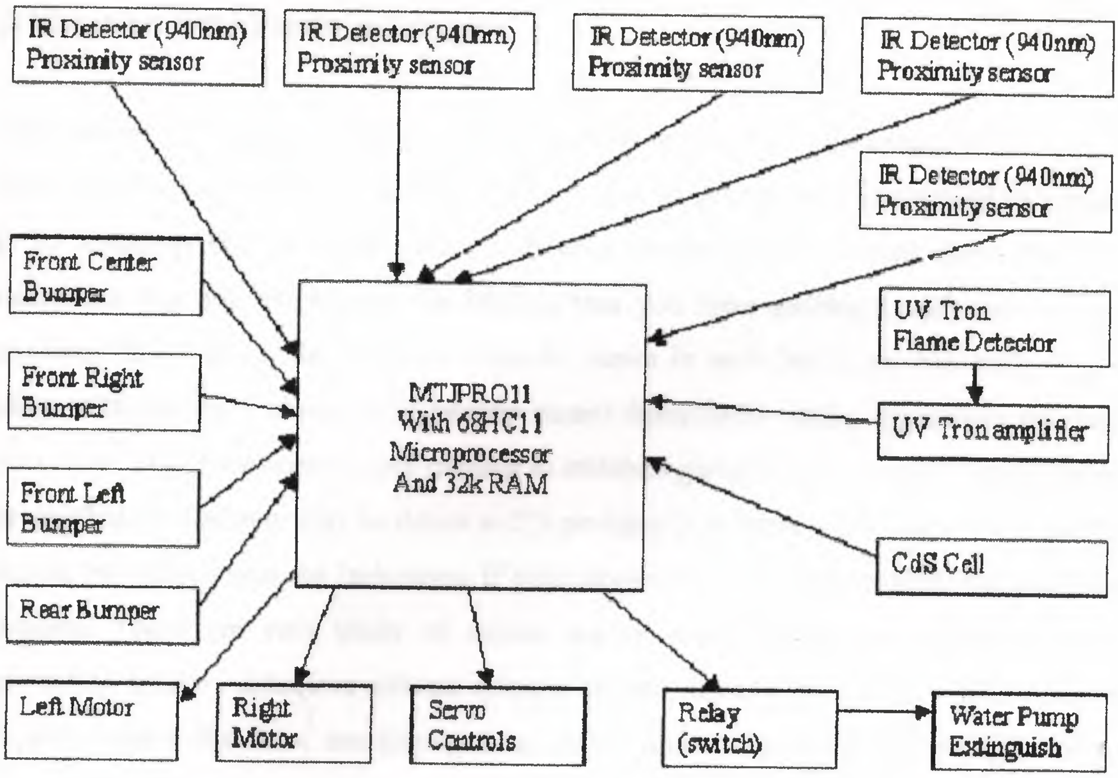

Figure 8

The robot uses all eight pins from the analog port. It also uses four pins from the input Port A.

2.3.5 Smoke and Carbon Monoxide (CO) Alarms for Manufactured Homes

2.3.5.1 Home Dangers

Every year nearly 4,000 Americans d i.e. in home fires and more than 25,000 are injured. Children and the elderly are especially at risk in home fires because they are less able to escape when fire strikes. There are a few hundred CO fatalities annually, and many more persons suffer flu-like symptoms from CO exposure. You can improve the chances that your family will survive a home fire or CO leak by installing smoke and CO alarm s and knowing what to do if they sound.

2.3.5.2 Alert Your Family to Danger

The primary fire safety strategy for any home is to warn the occupants early and get everyone out as quickly as possible. The best way to get the earliest warning of danger is by installing enough smoke alarms. Homes should have a smoke alarm near the bedrooms, but not so close to the kitchen that you have problems with alarms from cooking. It's a good idea to have a smoke alarm in each bedroom, especially if you sleep with the door closed. CO usually comes from faulty eating appliances but may also come from fireplaces or cars running in attached garages. CO cannot be seen, tasted or smelled, so the only way to detect a CO problem is to have a CO alarm. CO alarms should be located near the bedrooms. If your smoke or CO alarms sounds, get everyone outside. There are two kinds of smoke alarms ionization and photoelectric. The ionization smoke detectors activate quicker for fast, flaming fires and the photoelectric type is quicker for slow, smoldering fires. Either one will provide you enough time to get out, but having a mix of the two types is a good idea. Models with both sensors are better than single sensor units, but of course they cost more. Smoke alarms are powered either by household current (ac), a battery, or ac with a battery that keeps it operating during power outages. The battery type is easy to install in existing homes but the battery m must be Chan geed annually. Building codes for new homes require ac powered alarms with battery backup. For greater safety, older ac only smoke alarms should be replaced with ac/battery alarm, and new codes requires any smoke alarm older than 10 years to be replaced. Many local building codes now require CO alarms when a home e uses gas or oil, or has a fireplace. CO alarms are also powered either by household current (ac), a battery, or ac with a battery. Most CO comes from equipment that will not be working during a power out tags so plug-in units are good. But if you might heat your home with a fireplace, wood stove, or kerosene heater when the power is out, you may want to use a battery-powered alarm. The sensor element in some CO alarms must be replaced regularly. Consider the cost of the replacement element in making your selection.

2.3.6 Smoke Effectiveness Modeling and Analysis (SEMA)

Under this effort OptiMetrics is building upon the model development program initiated jointly by the Edgewood Research, Development and Engineering Center (ERDEC) and the Joint Project Office for Smoke Obscurants and Special Technology Countermeasures (JPO-SOSTC) and executed to a large extent by OptiMetrics, Inc. over the preceding four years. This recently-executed model development program was oriented on improving the physical realism of existing aerosol transport and diffusion models and then integrating these models with other existing software packages that are designed to simulate the performance of various military sensors. The resulting enhanced models could then be used to evaluate the effects of obscurants on sensors in simulation with confidence that the results are representative of the actual event being simulated. This Smoke Effects Modeling Applications (SEMA) program is designed to capitalize on the model development and improvement efforts of the previous years, thereby minimizing the effort spent on new algorithm development, and allowing us to concentrate on demonstrating the utility of these high fidelity computer simulations in support of doctrine and materiel development. The technical objective of the program is to upgrade, validate and apply predictive models for quantification of smoke and obscurants effectiveness that have been previously developed under ERDEC sponsorship. These enhanced models will provide the government with analytical tools useful in the development of design specifications for obscurants. Additionally, these tools will allow the ERDEC to participate with other materiel developers in defining performance requirements for EO sensors through the realistic modeling of obscurant behavior and characteristics in war games and engagement models exercised by the appropriate Battle Labs. To ensure the effective applications of computer models and simulations to the development of obscurant materials and systems, OptiMetrics is conducting a study to identify the role of M&S in the development cycle. The study will result in a suggested process for identifying the requirement for modeling, selecting tools appropriate to the task at hand and a methodology for quantifying the value-added contribution in terms that are meaningful to the intended user.

