Sudan University of Science and Technology

College of Engineering

Electrical Engineering Department

Advanced Footstep Generation

توليد الكهرباء بخطوات المشي

A Project Submitted In Partial Fulfillment for the Requirements of the Degree of B.Sc. (Honor) In Electrical Engineering

Prepared By:

1. Mohammed Elhadi Osman Nasr
2. Nasr Refaat Nasr Fageery
3. Saeed Saifalyazal Saeed Mohammed
4. Mohammed Fathalrahman Mohammed Ishaag

Supervised By:

Ust.Galal Abdalrahman Mohammed

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الآية

قال تعالى:

وَقُلِ اعْمَلُوا فَسَيَرَى اللَّهُ عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ ۖ وَسَتُرَدُّونَ إِلَىٰ عَالِمِ الْغَيْبِ وَالشَّهَادَةِ فَيُنَبِّئُكُم بِمَا كُنتُمْ تَعْمَلُونَ

صدق الله العظيم

{سورة التوبة: 105}

DEDICATION

To the Song of tenderness and the source of the effort of stayed on my comfort, to the one who inhabit paradise under their feet ...

''' my beloved mother'''

To the shield solid who taught me the meaning of life and grew in me love of science and work and self-reliance

'''dear dad'''

To the one who I am very proud of their presence with me, whom shine Rose in the garden of my life, my happiness was great

''' my friends'''

To each of the extended a helping hand to me and helped me in my research output, I dedicate this research to all of them

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Before all, greater thank and grace to Allah firstly and lastly, who always Inspire and guide us.

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ABSTRACT

Everywhere a person goes, some amount of energy is used by them. Since time is immemorial energy is needed for the well-being and sustenance of our- lives. The utilization of waste energy used in the foot power is very much useful and important for place where there will be a huge crowd each day. When the flooring is engineered with technology, the electrical energy produced by the pressure captured by floor sensor and convened to an electrical by piezo transducer, then stored and used as a power source. This power source is used in home application crowded areas like railway station, streetlight, school and colleges.

المستخلص

في كل مكان يذهب إليه الشخص ، يستخدم قدرًا من الطاقة. منذ زمن سحيق الطاقة ضرورية لرفاهية حياتنا وقوتها. الاستفادة من الطاقة المهدرة المستخدمة في حركة القدم مفيدة ومهمة للغاية للمكان الذي سيكون فيه حشود ضخمة كل يوم. عندما يتم تصميم الأرضيات باستخدام التكنولوجيا ، فإن الكهرباء الطاقة الناتجة عن الضغط الذي تم التقاطه بواسطة مستشعر الأرض وتحويله إلى جهاز كهربائي بواسطة محول طاقة بيزو ، ثم يتم تخزينه واستخدامه كمصدر للطاقة. يستخدم مصدر الطاقة هذا في التطبيقات المنزلية المناطق المزدحمة مثل محطة السكة الحديد وضوء الشارع والمدارس والكليات.

TABLE OF CONTENTS

	Page no.
الآية	I
DEDICATION	II
ACKNOWLEDGEMENT	III
ABSTRACT	IV
مستخلص	V
TABLE OF CONTENTS	VI
CHAPTER ONE **INTRODUCTION**	
1.1 Literature Review	1
1.2 Problem Statement	2
1.3 Objective of Project	3
1.4 Methodology	3
1.5 Thesis Layout	5
CHAPTER TWO **GENERAL OVERVIEW**	
2.1 Overview	6
2.2 Piezoelectricity	6
2.3 Flooring Tiles	7
2.3 Control system	7
2.4 Microcontroller	8
2.4.1 Microcontroller components	9

2.5 Sensors	11
CHAPTER THREE **HARDWARE AND SOFTWARE CONSIDRATION**	
3.1 System Description	13
3.2 System Hardware	13
3.2.1 Piezo sensors	14
3.2.2 Bridge Rectifier	16
3.2.3 Capacitor	18
3.2.4 LCD	19
3.2.5 LED	21
3.2.6 Diodes	22
3.2.7 Jumper wires	23
3.2.8 Breadbord	24
3.2.9 Potentiometer	25
3.3 Block diagram	26
CHAPTER FOUR **SYSTEM IMPLEMENTATION AND TESTING**	
4.1 Introduction	27
4.2 System Implementation	27
4.2.1 The connections of project	28
4.3 System Simulation	28
4.4 System Testing	30
CHAPTER FIVE **CONCLUSION AND RECOMMENDATION**	

5.1 Conclusion	31
5.2 Recommendations	32
References	33
APPENEDIX	35

TABLE OF FIGURES

	Page no.
Figure 2.1: The microcontroller	11
Figure 3.1: Piezo Sensor	14
Figure 3.2: Series Combination	14
Figure 3.3: Parallel Combination	15
Figure 3.4: Series and Parallel Combination	15
Figure 3.5: Bridge rectifier	16
Figure 3.6: A Typical Capacitor	19
Figure 3.7: LCD pin diagram	21
Figure 3.8: LED	22
Figure 3.9: Diode	23
Figure 3.10: jump wire	23
Figure 3.11: breadbord	25
Figure 3.12: potentiometer	26
Figure 3.13:Block diagram	26
Figure 4.2.1.1 Microcontroller connection	27
Figure 4.2.1.2: Connection of the main circuit	28
Figure 4.3.1: Proteus Design	29
Figure 4.3.2 :System Simulation	29

LIST OF ABBREVIATIONS

CPU	Central processing unit
RAM	Random Access Memory
ROM	Read only Memory
EPROM	Erasable Programmable Read only Memory
ADC	Analog to Digital Convertor
DAC	Digital to Analog Convertor
LED	Light Emitting Diode
AC	Alternating Current
DC	Direct Current
LCD	Liquid Crystal Display
SOC	Common Use in The System on a chip
MCU	Microcontroller
PCB	Pre-assembled printed Circuit Board
I/O	Input / Output
PWM	Pulse-Width Modulation
MIMO	Multiple-Input and Multiple-Output
PID	Proportional Integral Derivative
SISO	Single Input Single Output
SPI	Serial Peripheral Interface

CHAPTER ONE
INTRODUCTION

1.1 Literature Review

Since the human beings came to earth a few million years ago, their needs and of electrical energy is growing very fast for their- sustenance and comfort. Embryonic nun needs energy mostly in the form of diet. Over time, nun began farming the land for and cultivating the land for farming. With an additional demand for energy, Energy harvesting or scavenging is the process of capturing the wasted energy from naturally occurring energy sources, accumulating and storing it for later use [1]. In another definition by Kazmierski and Beeby [2] energy harvesting is the conversion of ambient energy, exist in the environment into electrical energy. Harvesting energy is one of the most promising techniques in response to the global energy problem without depleting natural resources. Energy harvesting typically refers to micro- to milli-watts small power generation systems that is developed as a method for replacing or augmenting batteries. It exploits kinetic, thermal, solar sources or electromagnetic radiation sources. The kinetic energy harvesting that is the purpose of this study, converts movement, mainly in form of vibrations, into electrical energy. An energy harvester has typically three main components; the micro-generator for converting ambient energy into electrical energy, the voltage booster to pumps up and regulate the generator voltage and the storage element [3]. Since vibration power generators are mainly resonant systems, the maximum power is generated when the resonant frequency of the generators matches ambient vibration frequency [4]. Regarding the scope of the study that is harvesting kinetic energy of walking, the frequency of the human movements is less than 10 Hz [5]. Harvesting kinetic energy of the human body including walking energy is one of the methods of providing electricity for low-powered devices through implementing energy harvesting technologies, which in the individual has the potential to become a power generator [6]. There are different types of vibration energy to harvest, that have been studied by several scholars, such as human motion [7], ocean wave [8] or harvesting strain from beam elements in critical structures [9]. Energy harvesting from mechanical loading generated in the ground in the shape of compressive forces while people move across the floor, is a sustainable method to generate electrical energy [10]. The generic model of kinetic energy harvesters was first developed by Williams and Yatus [4, 11]. Kinetic energy harvesters, also known as vibration power generators, extract electrical power by employing one or a combination of different mechanisms including piezoelectric, electromagnetic, electrostatic or by using magnetostrictive materials [4]. Many scholars have studied the properties of theses transductions, the advantages and the disadvantages of each mechanism [1]. This study aims to focus on the harvesting of walking energy as a type of kinetic energy. Hence, firstly it is needed to study harvesting the kinetic energy of body during walking and then focuses on harvesting of the walking energy using piezoelectric harvesters in the floor.