CHAPTER THREE

ALARM SYSTEMS

3.1 Sound Alarm Systems

Sounds evoke certain reactions. Some sounds can be hard to localize. Knowledge of the properties of sounds enables us to design effective alarm systems, for example. A square-ended waveform (i.e. sudden-onset) will evoke a startle reaction, and if the sound is at high volume, the effect can cause quite severe panic. Bell-based alarm clocks are a good example - people often train themselves to wake up just before the alarm in order to turn it off! The startle reaction is automatic, even if you know it is going to happen, you are still startled. Sounds such as from klaxons and bells tends to be square-wave sounds. They also tend to be hard to localize and can be hard to discriminate one from another, especially when occurring at the same time. A typical reaction to such alarms is panic, a concern with stopping the high noise, and not processing the emergency. The aircraft in the Keg worth crash had poor alarms. In a number of disasters in environments with high false alarm rates you discover partially disabled alarms because of the unpleasantness of the noise. ALARMS should not be unpleasant. For example, the desired reaction from a fire alarm is an orderly exit via the nearest door, not a panic rush for the door you came in by. This is the behavior observed by investigators following fire tragedies - people have a strong instinct to go out the way they came in when panicked. If alarms are to evoke the "right" responses then they need to be carefully designed. No square-end waves - it turns out that the curve can be very steep and still evoke no startle reaction; distinctive but not very high intensity sounds. High intensity causes panic - it does not denote urgency. Urgency can be conveyed by the speed of an alarm - a tri-one alarm which doubles its speed will suddenly sound very urgent. Principles to derive from this:

- High distinctiveness
- Steep, but not square wave shape
- Urgency conveyed first by speed, and later by intensity.

These principles have been applied in hospital intensive care wards and in helicopters, and soon will be in many aeroplanes. They have been an enormous success - yet the work is not widely known.

3.1.1 Sound Alarm System and Detection

Dispute between empiricists and nativity-focused attention on the role of the senses. Empiricists: all knowledge comes from experience through the senses and is linked or associated through co-occurrence Nativity: information is received from the senses and organized according to innate principles (e.g. the a priori categories of Kant) Natural question: what is the chain of events that leads from a stimulus to report of a sensation? There are several basic steps:

The Proximal Stimulus is

- Transuded, whereby the physical stimulus is converted to a neural message,
- Transmitted, and
- Modified to produce

A Psychological Response (conscious sensation) We can study this sequence in several ways, including: Psychophysics - relate physical stimuli to psychological sensory experiences. Psychophysiology - relate physical stimulus to physiological response (e.g. neural response) Let's look at psychophysics for the moment. Variety of stimuli to which we are sensitive:

- Smell and taste molecules in air and saliva
- Feel temperature changes on skin
- Hear sound pressure waves
- See electromagnetic waves
- Feel pressure on skin
- Sense acceleration of one's head (vestibular system)

There are limitations:

- A sensory system will not respond unless stimulus energy above some critical intensity level called the absolute threshold.
- The range of stimuli is limited: visible spectrum, audible frequencies, etc. Within these limitations one can try to measure sensory intensity. The physical intensity of a stimulus related to its psychological intensity, Physical intensities are, in principle, straightforward to measure. E.G., Physical intensity of a light using a light

meter, Temperature using a thermometer, etc. Measuring psychological intensities, well, that's a different matter. Gustav Fetcher (19th cent.) founder of psychophysics held that one couldn't measure psychological sensations directly.

Psychological intensities belong in a realm different from that in which physical intensities are measured One CANNOT use a light meter to report how bright a person thinks a light is; One CANNOT use a thermometer to report how hot a person thinks a cup of tea is. While we cannot directly compare physical and psychological intensities, we CAN ask a subject to compare two or more sensations (e.g., this light is brighter than that light). One can ask, furthermore, what is the smallest amount that two lights can differ in physical intensity and still differ detectably in brightness, when we start probing how well we detect differences between stimuli this way we are measuring what is called a difference threshold. These come in two flavors: increment threshold (how much of an increase in intensity is required for the difference to be detectable) and decrement threshold (how much of a decrease in intensity is required for the difference to be detectable). Now the amount by which a light must be increased in intensity for the increase to be detectable, namely the increment, is also called a jnd or just noticeable difference. The jnd is expressed in terms of physical units of intensity. Fetcher wanted to find a general law relating stimulus physical intensity to psychological sensory magnitude. He derived such a law from a result found by Weber (another 19th century German physiologist). Weber's Law: the size of the difference threshold (increment or decrement) is a constant ratio of the standard reference stimulus E.g. Standard light of 100 cd/m one jnd away from light of 108 cd/m: 100 ~ 108. If the ratio is constant, then that means 200 ~ 216, 400. ~ 432, etc. Likewise 8/100 = 16/200 = 32/400 and generalization gives

c = delta I / I .

Delta I is the change in intensity I, the fraction delta I / I is called the Weber fraction and c is a constant number. A lot of research in all the sensory modalities shows that Weber's Law holds VERY roughly in normal ranges of stimulus intensity, Weber fraction for :

- Vision (white light brightness) .08
- Audition (noise loudness) .05
- Kinesthesia (lifted weights) .02

The smaller the Weber fraction, the more sensitive one is to differences between stimuli in that modality; the larger the Weber fraction the less sensitive.

OKAY: that is Weber's Law. Fetcher use it to get a general law,

Fetcher's Law: S = k log I

S = subjective magnitude
k = a constant number appropriate for the modality (like the Weber fraction)
I = physical intensity

One way to think about the logarithm is in terms of compressing large physical intensity ranges (e.g., billion fold range for light intensities) into smaller psycho physiological response ranges (e.g., 30-fold response range for neurons). Fetcher's Law related to Weber's Law Weber: Ratio between physical intensities is constant for a jnd. Difference between psychological intensities (or subjective magnitudes) is constant - some threshold difference. OK. Call the subjective magnitudes S1 and S2. Then S2 - S1 = t, some threshold difference, Call the physical intensities I1 and I2. Then I2 / I1 = constant. Physically, we have a constant ratio. Psychologically, we want a constant difference. How do we turn a ratio into a difference? Take logarithms log (a/b) = log a - log b Those of you who know calculus will remember a relevant formula that converts Weber's Law into Fetcher's Law. If you have not taken calculus yet.