Footstep energy generation can be an effective method to generate electricity. Walking is the most common activity human life. When a person walks, he loses some energy to road surface the form of impact, vibration sounds etc due to transfer of his weight on to the road surface, through foots falls on the ground during every step results losing kinetic energy. This energy can be tapped and convened in to useable form such as in form. This procedure contains number of Simple configurations that are fitted under the walking floor. Walking on this platform, body weight compresses the piezoelectric transducers that produce electric power. the current generated is stored in the battery, Greater circulation of people will generate more power. A piezoelectric transducer is an electrical generator that produces direct current when pressure applied upon it .

1.2 Problem Statement

Some developing countries and newly-industrialized countries have several hours of daily power-cuts in almost all cities and villages. People in these countries may use a power- inverter (rechargeable batteries) or a diesel/petrol-run generator at their- homes during the power- cut, the objective of this work is power generator through footsteps as a source of renewable energy that we can obtained while walking on to the certain arrangements Like footpath, stairs, plate forms and these systems can be install elsewhere specially in the dense populated areas.

Sudan is having long and frequent black days of power crisis, Therefore, utilizing this power resource is good for our country in every field. However, although that the produced power of a single model is not enough to solve this problem, the system can be customized and enhanced to give more energy for more extended usages, such as applying this single model into several places in large numbers to obtain the amount of power needed.

1.3 Objective of Project

- the main aim of this project is to develop much clearer cost effective way of power generation method, which in tums helps to bring down the global warming as well as reduce the power shortages.
- Analyze hybrid energy harvesting system with different width and length of bimorph piezoelectric beam to produce power from the mechanical strain.
- Utilized human waste walking energy into electrical energy
- Reduce Environment pollution.

1.4 Methodology

1.4.1 Study of project

Electricity has become a lifeline for the human population. The need for electricity is increasing day by day. Some technology needs enormous of electrical power to perform various operations. As we know electricity is generated by some sources like water, wind etc.
Piezoelectric transducer has following advantages:

- High electromechanical transformation efficiency.
- High machinability.
- A broad range of characteristics can be achieved with different material compositions
- High stability.

In another proposed system the Faraday's law of induction is used for cutting the flux by coils. In this, the spur gear mechanism with magnet attached to the shaft is used to generate AC voltage.

1.4.2 Analysis for project

The working of the foot step power generation system involves:
1. Interface and transducing
    - Consists array of piezoelectric sensor
    - Kinetic energy is converted into electrical energy

2. Processing
    - Here the generated degraded vibrating voltage will be fed to different blocks of a circuit element to get a proper output.

4. This wastage of energy can be converted to usable form using the help of piezoelectric sensor

5. The piezoelectric sensor is a device which can convert pressure into voltage.
6. We know that energy can be neither be created nor be destroyed but can be transformed from one form to another.
7. By using this energy conversion theorem and Piezo theorem sensor we are proposing a new method for power generation

1.4.3 Circuit design

This project is used to generate voltage using footstep force. The proposed system works as a medium to generate power using force. This project is very useful in public places like bus stands, theaters, railway stations, shopping malls, etc. So, these systems are placed in public places where people walk and they have to travel on this system to get through the entrance or exists.

Then, these systems may generate voltage on each and every step of a foot. For this purpose, piezoelectric sensor is used in order to measure force, pressure and acceleration by its change into electric signals. This system uses voltmeter for measuring output, led lights, weight measurement system for better demonstration of the system.

Whenever force is applied on piezoelectric sensor, then the force is converted into electrical energy. In that movement, the output voltage is stored in the battery,The output voltage which is generated from the sensor is used to drive DC loads.

The main components of the footstep power generation system involves the following :

- Pic 16f887a microcontroller
- Piezoelectric Sensor
- Bridge rectifier
- Capacitor
- 16X2 LCD
- Jump wire
- Push-button
- Breadboard
- Led

1.4.5 Software program

The microcontroller examines the information concerning the voltage current and the wattages generated by the piezoelectric sheet when the force is applied. The microcontroller be programmed using the inserted 'C' language

1.4.6 Testing and Result

The piezo sensor will initially sense the kinetic energy and display the measured on the LCD screen. The piezo sensor is then held by a human footstep After that power is generate and charge the capacitor and The capacitor discharges charge on Led and turn on.

1.5 Thesis Layout

This project consists of five chapters: Chapter one gives an introduction about the principles of the project, in addition its reasons, motivation and objectives. Chapter two discusses all the data that has been collected such as theories and possible solutions are written in this chapter. This chapter is necessary to enable or verify that this invention is achievable, based on many methods from various Sources of reference. In other words, chapter two is more on comparisons of Researchers, fundamental working principles of the components involved and Formulas. Chapter three explains the components of the project are discussed in a detailed manner by defining the components and describe it and give a review for their operation as well as where they connect in the project and what they do as each one helped to build the project and provide a block diagram for it.
Chapter four shows the system implementation also shows the experimental results. Finally, chapter five provides the conclusion and recommendations.

CHAPTER TWO
General Information

2.1 Overview

Electricity has become lifeline for human population. Demand of electricity is increasing day by day. Some technology needs high amount of electrical power to perform various operations. As we know electricity is generated by some sources like water, wind etc. To generate the electricity from these resources, development of big plants or big mills is needed having high maintenance cost. As the use of energy is increases, no of energy resources are generated and wasted. If the wastage of energy is rapidly increases then one day will come at that time we will face totally absence of energy. This technology is based on principle of piezoelectric effect which has ability to build up electrical charge from pressure and strain applied to them. Piezoelectricity refers to the ability of some materials to generate an electric potential in response to applied pressure. Harvesting of energy which means energy is already available, but is going to waste if not utilized. Embedded piezoelectric material can provide the magic of converting pressure exerted by the moving people into electric current.

2.2 Piezoelectricity

Piezoelectricity was discovered in 1880 by Pierre-e Paul-Jacques Curie, who found that when they compressed certain types of crystals including quartz, tourmaline, and Rochelle salt, along certain axes, a voltage was produced on the surface of the crystal. This effect is known as piezoelectric effect. is a form of electricity created when certain crystals are bent or otherwise deformed. These same crystals can also be made to bend slightly when a small current is run through them encouraging their use in for which great degrees of mechanical control are necessary.

A piezoelectric crystal consists of multiple interlocking domains Which have positive ,negative charges. These domains are symmetrical within the crystal lattice, causing the lattice as a whole to be electrically neutral When stress is put on the crystal, the symmetry is slightly broken generating voltages .