3.1.2 Signal Detection Theory

Signal detection theory has three components. It takes into account sensory mechanisms and decision-making mechanisms and assumes that the value received by decision-making mechanisms from sensory mechanisms is noisy. Noise: uncontrollable variability in the sensory impression sent to the decision maker.

There are two varieties:

- Extrinsic noise - in an experiment on audition, rumbles from the ventilation system, footsteps down the hall, etc., are sources of external or extrinsic noise.
- Intrinsic noise - in an experiment on vision, there are internal sources of noise like variability in neural response and variability in observer attention.
- Total noise=extrinsic intrinsic

In the following exposition of signal detection theory, please keep in mind the following detection task. On 50% of trials, chosen randomly, no stimulus is presented (noise alone). On the other 50% of the trials, the stimulus is presented (signal + noise). The observer's task is to state whether or not the stimulus (signal) was presented. In an actual experiment, the signal might be a very faint beep presented over some headphones or a very faint pattern presented on a color television display.

3.1.2.1 Noise-Alone and Signal Noise Distributions

The following figure at the top uses a frequency histogram to show the sensory impressions that would arise from such a detection task in the absence of noise. On trials where the signal is absent, a small sensory impression results (the vertical bar at left), while on trials for which the signal was present, a larger sensory impression results (the vertical bar at right). The distance d represents the strength of the signal.

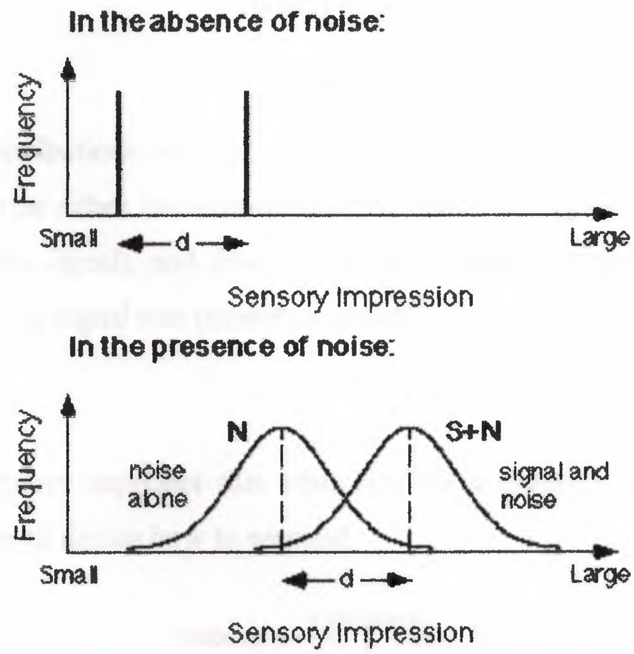

Figure 1

At the bottom of the figure is shown the situation when noise is present. For trials where the signal is absent, there is noise alone, and its fluctuating value from trial to trial gives rise to a spread of sensory impression values (the most frequent value being the one marked by the dashed vertical line on the left).

The bell curve or *normal distribution* marked N is used to indicate how frequent each particular sensory impression is on noise-alone trials. For trials where the signal is present, the fluctuating noise adds to the signal to provide a range of sensory impression values described by the normal distribution marked S+N on the right. The distance d between the means (average values) of the normal distributions continues to represent signal strength. Result of noise: sensory impressions of stimuli are represented by distributions, namely the noise-alone and signal noise distributions. The two distributions often overlap.

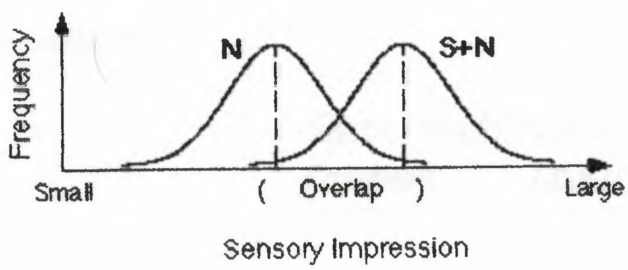

Figure 2

When the two distributions overlap, there are sensory impressions (in the overlap region) that can arise either on noise-alone trials (loud noise) or on signal noise trials (soft noise, with the signal), and from the sensory impression value alone one cannot determine whether the signal was present or absent.

3.1.2.2 Criterion

Signal detection theory supposes that observers set a criterion on the continuum of sensory impressions to decide how to respond.

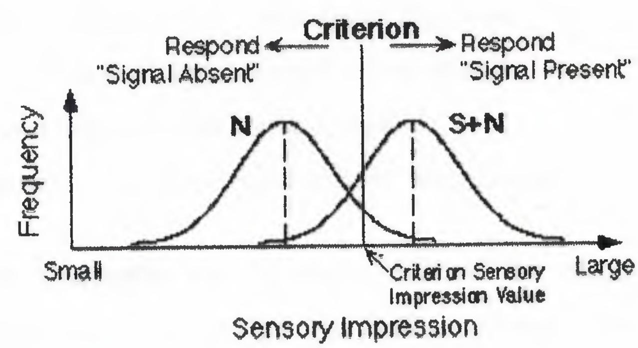

Figure 3

For instance,

- If sensory impression value exceeds criterion level, then respond "yes the signal is present"
- If sensory impression value is less than the criterion level, then respond "no, the signal is absent"

This response strategy can lead to errors. To understand fully what can happen in the simple experiment, consider that there are two possible kinds of trial (signal absent, signal present) and two possible responses ("absent", "present"). These possibilities give rise to four response categories:

		Observer Responds	
		Present	Absent
Signal Was	Present	HIT	MISS
	Absent	FALSE ALARM	CORRECT REJECTION

Figure 4

In words, Response categories:

- Hit - respond "signal present" when signal is present
- False Alarm - respond "signal present" when absent
- Miss - respond "signal absent" when present
- Correct rejection - respond "signal absent" when absent

To determine how frequently one observes each of the response categories in a particular experiment, one works with the distributions of sensory impressions.