Footstep power generation using piezoelectric sensors ,There are a number of approaches being used to generate alternative power supply.

Piezoelectric smart road sensor one among the other methods is piezoelectric smart road sensor. Here smart roads refer to the roads on which piezoelectric sensors can be placed order to generate electricity.

When any vehicle moves on the roads it produces very small vertical deformations and vibrations on the roads. The increasing demand of the electricity forces us to think about harvesting that vibration energy from vehicles which wasted otherwise.

2.3 Flooring Tiles

Japan has already started experimentation with the of piezoelectric effect for energy generation They implement piezoelectric effect on the stairs of the bus. Thus every time passenger steps on the tiles; they trigger a small vibration that can be stored as energy.

The flooring are made up of rubber which can absorb the vibration This vibration generates when running or walking on it. Under these tiles piezoelectric material are placed. When the movement felt by the material they can generate the electricity. This generated energy is simultaneously stored into the battery. Generated electricity we can use the lighting of lamp or street light. Energy is generated by step of one human being is too less but if number of steps increases ultimately energy production also increases.

2.4 Control System

There are two major divisions in control theory, namely, classical and modern, which have direct implications over the control engineering applications. The scope of classical control theory is limited to Single-Input and Single-Output (SISO) system design, except when analyzing for disturbance rejection using a second input. The system analysis is carried out in the time domain using differential equations, in the complex-s domain with the Laplace transform, or in the frequency domain by transforming from the complex-s domain. Many systems may be assumed to have a second order and single variable system response in the time domain. A controller designed using classical theory often requires on-site tuning due to incorrect design approximations. Yet, due to the easier physical implementation of classical controller designs as compared to systems designed using modern control theory, these controllers are preferred in most industrial applications. The most common controllers designed using classical control theory is Proportional-Integral-Derivative (PID) controllers. A less common implementation may include either or both a lead and lag filter ,ultimate the end goal is to meet requirements set typically provided in the time-domain called the Step response, or at times in the frequency domain called the Open-Loop response. The Step response characteristics applied in a specification are typically percent overshoot, settling time, etc. The open-loop response characteristics applied in a specification are typically Gain and Phase margin and

bandwidth. These characteristics may be evaluated through simulation including a dynamic model of the system under control coupled with the compensation model. In contrast, modern control theory is carried out in the state space, and can deal with Multiple-Input and Multiple-Output (MIMO) systems. This overcomes the limitations of classical control theory in more sophisticated design problems, such as fighter aircraft control, with the limitation that no frequency domain analysis is possible. In modern design, a system is represented to the greatest advantage as a set of decoupled first order differential equations defined using state variables. Nonlinear, multivariable, adaptive and robust control theories come under this division. Matrix methods are significantly limited for MIMO systems where linear independence cannot be assured in the relationship between inputs and outputs .
A control system is a device, or set of devices, that manages, commands, directs or regulates the behavior of other devices or systems. Industrial control systems are used in industrial production for controlling equipment or machines . There are two common classes of control systems, open loop control systems and closed loop control systems. In open loop control systems output is generated based on inputs. In closed loop control systems current output is taken into consideration and corrections are made based on feedback. A closed loop system is also called a feedback control system.

2.5 Microcontroller

A microcontroller is a single-chip computer .Micro suggests that the device is small, and controller suggests that it is used in control applications. Another term for microcontroller is embedded controller, since most of the microcontrollers are built into or embedded in the devices that controlling. Microcontrollers have traditionally been programmed using the assembly language of the target device. Although the assembly language is fast, it has several disadvantages. An assembly program consists of mnemonics, which makes learning and maintaining a program written using the assembly language difficult. Also, microcontrollers manufactured by different firms have different assembly languages, so the user must learn a new language with every new microcontroller he or she uses. Microcontrollers can also be programmed using a high-level language, such as BASIC, PASCAL, or C. High-level languages are much easier to learn than assembly languages and also facilitate the development of large and Complex programs.
Microcontroller is a highly integrated chip that contains Central Processing Unit (CPU), Random Access Memory (RAM), Read Only Memory (ROM) and Input/output (I/O) ports. Unlike general-purpose computer, which also includes all of these components, microcontroller is designed for a very specific task to control a particular system. As a

result, the parts can be simplified and reduced, which cuts down on production cost.

2.5.1Microcontroller components

A microcontroller basically contains one or more following components:

1. Central processing unit CPU

Microcontrollers contain a central processing unit (CPU), CPU is the brain of a microcontroller, CPU is responsible for fetching the instruction and executes it that perform the basic logic, math, and data-moving functions of a computer To make a complete computer, CPU connects every part of a microcontroller into a single system a microprocessor requires memory for storing data and programs, and input/output (I/O) interfaces for connecting external devices like keyboards and displays

2. Memory

Memory in a microcontroller is same as microprocessor. It is used to store data and program. A microcontroller usually has a certain amount of RAM and ROM (EEPROM, EPROM, etc.) or flash memories for storing program source codes. There are many types of memory inside the microcontroller, these memories can be found all of them or some of them in microcontroller chip. The main types of memory are:

- **Random access memory**

Random Access Memory (RAM) is a general-purpose memory which usually stores the user data used in a program. RAM is volatile, i.e. data is lost after the removal of power. Most microcontrollers have some amount of internal RAM. 256 bytes is a common amount, although some microcontrollers have more, some less. In general it is possible to extend the memory by adding external memory chips.

- **Read only memory**

Read Only Memory (ROM) is a type of memory usually holds program or fixed user data. ROM memories are programmed at factory during the manufacturing process and their contents cannot be changed by the user .ROM memories are only useful if you have developed a program and wish to order several thousand copies of it.

- **Erasable programmable read only memory**

Erasable Programmable Read Only Memory (EPROM) is similar to ROM, but the EPROM can be programmed using a suitable programming device. EPROM memories have a small clear glass window on top of the chip where the data can be erased under UV light. Many development versions of microcontrollers are manufactured with EPROM memories where the user program can be stored. These memories are erased and re-programmed until the user is satisfied with the program. Some versions of EPROMs, known as one Time Programmable (OTP), can be programmed using a suitable programmer device but these memories cannot be erased. OTP memories cost much less than the EPROMs. OTP is useful after a project has been developed completely and it is required to make many copies of the program memory.

❖ **Flash EPROM**

is electrically erasable, like EEPROM, but most Flash devices erase all at once, rather than byte-by-byte like EEPROM.

3. Parallel input/output ports

Parallel input/output ports are mainly used to drive/interface various devices such as LCD'S, LED'S, printers, memories, etc. to a microcontroller.

4. Serial interfacing ports

Serial ports provide various serial interfaces between microcontroller and other peripherals like parallel ports.

5. Timers and counters

This is the one of the useful function of a microcontroller. A microcontroller may have more than one timer and counters. The timers and counters provide all timing and counting functions inside the microcontroller. The major operations of this section are perform clock functions, modulations, pulse generations, frequency measuring, making oscillations, etc. This also can be used for counting external pulses.

6. Analog to digital converter

Analog to Digital Converter (ADC) converters are used for converting the analog signal to digital form. The input signal in this converter should be in analog form (e.g. sensor output) and the output from this unit is in digital form. The digital output can be used for various digital applications (e.g. measurement devices).

7. Digital to analog converter

Digital to Analog Converter (DAC) perform reversal operation of ADC conversion. DAC convert the digital signal into analog format. It usually used for controlling analog devices like DC motors, various drives, etc.

8. Interrupt control

The interrupt control used for providing interrupt (delay) for a working program. The interrupt may be external (activated by using interrupt pin) or internal (by using interrupt) instruction during programming.

2.5.2 Microcontroller application

Microcontrollers are widely used in modern electronic equipment. Some basic applications of microcontroller are given below:

- Used in biomedical instruments.
- Widely used in communication systems.
- Used as peripheral controller in Personal Computer (PC).
- Used in robotics.

Used in automobile fields. Microcontroller applications found in many lives filed, for example in Cell phone, watch, Microcontroller applications found in many lives filed, for example in Cell phone, watch, recorder, calculators ,mouse, keyboard, modem, fax card, sound card, battery charger, door lock, alarm clock, thermostat, air conditioner, TV Remotes, in Industrial equipment like Temperature and pressure controllers, counters and timers.

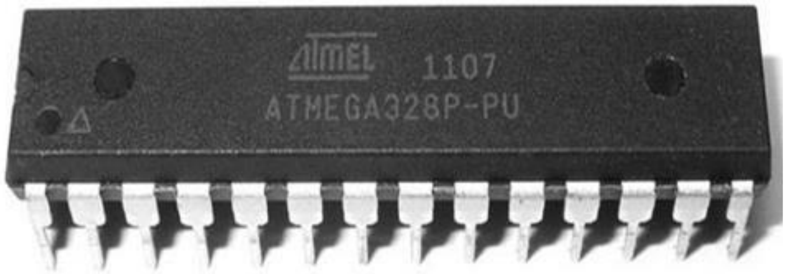

Figure 2.1 Microcontroller

2.6 Sensors

A sensor is a device that converts a physical phenomenon into an electrical signal. As such, sensors represent part of the interface between the physical world and the world of electrical devices, such as computers. The other part of this interface is represented by actuators, which convert electrical signals into physical phenomena. In recent years, enormous capability for information processing has been developed within the electronics industry. The most significant example of this capability is the personal computer. In addition, the availability of inexpensive microprocessors is having a tremendous impact on the design of embedded computing products ranging from automobiles to microwave ovens to toys. In recent years, versions of these products that use microprocessors for control of functionality are becoming widely available. In automobiles, such capability is necessary to achieve compliance with pollution restrictions. In other cases, such capability simply offers an inexpensive performance advantage.

All of these microprocessors need electrical input voltages in order to receive instructions and information. So, along with the availability of inexpensive microprocessors has grown an opportunity for the use of sensors in a wide variety of products. In addition, since the output of the sensor is an electrical signal, sensors tend to be characterized in the same way as electronic devices. The data sheets for many sensors are formatted just like electronic product datasheets. However, there are many formats in existence, and there is nothing close to an international standard for sensor specifications. The system designer will encounter a variety of

interpretations of sensor performance parameters, and it can be confusing. It is important to realize that
this confusion is not due to an inability to explain the meaning of the terms rather it is a result of the fact that different parts of the sensor community have grown comfortable using these terms differently

CHAPTER THREE
HARDWARE AND SOFTWARE CONSIDRATION

3.1 System Description

This chapter will discuss the components used to complete the project. Each of the hardware devices that helped to design a smart white cane that can help the Blind people in many various ways is discussed in a detailed manner to fully understand the Functionality of the components The piezoelectric material converts the pressure applied to it into electrical energy. The source of pressure can be either from the weight of the moving vehicles or from the weight of the people walking over it. The output of the piezoelectric material is not a steady one. So a bridge circuit is used to convert this variable voltage into a linear one. Again an AC ripple filter is used to filter out any further fluctuations in the output. The output dc voltage is then stored in a rechargeable battery. As the power output from a single piezo-film was extremely low, combination of few Piezo films was investigated. Two possible connections were tested -parallel and series connections. The parallel connection did not show significant increase in the voltage output. With series connection, additional piezo-film results in increased of voltage output but not in linear proportion. So here a combination of both parallel and series connection is employed for producing 40V voltage output with high current density. From battery provisions are provided to connect dc load. An inverter is connected to battery to provide provision to connect AC load. The voltage produced across the tile can be seen in a LCD. For this purpose microcontroller PIC16F877A is used. The microcontroller uses a crystal oscillator for its operation. The output of the microcontroller is then given to the LCD which then displays the voltage levels.

3.2 System Hardware

The system Hardware of the project is:

3.2.1 Piezo Sensors

The piezo sensors can be used in series parallel combination depend upon our required current or voltages values. One piezo sensor produces maximum voltage 5 V and maximum current I mA .

Figure 3.1: Piezo Sensor

3.2.1.1 Suitable Piezoelectric Sensor Arrangements

I. Series Combination

II. Parallel Combination

III. Series-Parallel Combination

I. Series Combination

In this type of combination, sensors are connected in such a way that current flowing through all sensors is same and voltage is different Veq =Vl+V2+V3...Vn

Figure 3.2: Series Combination

II. Parallel Combination

In this type of combination, Voltage across each sensor the same while current flowing through each sensor is different. Ieq= I1+I2+I3..In.

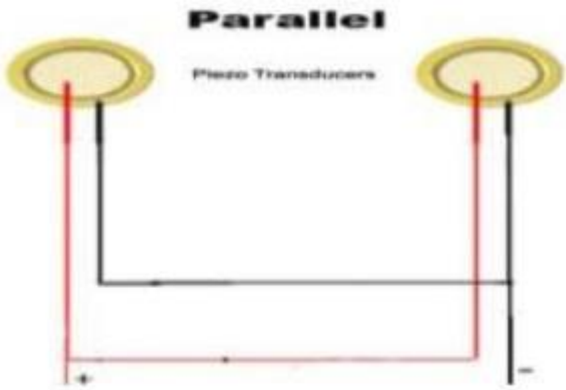

Figure 3.3: Parallel Combination

III. Series-Parallel Combination

In series & parallel combination both voltages and currents are maintained to get the required value

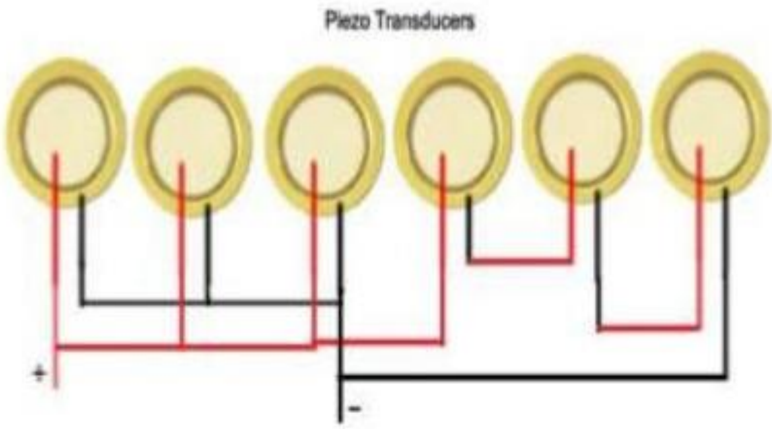

Figure 3.4: Series and Parallel Combination

3.2.2 Bridge rectifier

bridge rectifier is a type of full wave rectifier which uses four or more diodes in a bridge circuit configuration to efficiently convert the Alternating Current (AC) into Direct Current (DC),The construction diagram of a bridge rectifier is shown in the below figure. The bridge rectifier is made up of four diodes namely D1, D2, D3, D4 and load resistor RL. The four diodes are connected in a closed loop (Bridge) configuration to efficiently convert the Alternating Current (AC) into Direct Current (DC). The main advantage of this bridge circuit configuration is that we do not require an expensive center tapped transformer, thereby reducing its cost and size.