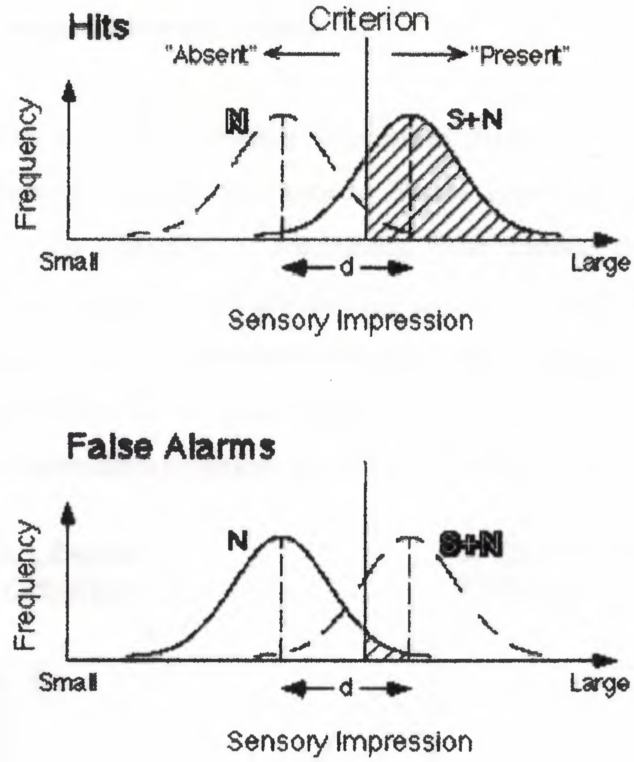

Figure 5

Look at the top of the figure above ("Hits"). Hits arise when the signal is present, so attend only to the S+N distribution. Having chosen a criterion, one can find the frequency of hits by finding the area under the S+N curve to the right of the criterion. We integrate to the right of the criterion because it is with sensory impressions greater than the criterion (to the right) that the observer responds "present". The signal is present and the observer responds "present" for a hit. Look now at the bottom of the figure ("False Alarms"). False alarms rise when the signal is absent, so attend only to the N distribution. The frequency of false alarms is given by the area under the N curve to the right of the criterion. We integrate to the right of the criterion because these sensory impressions lead to "present" responses. Recall that the signal is absent and the observer responds, "present" for a false alarm.

3.1.2.3 Conservative and Liberal Criteria

An observer chooses a criterion sensory impression from a spectrum of criteria that ranges from conservative through moderate to liberal. A conservative criterion is one that corresponds to the objective of minimizing false alarms: one responds "signal present" only if one is *completely* certain that the signal is present, so that there are no false alarm responses. Such a conservative criterion level corresponds to a large sensory impression value, as shown in the graph below. Only large sensory impression values will exceed such a conservative criterion, leading to a "signal present" response.

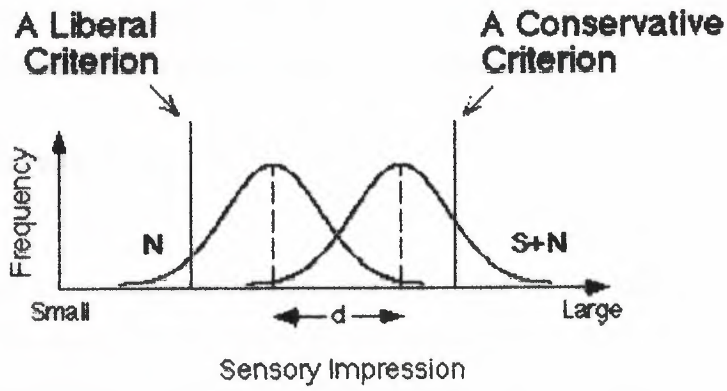

Figure 6

A liberal criterion is one that corresponds to the objective of maximizing hits: one responds "signal present" on the slightest evidence. Such a liberal criterion corresponds to a small sensory impression value, as shown in the graph. All sensory impressions that may arise in a trial in which the signal is present exceed the criterion, so that the hit rate may reach 100%. A negative consequence of a conservative criterion, which minimizes false alarms, is that the hit rate is low. With a conservative criterion, there are trials on which the signal is presented that produce sensory impressions that do not exceed the conservative criterion, and these will be missed. A negative consequence of a liberal criterion, which maximizes hits, is that the false alarm rate is also high. With a liberal criterion, there are trials on which the signal is absent that produce sensory impressions that exceed the liberal criterion, and these produce false alarms.

3.1.3 Measuring Sounds

The decibel scale. The decibel scale for sound intensity is a relative logarithmic scale where 10 decibels = 1 log unit ratio of energy. If the threshold of hearing is 0 dB then a whisper registers 20 dB and normal conversation registers between 50 dB and 70 dB. Ear damage is likely to occur if the sound exceeds 140 dB. The ear is insensitive to frequency changes below about 20 dB (i.e. below a whisper). The sensitivity to both frequency and loudness varies from person to person. The intensities of various commons sound are plotted on the scale below. The energy in much rock music is thus 100 trillion times threshold (or more than 100,000 times the intensity at which permanent hearing loss begins to be produced by long-term exposure). This level, indicated by the dashed line, is often surpasses by industrial jobs.

3.2. Smoke Alarms

A smoke alarm is a warning device that detects smoke at the earliest stages of a fire Smoke alarms are cheap at less than £5 and available in DIY stores and at many supermarkets. Buy a smoke alarm with a 'hush button', then you can stop it if it goes off by mistake. Always make sure they are fitted in accordance with the instructions provided. The more alarms you have around your home the safer you, and your family, will be. Very useful for those nuisance alarms, which we all get when we are cooking sausages etc. By pressing this button the alarm will be silenced for about 8 minutes allowing you to continue cooking uninterrupted. During this time the alarm will still be working just in case a real fire breaks out!

3.2.1. Smoke Detectors and Alarms

Smoke alarm technology detects smoke from a fire and sounds an alarm. Several types of smoke alarm technologies are available. Smoke alarm systems designed for hearing people to use in the home are small units that give off a loud, high-pitched alarm. Smoke alarms designed for deaf people are quite different. They have several separate parts and use vibrating pads and flashing strobe lights to let you know that smoke has been detected.

A typical smoke alarms system for deaf people has the following parts:

- A smoke detector with an alarm which makes a high pitched noise when it detects smoke.
- A control box.
- A vibrating pad to place under your mattress or pillow.
- A strobe light that flashes when the detector senses smoke (this if often built into the control box).
- Wires for connecting these parts together.

Some of the cheaper systems are battery only but most systems are powered by the mains and have a battery back up in case the mains fails.

You can add extra strobe lights and smoke detectors to some systems. This means they can cover a wider area in your home and give you greater protection from fire.

3.2.1.1 Different Types Of Smoke Detector

You can get two different types of smoke detector. Ideally, you should install the correct type for different parts of your home, but any smoke detector is far better than none at all.

- Ionization detectors. These respond to a wide range of fires and are for general use. They are particularly responsive to fires that spread quickly. Cooking fumes or steam can give false alarms so you should not fit them near kitchens or bathrooms.
- Optical detectors. These also respond to a wide range of fires, but particularly to slow smoldering fires and dense smoke given off by foam-filled furniture and bedding. They can occasionally give false alarms, particularly if dust and insects get into them.