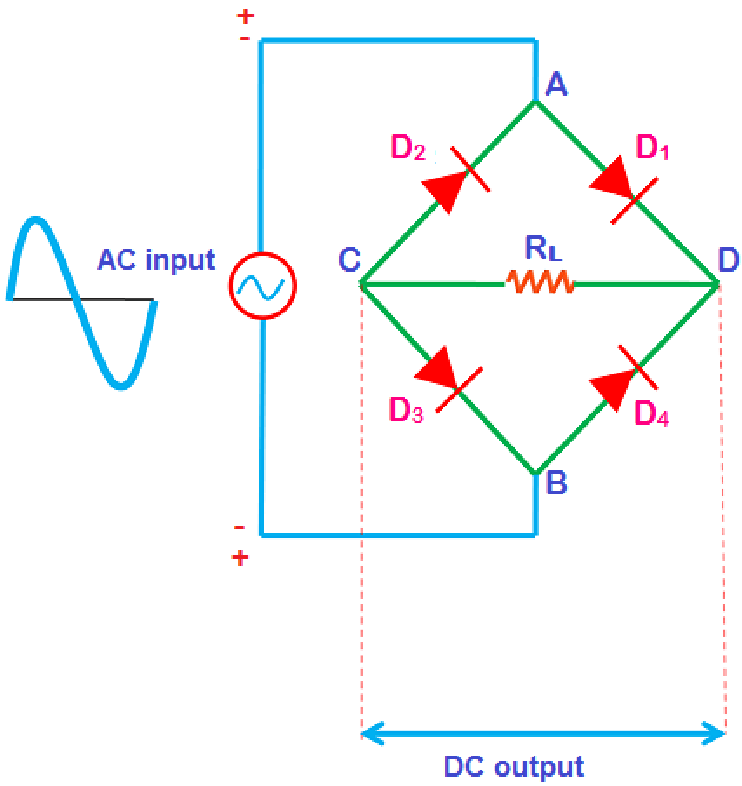

Figure 3.5 Bridge rectifier

The input AC signal is applied across two terminals A and B and the output DC signal is obtained across the load resistor RL which is connected between the terminals C and D.

The four diodes D1, D2, D3, D4 are arranged in series with only two diodes allowing electric current during each half cycle. For example, diodes D1 and D3 are considered as one pair which allows electric current during the positive half cycle whereas diodes D2 and D4 are considered as another pair which allows electric current during the negative half cycle of the input AC signal.

bridge rectifier works when input AC signal is applied across the bridge rectifier, During the positive half cycle diodes D1 and D3 are forward biased and allows electric current while the diodes D2 and D4 are reverse biased and blocks electric current. On the other hand, during the negative half cycle diodes D2 and D4 are forward biased and allows electric current while diodes D1 and D3 are reverse biased and blocks electric current.

During the positive half cycle, the terminal A becomes positive while the terminal B becomes negative, this causes the diodes D1 and D3 forward biased and at the same time, It causes the diodes D2 and D4 reverse biased.

3.2.3 Capacitor

Capacitor is a component which has the ability or "capacity" to store energy in the form of an electrical charge producing a potential difference (Static Voltage) across its plates, much like a small rechargeable battery.

There are many different kinds of capacitors available from very small capacitor beads used in resonance circuits to large power factor correction capacitors, but they all do the same thing, they store charge.

In its basic form, a capacitor consists of two or more parallel conductive (metal) plates which are not The connected or touching each other, but are electrically separated either by air or by some form of a good insulating material such as waxed paper, mica, ceramic, plastic or some form of a liquid gel as used in electrolytic capacitors. The insulating layer between a capacitors plates is commonly called the Dielectric. Due to this insulating layer, DC current cannot flow through the capacitor as it blocks it allowing instead a voltage to be present across the plates in the form of an electrical charge.

The conductive metal plates of a capacitor can be either square, circular or rectangular, or they can be of a cylindrical or spherical shape with the general shape, size and construction of a parallel plate capacitor depending on its application and voltage rating.

When used in a direct current or DC circuit, a capacitor charges up to its supply voltage but blocks the flow of current through it because the dielectric of a capacitor is non-conductive and basically an insulator. However, when a capacitor is connected to an alternating current or AC circuit, the flow of the current appears to pass straight through the capacitor with little or no resistance.

There are two types of electrical charge, a positive charge in the form of Protons and a negative charge in the form of Electrons. When a DC voltage is placed across a capacitor, the positive (+ve) charge quickly accumulates on one plate while a corresponding and opposite negative (-ve) charge accumulates on the other plate. For every particle of +ve charge that arrives at one plate a charge of the same sign will depart from the -ve plate.

Then the plates remain charge neutral and a potential difference due to this charge is established between the two plates. Once the capacitor reaches its steady state condition an electrical current is unable to flow through the capacitor itself and around the circuit due to the insulating properties of the dielectric used to separate the plates.

The flow of electrons onto the plates is known as the capacitors Charging Current which continues to flow until the voltage across both plates (and hence the capacitor) is equal to the applied voltage Vc. At this point the capacitor is said to be “fully charged” with electrons.

The strength or rate of this charging current is at its maximum value when the plates are fully discharged (initial condition) and slowly reduces in value to zero as the plates charge up to a potential difference across the capacitors plates equal to the source voltage.

Figure 3.6 A Typical Capacitor

3.2.4 LCD

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits and devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

LCD 16×2 Pin Diagram

The 16×2 LCD pinout is shown below.

Pin1 (Ground/Source Pin): This is a GND pin of display, used to connect the GND terminal of the microcontroller unit or power source.

Pin2 (VCC/Source Pin): This is the voltage supply pin of the display, used to connect the supply pin of the power source.

Pin3 (V0/VEE/Control Pin): This pin regulates the difference of the display, used to connect a changeable POT that can supply 0 to 5V.

Pin4 (Register Select/Control Pin): This pin toggles among command or data register, used to connect a microcontroller unit pin and obtains either 0 or 1(0 = data mode, and 1 = command mode).

Pin5 (Read/Write/Control Pin): This pin toggles the display among the read or writes operation, and it is connected to a microcontroller unit pin to get either 0 or 1 (0 = Write Operation, and 1 = Read Operation).

Pin 6 (Enable/Control Pin): This pin should be held high to execute Read/Write process, and it is connected to the microcontroller unit & constantly held high.

Pins 7-14 (Data Pins): These pins are used to send data to the display. These pins are connected in two-wire modes like 4-wire mode and 8-wire mode. In 4-wire mode, only four pins are connected to the microcontroller unit like 0 to 3, whereas in 8-wire mode, 8-pins are connected to microcontroller unit like 0 to 7.

Pin15 (+ve pin of the LED): This pin is connected to +5V

Pin 16 (-ve pin of the LED): This pin is connected to GND.

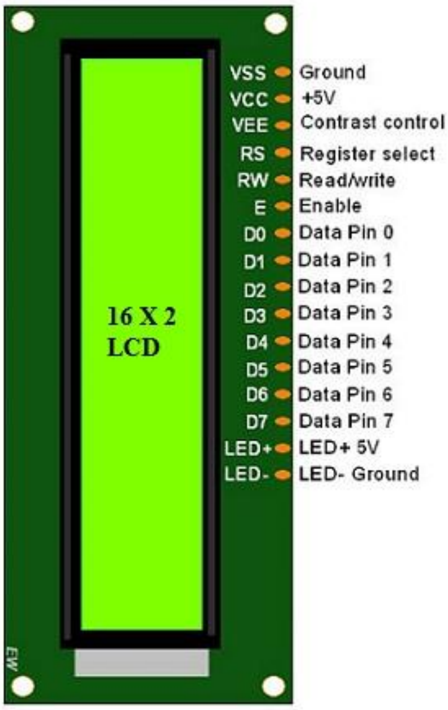

Figure 3.7 LCD pin diagram

3.2.5 LED

A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor. White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device.

Figure 3.8 LED

3.2.6 Diode

A diode is defined as a two-terminal electronic component that only conducts current in one direction (so long as it is operated within a specified voltage level). An ideal diode will have zero resistance in one direction, and infinite resistance in the reverse direction

Although in the real world, diodes can not achieve zero or infinite resistance. Instead, a diode will have negligible resistance in one direction (to allow current flow), and very high resistance in the reverse direction (to prevent current flow). A diode is effectively like a valve for an electrical circuit.

Semiconductor diodes are the most common type of diode. These diodes begin conducting electricity only if a certain threshold voltage is present in the forward direction (i.e. the "low resistance" direction). The diode is said to be "forward biased" when conducting current in this direction. When connected within a circuit in the reverse direction (i.e. the "high resistance" direction), the diode is said to be "reverse biased".the mbol of a diode is shown below. The arrowhead points in the direction of conventional current flow in the forward biased condition. That means the anode is connected to the positive side and the cathode is connected to the negative side

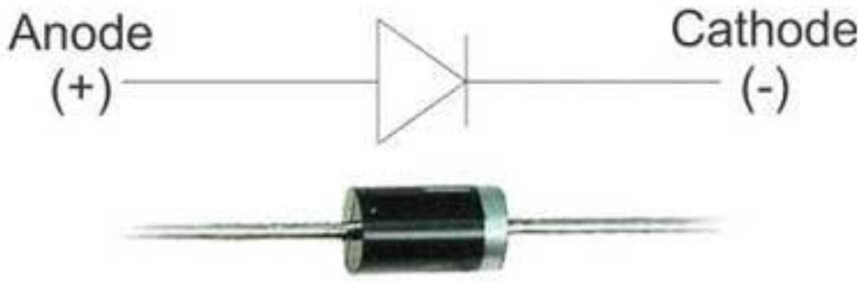

Figure 3.9 Diode

3.2.7 jump wires

A jump wire (also known as jumper wire, or jumper) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.

Figure 3.10: jump wire

3.2.8 breadbord

A breadboard is a construction base for prototyping of electronics. Originally the word referred to a literal bread board, a polished piece of wood used for slicing bread. In the 1970s the solderless breadboard (a.k.a. plug board, a terminal array board) became available and nowadays the term "breadboard" is commonly used to refer to these.

Because the solderless breadboard does not require soldering, it is reusable. This makes it easy to use for creating temporary prototypes and experimenting with circuit design. For this reason, solderless breadboards are also popular with students and in technological education. Older breadboard types did not have this property. A stripboard and similar prototyping printed circuit boards, which are used to build semi-permanent soldered prototypes or one-offs, cannot easily be reused. A variety of electronic systems may be prototyped by using breadboards, from small analog and digital circuits to complete central processing units (CPUs).

Compared to more permanent circuit connection methods, modern breadboards have high parasitic capacitance, relatively high resistance, and less reliable connections, which are subject to jostle and physical degradation. Signaling is limited to about 10 MHz, and not everything works properly even well below that frequency.

A common use in the system on a chip (SoC) is to obtain an microcontroller (MCU) on a pre-assembled printed circuit board (PCB) which exposes an array of input/output (IO) pins in a header suitable to plug into a breadboard, and then to prototype a circuit which exploits one or more of the MCU's peripherals, such as general-purpose input/output (GPIO), UART/USART serial transceivers, analog-to-digital converter (ADC), digital-to-analog converter (DAC), pulse-width modulation (PWM; used in motor control), Serial Peripheral Interface (SPI), or I²C.

Firmware is then developed for the MCU to test, debug, and interact with the circuit prototype. High frequency operation is then largely confined to the SOC's PCB in the case of high speed interconnects such as SPI and I²C, these can be debugged at a lower speed and later rewired using a different circuit assembly methodology to exploit full-speed operation. A single small SOC often provides most of these electrical interface options in a form factor barely larger than a large postage stamp, available in the

American hobby market (and elsewhere) for a few dollars, allowing fairly sophisticated breadboard projects to be created at modest expense.

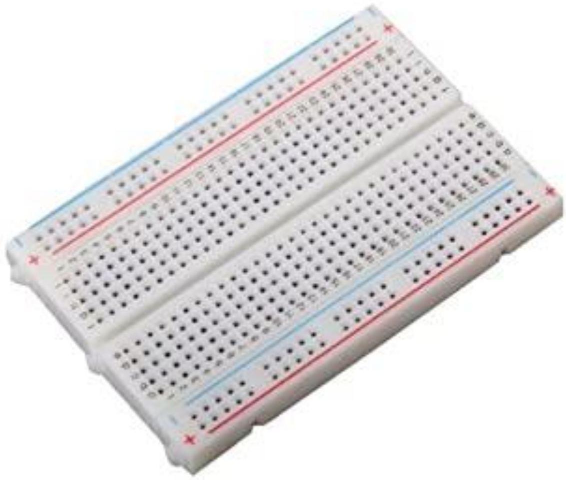

Figure 3.11: breadboard

3.2.9 Potentiometer

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider,If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat

On an LCD the potentiometer is used to adjust the bias level of the LCD - that is the contrast. You need to use it to set a voltage between Vcc and Vee, which you feed into Vo. That is, a voltage somewhere between +5V ,-5V and You can't do that with one resistor.