3.2.1.2 Fitting The Smoke Detectors

It is important to install the smoke detector part of the system in the correct place in your home. This will mean you get the earliest possible warning if there is a fire. The detector should usually be fitted at least 30 centimeters (12 inches) away from any wall or light fitting and as close to the center of the room, hallway or landing ceiling as possible. The number of smoke detectors you fit depends on your home. Fires can start anywhere, so the more alarms you have the safer you will be.

For minimum protection do the following:

- If your home is on one floor, fit the detector in the hallway between the living and sleeping areas.
- If your home has more than one floor fit one detector at the bottom of the staircase and further alarms on each staircase or landing.
- Do not fit a smoke detector in the kitchen or bathroom, as cooking fumes or steam may trigger the alarm. Similarly, do not fit a detector in a garage where exhaust fumes are likely to set it off.
- Do not fit a detector on a shelf or in a drawer. Smoke arises straight towards the ceiling and will set off the alarm more quickly if the detector is fitted on the ceiling.

If you are a smoker, cigarette smoke will not normally set off a detector, but cigarettes do cause fires. Fires set of smoke detectors. Think safe and be safe. You need a smoke alarm.

3.2.1.3 Fitting The Control Box

The control box should normally be positioned close to the bed and can be fixed to a wall or placed on a flat surface, such as a bedside table. It is usually linked by wire to the smoke detector(s). You can also get some smoke alarm systems that connect by radio link.

3.2.2. Installing A Smoke Alarm System

If you are good at DIY and wiring you can easily install most smoke alarm systems yourself if you carefully follow the manufacturer's instructions. Research has shown that vibration is the most reliable way to wake a deaf person from a deep sleep. You should use a vibrating pad under your mattress or pillow while you sleep. If your smoke alarm system also has a strobe light it will flash when the alarm goes off. This is an added help to waking you at night. During daytime, it might be the only way of letting you know there is a fire, unless you use a system that uses pagers. if your smoke alarm system only has one strobe light and you fit it in the bedroom you may not know it is flashing when you are in other parts of the house during the day or evening.

3.2.2.1 Linking To A Smoke Alarm System Designed For Hearing People

Since 1992 all new homes should be fitted with mains powered smoke alarms for hearing people on each level of the home. If your home already has an alarm of this type, you may be able to connect a smoke alarm system for deaf people to it. Check with the manufacturer or supplier before you do this and you may need to get an electrician to do the work. If you already have a battery powered smoke alarm for hearing people in your home, leave it in place and set up your new system separately. Many smoke alarm systems for deaf people have 'fail-safe' monitoring circuits - this means that if a fault develops in the wiring that connects the different parts of the system, you will receive a visual warning. As a further safety measure, you will also be warned if the vibrating pad is unplugged from the control box.

3.2.2.2 Testing Your Smoke Alarm System

The smoke detector and control box are usually fitted with test buttons. These allow you to check that the system is working. You should do this regularly - as often as the manufacturer recommends. The test button on the smoke detector lets you check the whole system. You usually need two people to carry out the tests - one to press the test button and the other to check that the vibrating pad and any strobe lights are working. The button on the control box only tests the flashing strobe light and vibrating pad. Smoke alarms for deaf people cost from about £50 for a battery-operated system that gives basic protection. A mains-operated system with battery back-up and fail-safe monitoring may cost up to £150. You should allow extra if you need to pay an electrician to install the system.

3.3. Multi-Alerting Systems

Multi-alerting systems are designed to attract your attention to a number of everyday sounds around your home. These sounds include the doorbell or door entry system, telephone or baby crying. Most systems use flashing lights, vibrations or loud ringers to attract your attention. Some manufacturers have added safety functions to their multi-alerting systems, these can warn you about smoke, carbon monoxide or your burglar alarm going off. Cordless multi-alerting systems alert you to the same type of sounds but use a small pager you can clip to your clothing.

This means you will be alerted to smoke wherever you are in the home but you must wear the pager at all times in order to be alerted. You should also make sure that it works in all areas of your home by getting someone to press the test button on the smoke detector. You also need to be confident that the pager will wake you at night if you rely on it as your only smoke alarm. Smoke alarms are important for your safety. It is essential that no other feature on a multi-alerting system interfere with the correct operation of the smoke alarm function.

3.4 Light Activated Alarms

Smart Polymers Provide Light-Activated Switch To Turn Enzymes On And OffResearchers at the University of Washington have applied research in how proteins bind with different molecules to create a molecular switch that enables them to turn an enzyme on and off. The innovation holds promise for a wide range of laboratory processes, including highly targeted drug therapies. The study, published last week in the Proceedings of the National Academy of Sciences, describes a reversible switch for the enzyme endoglucanase in which light is the trigger for turning the switch on and off.

An enzyme is a protein that acts as a catalyst in initiating or speeding up a chemical reaction in the body. Endoglucanase facilitates the breakdown of cellulose. The latest research builds on earlier work by the group in the use of so-called "smart polymers" to control access to binding sites on proteins. The polymers are described as "smart" because they sense their environment and alter their properties according to changes in external conditions. The conditions in the earlier work that prompted the polymers to react were temperature and acidity. The latest findings are even more exciting, according to Patrick Stayton, UW professor of bioengineering, because the trigger is light. "Light is the real interesting one," said Stayton, who, with colleague Allan S. Hoffman, professor of bioengineering, leads the group, which also includes researchers from Genecor International, a California biotech firm. "It's easily reversible – it really is a true switch." To build the switch, the researchers attach tiny smart polymer chains next to the active sites, or the spots where the enzyme binds with target molecules to do their work. Depending on conditions, the polymer threads either extend or contract. One state blocks the site, while the other leaves it open – which state accomplishes which function depends on the size of the target molecule.

In the case of endoglucanase, a contracted polymer thread blocks the site and an expanded one moves away from the site, leaving it open. Researchers synthesized two light-sensitive polymers, called DMAA and DMAAm. When exposed to visible light, DMAA becomes hydrophilic – it attracts water molecules and expands. When the visible light is replaced by ultraviolet light, DMMA becomes hydrophobic, expelling the water molecules and contracting into a coil. DMMAm works in reverse: under UV light it expands, and under visible light it contracts. So the switch works by enabling endoglucanase to bind or unbind with cellulose, depending on the type of light applied.