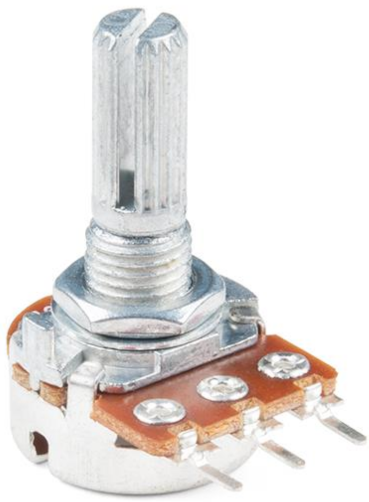

Figure 3.12: potentiometer

3.3 Block Diagram

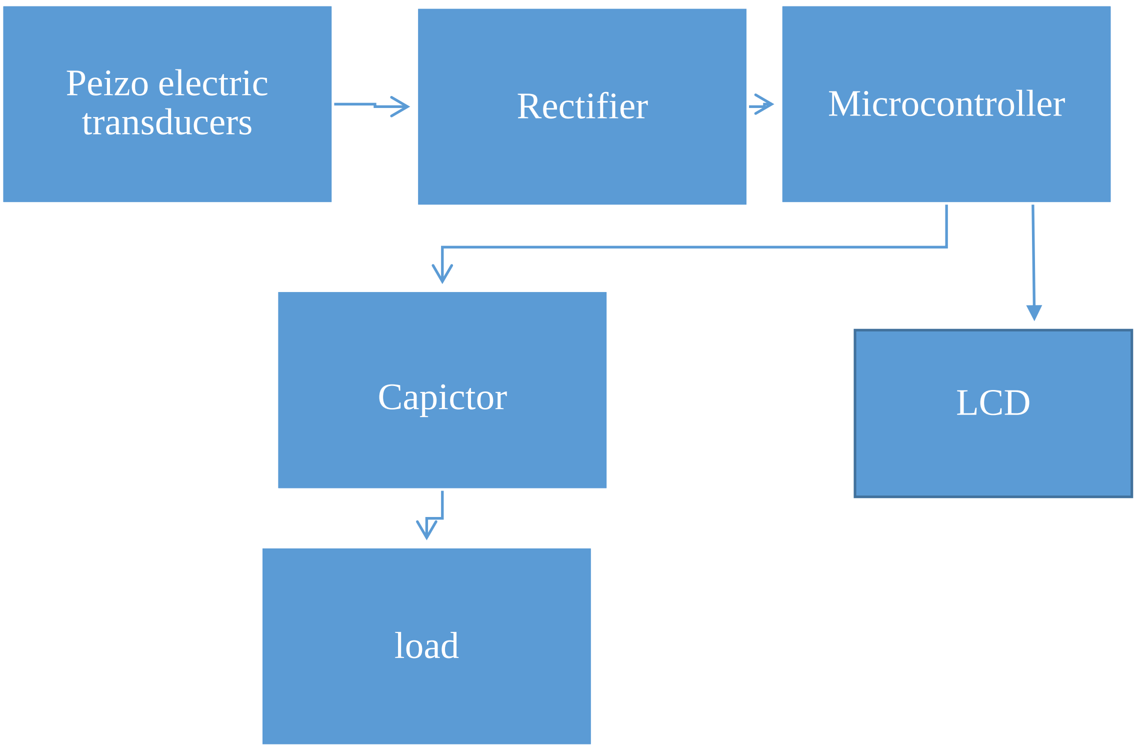

Figure 3.13: Block diagram

CHAPTER FOUR
SYSTEM IMPLEMENTATION AND TESTING

4.1Introudction

Energy harvesting from mechanical vibration is a potential power source which can be used for conversion to electrical energy through Micro electromechanical systems technology ,In a piezoelectric crystal, the positive and negative charges are separated from each other, but they are symmetrically distributed in order to keep the crystal electrically neutral. When a stress is applied, this symmetrical position is disturbed, and the asymmetrical charge generates a voltage.

4.2 System Implementation

This chapter describes the implementation of the project in steps below.

4.2.1 The connections of project

Firstly every circuit connected separately then all the circuits connected to work with each other the following steps explain that.

- The piezo sensor is connected to pin 2 microcontroller and oscillator connected to pin 13 and 14 respectively

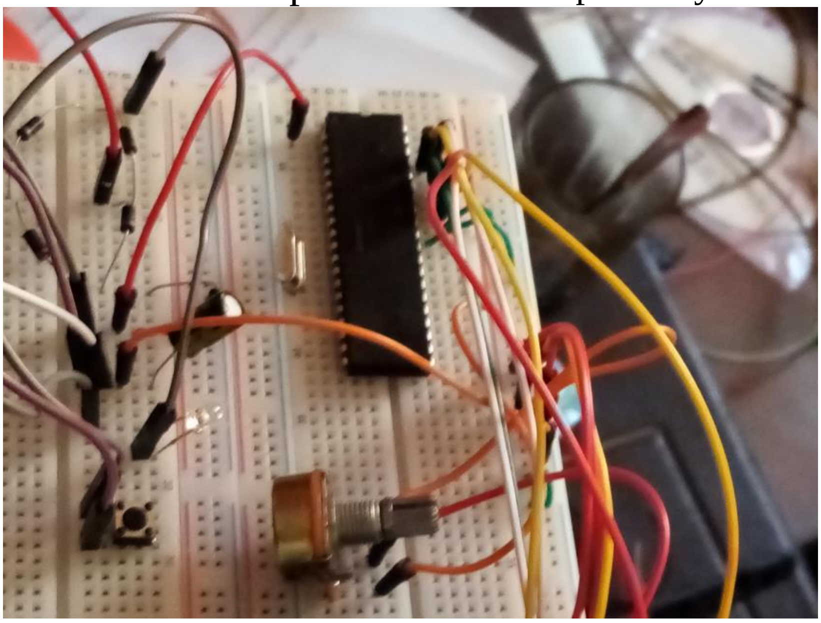

Figure 4.2.1.1 Microcontroller connection

❖ secondly all the components of the project are connected in two circuits one of them representing the main circuit, it contains eight piezo electric sensors to produce energy ,also contains potentiometer all them connected with microcontroller .

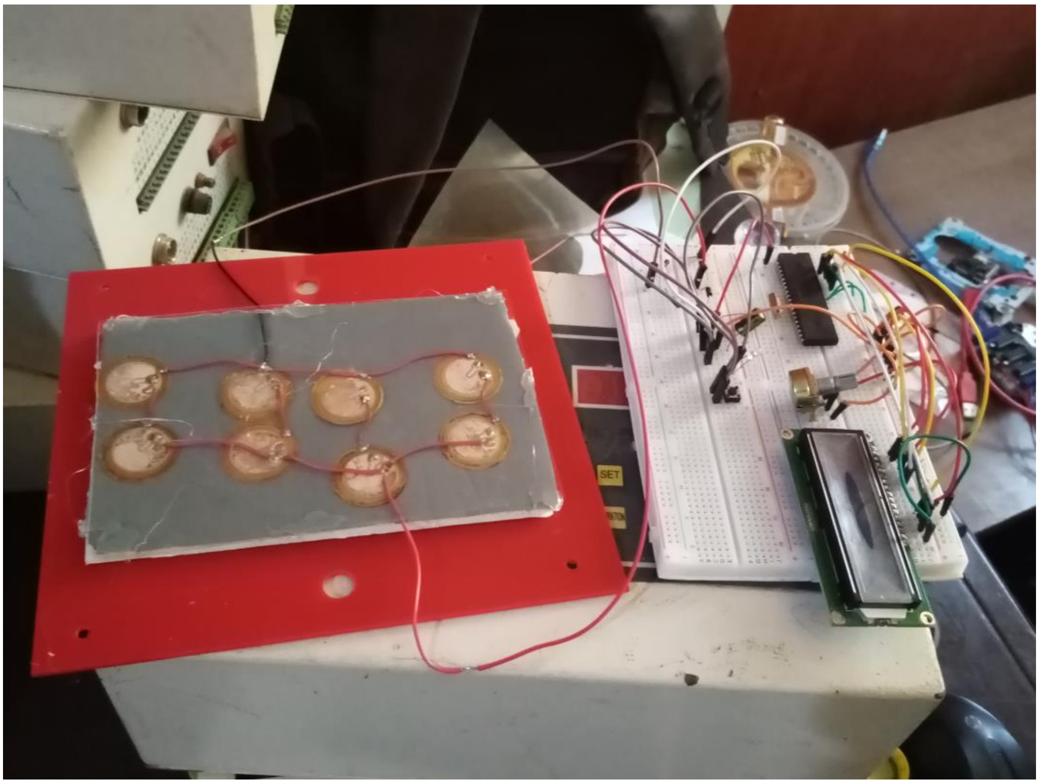

Figure 4.2.1.2: Connection of the main circuit

4.3 System Simulation

4.3.1 Proteus software

Suite (designed by Lab center Electronics Ltd.) is a software tool set, mainly used for creating schematics, simulating Electronics & Embedded Circuits and designing PCB Layouts , Proteus ISIS is used by Engineering students and professionals to create schematics and simulations of different electronic circuits.

Proteus ARES is used for designing PCB Layouts of electronic circuits.