The technique should be useful over a broad range of applications. The diminutive size of the enzymes and molecules involved could open avenues into advanced concepts like microfluidics and "lab on a chip" – the ability to fit a full range of laboratory functions on a single computer chip. The technique could also be valuable in drug therapies that involve an enzyme that needs to remain inactive until it reaches its target. Dartmouth researchers report in the March 1 issue of Cancer Research they have discovered an effective combination therapy to treat tumors. In the journal, which is a publication of the American Association for Cancer Research, the researchers report that administering light-activated, or photodynamic, therapy (PDT) immediately before radiation therapy appears to kill tumors more effectively than just the sum of the two treatments. "Our study shows that the close combination of the two treatments complement each other, allowing more effective therapy for the same delivered dose," says Brian Pogue, the lead author, an Associate Professor at Dartmouth's Thayer School of Engineering and a Research Scientist at Harvard Medical School. PDT is used to treat a variety of illnesses, from lung cancer to age-related blindness. The treatment uses a light-activated drug to kill tumor tissue. The drug, verteporfin in this study, is designed to accumulate within tissues with tumor-like characteristics, such as leaky vasculature and rapidly growing cells. Pogue and his colleagues studied the effectiveness of a combined approach for administering the photodynamic therapy and subsequent radiation for treating a mouse tumor. The multidisciplinary research team is composed of faculty from Dartmouth's Thayer School of Engineering, Dartmouth Medical School, the Norris Cotton Cancer Center at Dartmouth-Hitchcock Medical Center, and Massachusetts General Hospital.

"This finding could spark a new direction and new applications for PDT," says Pogue. "The key feature of this treatment is that the mechanism of cellular damage appears to be significantly targeted towards the cellular mitochondria, unlike radiation treatment that inflicts DNA damage." Verteporfin is a specially designed porphyrin molecule. Porphyrins occur widely in nature, are light sensitive and play an important role in various biological processes. Heme is one notable porphyrin found in hemoglobin, and it is responsible for oxygen transport and storage in tissues. Chlorophyll is another type of porphyrin. When activated by a beam of light, porphyrins interact with oxygen in the tissues, producing a kind of oxygen, called singlet state oxygen, which is toxic to cells. This photochemical process is an efficient way to kill tissues by producing massive doses of singlet state oxygen. Oxygen in tumors is a key component in both radiation therapy and PDT. The presence of oxygen significantly increases the ability of the therapy to induce singlet oxygen, which in turn more effectively kills the tumor tissue. "In this study, we found that verteporfin appears to increase oxygen within the tumor," says Pogue, "and this makes the subsequent radiation more effective." Previous studies by Pogue and colleagues have shown that PDT with verteporfin targets the mitochondria (responsible for cellular respiration), but only if the verteporfin is delivered in a manner that allows distribution throughout the tumor with partial clearance from the blood vessels. This means that the drug is cleared rapidly from the blood stream by the kidneys and the liver, which is a key feature in being compatible with outpatient medical treatment. This approach of targeting the tumor tissue rather than the blood vessels was further developed in the study. The researchers discovered that applying PDT to kill the mitochondria of the tumor cells caused a decrease in oxygen consumption, yet oxygen was still being delivered to the tumor tissue. This phenomenon resulted in an increase in available oxygen within the tumor, which improves PDT's ability to induce singlet-state oxygen and also allows the immediately-following second therapy of radiation to be more effective. Increased oxygenation of tumors is well-known to significantly increase the radiation sensitivity of the tissue, according to Pogue. The study was carried out in subcutaneous radiation-induced fibrosarcoma (RIF-1) tumors in mice. The tumor-killing effects were quantified by following the shrinkage of tumor volume over time after the treatments. The most effective therapy was determined by measuring the delay in the regrowth rate of the tumor, which is a standard method in cancer therapy research.

Pogue's co-authors on this study were: Julia O'Hara, Research Associate Professor of Radiology at Dartmouth Medical School; Eugene Demidenko, Research Associate Professor at the Norris Cotton Cancer Center at Dartmouth-Hitchcock Medical Center and Adjunct Associate Professor of Mathematics at Dartmouth College; Carmen Wilmot, Radiology Laboratory Technician at Dartmouth Medical School; Isak Goodwin, a Dartmouth alum from the class of '01 who will attend Drexel University Medical School this fall; Bin Chen; Research Associate at Dartmouth's Thayer School of Engineering, Harold Swartz, Professor of Radiology at Dartmouth Medical School, and Tayyaba Hasan, Professor at Wellman Laboratories of Photomedicine at the Massachusetts General Hospital and Harvard Medical School.

3.4.1 Light-Activated Therapy And Radiation Combined Effectively For Treating Tumors

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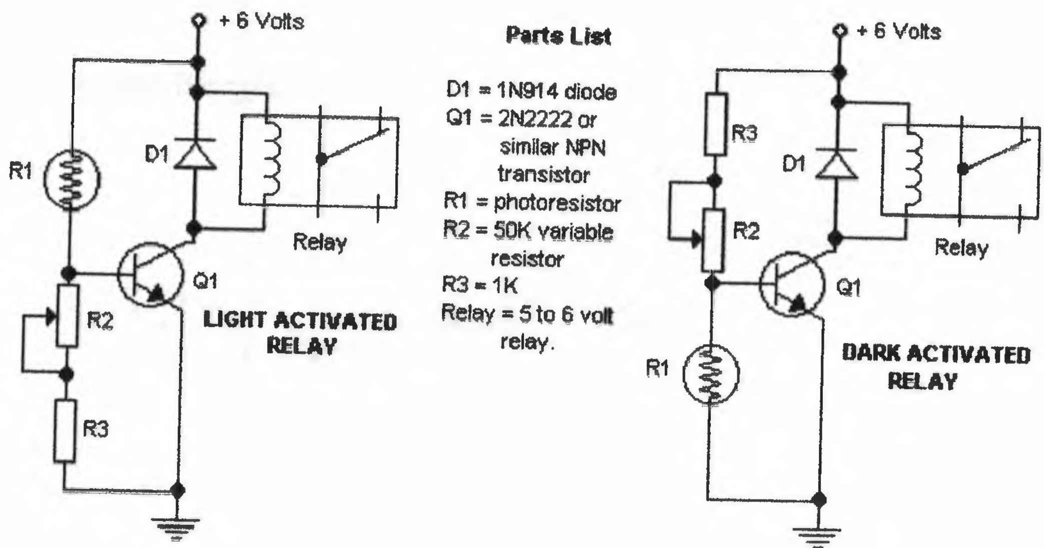
3.4.2 Light-Activated Drug Shrinks Plaque Buildup İn Arteries

A light-activated drug can partially dissolve the fatty deposits that clog arteries, say Stanford scientists who have successfully applied the treatment to several patients, using an optical fiber to "pipe" light directly to obstructed leg arteries. Atherosclerosis, the buildup of fat-laden plaque inside arteries, is a major cause of heart attack, stroke and inadequate circulation to the extremities. To battle this problem, the Stanford research team of assistant professor of radiology Mahmood Razavi, MD, and assistant professor of medicine Stanley Rockson, MD, in collaboration with scientists from Pharmacyclics, Inc., borrowed a drug used in cancer therapy. The drug, known as lutetium texaphyrin, is extremely specific. It kills cells that have absorbed it, but only when they are exposed to high-intensity red light. Only a few kinds of cells absorb the drug, including cancer cells and a specific type of cell that plays a role in plaque formation, said Razavi. Rockson and Razavi gave injections of lutetium texaphyrin to 16 patients with obstructed leg arteries. A day later, after cells in the plaque had plenty of time to absorb the drug, the researchers exposed the narrowed arteries to bright red light for 15 minutes. They delivered the light to the interior of the vessels through a tiny fiber-optic filament, as thin as a paper clip, that was inserted through a small slit in the artery and maneuvered to the blockage. Four weeks after the treatment, angiograms (arterial X-rays) showed that plaque deposits had shrunk in 12 of the 16 patients. The reductions ranged from 10 percent to 74 percent. Razavi will present the team's results on March 23 at the Society of Cardiovascular and Interventional Radiology's annual scientific meeting in Orlando, Fla.

These preliminary trials suggest that the treatment is safe for human use, Razavi said. This spring, the researchers plan to launch further trials to evaluate the treatment's effectiveness, he added. Razavi noted that the light treatment was much less invasive than balloon angioplasty, the most common way to remedy severe arterial blockages. In that procedure, a balloon is inflated inside the clogged vessel, squashing the plaque and opening a channel for blood flow. Even after receiving balloon angioplasty, however, a patient's vessels often narrow again as scar tissue builds up. Early studies suggest that the light treatment may prevent this accumulation of scar tissue, Razavi said. The researchers will further evaluate this possibility in their next study.

3.4.3 Dark/Light Activated Relay



None of the parts are critical and easy available. The potmeter adjust the trigger 'on' level. The diode in the diagram shows to be 1N914. This is ok if you have a light-duty relay, also the 1N914 is a signal diode so actually does not qualify. Use a 1N4001 (or better) instead. A couple of substitutes for the 2N2222 transistor are: NTE123A, ECG123A, PN100, etc.

CHAPTER FOUR

CIRCUIT REALIZATION

4.1 Operation Of Alarm Circuit

The high power gains, like leakage currents, and high current carrying capacities of S.C.R.s make them ideal for use in a variety of electronic alarm projects. Such as simple and advanced burglar alarms, light-beam alarms, smoke alarms, automatic fire alarms, over-temperature alarms, Frost alarms, under-temperature alarms, and alarm circuits that are operated by contact with water or steam. The alarm that each circuit uses can be any self-interrupting Bell, buzzer, or Siren that draws an operating circuit of less than 2A. Each circuit must be operated from a battery supply roughly 1.5V greater than the nominal operating voltage of the alarm device used.

4.2 Simple Burglar Alarm:

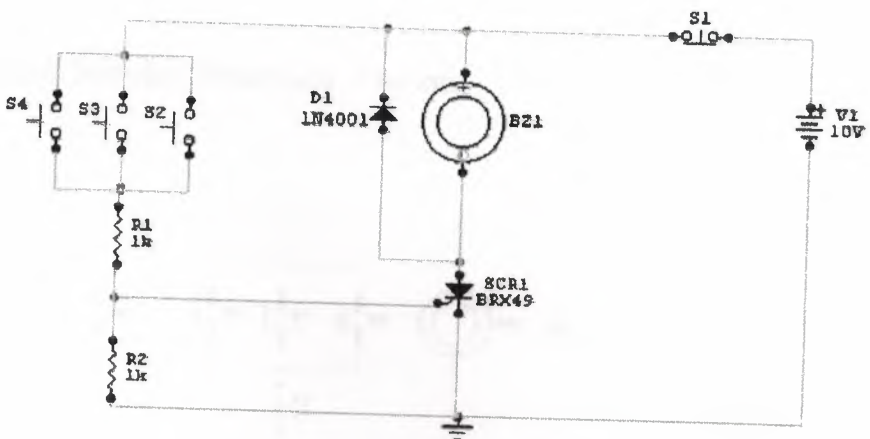


Figure 4.2.1: Simple burglar alarm

In the figure above, the circuit represents a simple burglar alarm, which has versatile uses. As an example it can be used as an alarm for doors whenever a door is open or for safe protection by placing it under the safe or in any place that is hidden keeping in mind that it has to be in touch with the safe body.

The circuit operates as following:

- When either switches (S4, S3, S2) operates the thyristor (S.C.R) will be triggered and start operating which causes the buzzer to sound. To turn off the buzzer, we have to reset (S1).

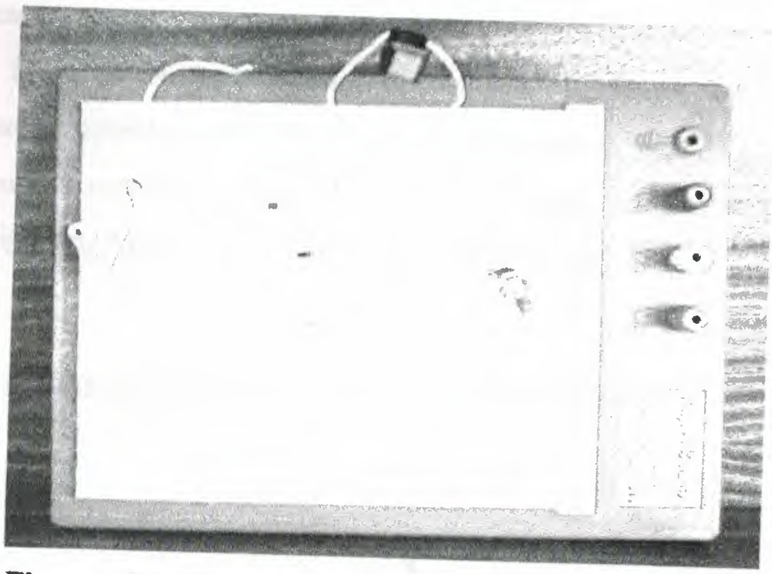


Figure 4.2.2: Simple burglar alarm real application (photo)

4.3 Fire and Smoke Detection Alarm:

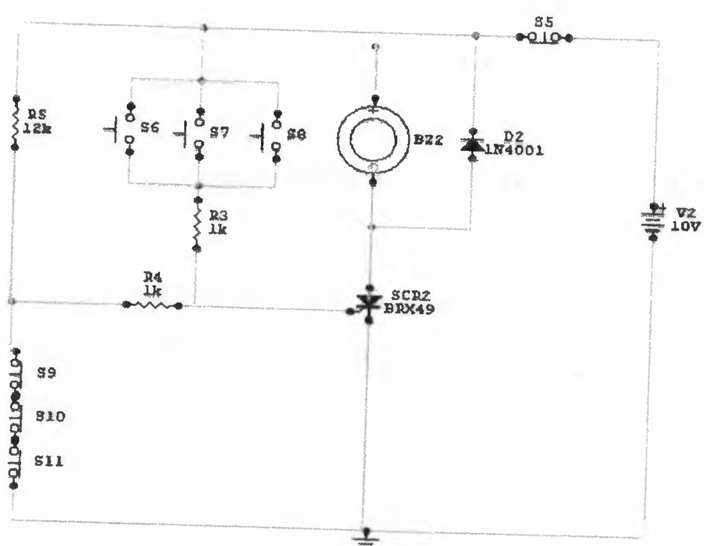


Figure 4.3: Fire and Smoke Detection Alarm

In figure 4.3, the circuit represents a fire and smoke detection alarm system. This circuit contains many sensors and switches, which are connected in parallel or series.
The circuit operates as following:

- When either of parallel sensors or switches (S 6, S7, S8) operates, the circuit will go into a loop, which triggers the thyristor, and make it operate which in turn causes the buzzer to sound.
- Also, if any of the Series sensors or switches operates, it will take trigger the thyristor to operate which in turns causes the buzzer to sound.
- The current needed to trigger the thyristor through the gate is approx. 0.01mA and triggering time interval is very little (unnoticeable).

4.4 Light Depending Resistor Alarm Circuit (LDR):

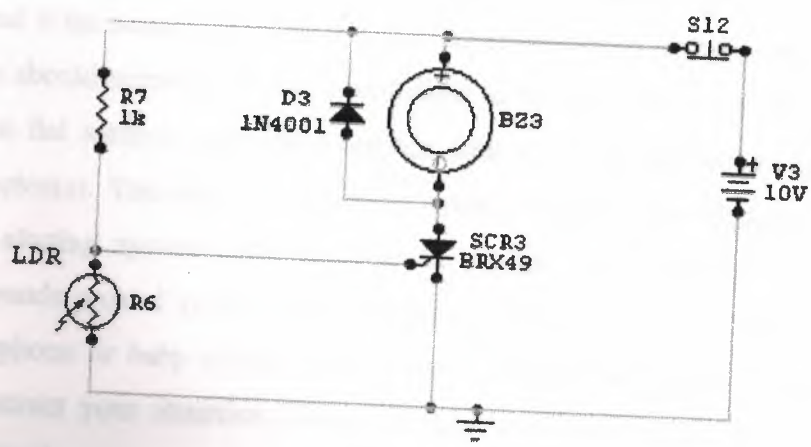


Figure 4.4: Light Depending Resistor Alarm Circuit (LDR):

In figure 4.4, the Circuit represents Light Depending Alarm Circuit, which operates according to light intensity. As LDR controls the circuit and triggering of the thyristor, it is sensitive to light intensity and it directly proportional to it. In other words, if light intensity increases, the LDR will operate and the circuit start operating by triggering the thyristor which in turn causes the buzzer to sound.

Conclusion

Alarm systems range from the simple alarm clock to sophisticated burglar alarms and national warning systems. They may be stand-alone devices or be complete systems involving control centers to support the end user. An alarm system always has two functions. The alarm system receives input from four sensors. Each sensor converts it's reading into a 2 bits unsigned value, and sends it to the alarm system. The role of the alarm system is to select the highest value reading coming from the highest priority sensor. Light sensors are the most common sensors used in small robotics, along with touch sensors. They're cheap, easy to wire, and can be used to produce an interesting set of behaviors. Small robots are fascinating to watch even while performing the simplest of tasks such as following a line or seeking bright light, both of which can use light sensors to good effect. Sounds evoke certain reactions. Some sounds can be hard to localize. Knowledge of the properties of sounds enables us to design effective alarm systems, for example. A square-ended waveform (i.e. sudden-onset) will evoke a startle reaction, and if the sound is at high volume, the effect can cause quite severe panic. The control box should normally be positioned close to the bed and can be fixed to a wall or placed on a flat surface, such as a bedside table. It is usually linked by wire to the smoke detector(s). You can also get some smoke alarm systems that connect by radio link. Multi-alerting systems are designed to attract your attention to a number of everyday sounds around your home. These sounds include the doorbell or door entry system, telephone or baby crying. Most systems use flashing lights, vibrations or loud ringers to attract your attention. Some manufacturers have added safety functions to their multi-alerting systems; these can warn you about smoke, carbon monoxide or your burglar alarm going off. Cordless multi-alerting systems alert you to the same type of sounds but use a small pager you can clip to your clothing.

REFRENCES

1. Www.alarmusers.com/magazine/maga_index.asp
2. Www.ul.com/alarmsystems/
3. Www.mrak.ucdavis.edu/web-mans/ppm/360/360-35.htm
4. Www.bnl.gov/emergencyservices/FP/sfasintr.htm
5. Www.youdoitsecurity.com/
6. Www.freeburglaralarms.com/home.htm
7. Www.news.wisc.edu/view.html?get=8602
8. Www.howstuffworks.com/car-alarm.htm
9. Www.lucent.com/products/solution/0,,CTID+2014-STID+10465-SOID+1052-LOCL+1,00.html
10. Www.thealarmstore.com/
11. Www.simplexgrinnell.com/fire/detection_alarm.jsp
12. Www.firemuseumcanada.com/
13. Www.miami.com/mld/miamiherald/5689981.htm
14. Ops5.triumf.ca/homepage/gordroy/triumf/TFASadd.htm
15. Www.co.henrico.va.us/police/alarms.htm
16. Www.ago.state.mo.us/080701.htm
17. Www.craigslist.org/sfo/sfc/trd/7194065.html
18. Police.ucdavis.edu/subpage/alarm_ordinance.htm
19. Www.alarmsbc.com/device.htm
20. Www.ci.austin.tx.us/police/images/ alarm_permit_form.pdf
21. Www.alarmusers.com/index.asp
22. Factsheets.disabledliving.org.uk/? Factsheetid=25
23. Www.madison.k12 wi.us/bldgsrvc/summer construction.htm