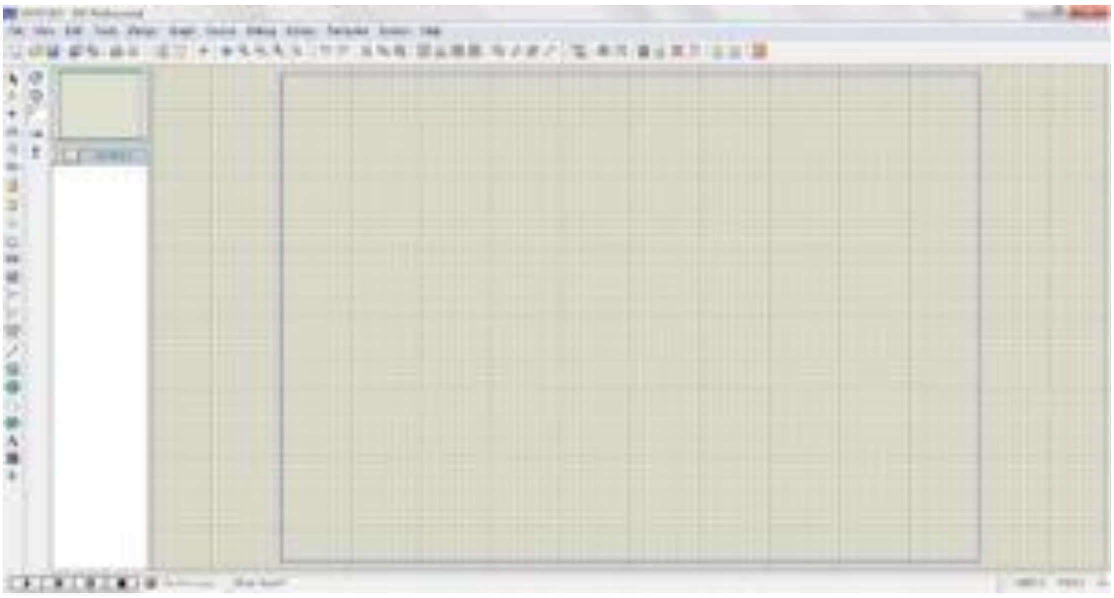

Figure 4.3.1 Proteus Design

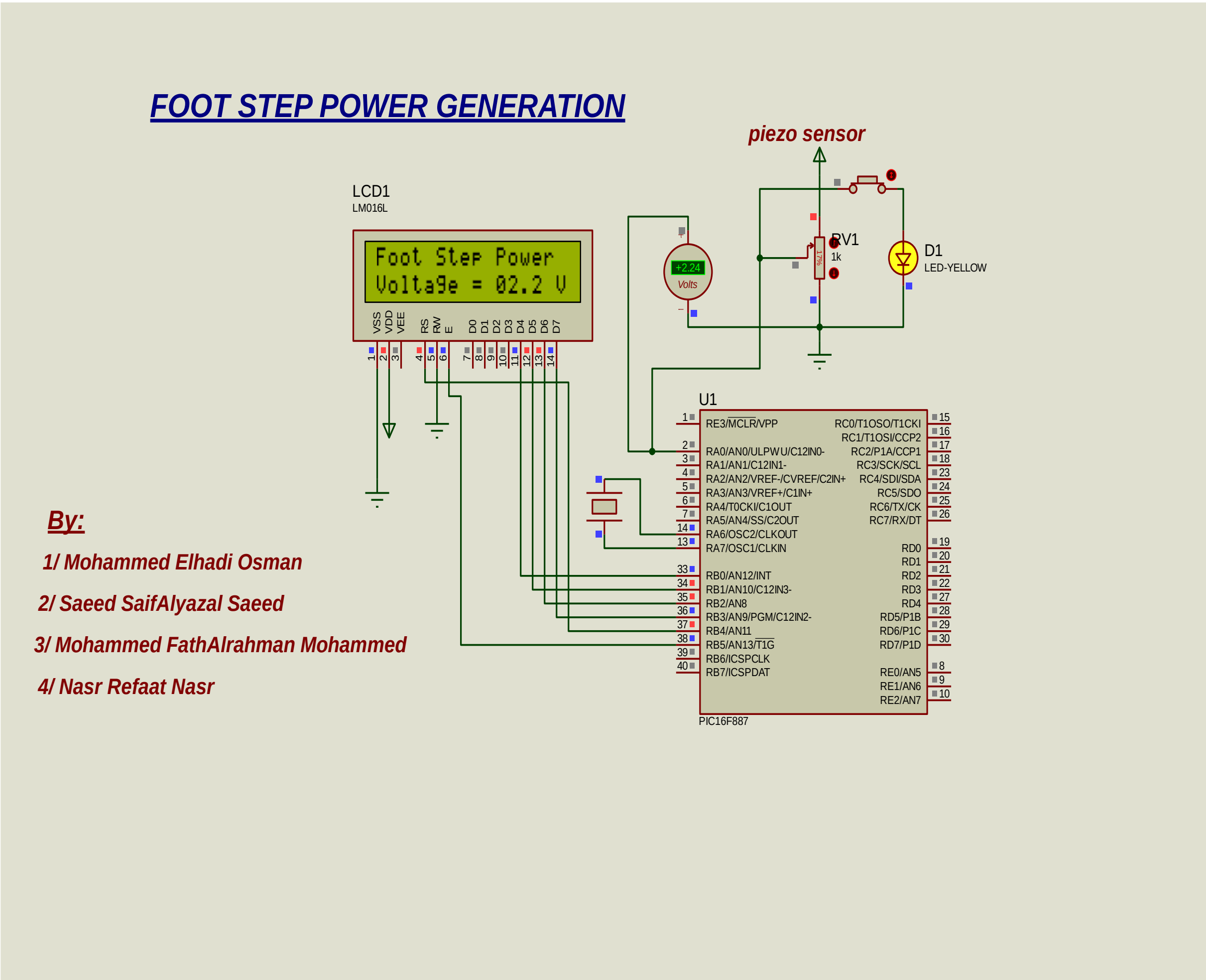

Figure 4.3.2 System Simulation

4.4 System Testing

The amount of voltage produced is depend on magnitude and power of press in piezo electric sensor, It has been observed that after press 50 steps, the storage capacitor charges to approximately 3.75 V, In a single step the storage capacitor charges to 0.075 V with eight piezo electric sensor together . when press the push button the charge of capacitor go to led and it turn on .

No. of piezo pressed	Produced voltage
8	0.07 v
4	0.032v
2	0.013v

Figure 4.4.1: System Testing

CHAPTER FIVE
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The study has reviewed the different methods of harvesting footsteps, the power output and in some cases the applications. By comparing the harvesting energy technologies located on the body and pavement, it is revealed that for body located harvester the power output depends on the physiological parameters. Therefore, it is better to implement the harvester within the pavement slab to gain a consistent output. Furthermore, in comparison between the different types of transductions used in the equipped pavements, although, the output current of the electromagnetic mechanism is high, the piezoelectric technology with the simple structure, flexibility of the design and geometry, small size of the sensors, the ability of easily meshing into hybrid materials has made the piezoelectric transduction desirable. Moreover, four proposed interrelated conditions, play a main role in achieving the desirable results. It is obvious that the number of pedestrian is the main factor when selecting the type of technology and can be effective on the generated power output. In the other word, the type of transduction has to be selected according to the number of footsteps and the needed services. The study recommends more exploration on the piezoelectric properties to optimize the power output in order to use the technology for the pavement in different application.

Footsteps are the main source of power generation ,There is no need of energy from conventional source of energy and there is zero percent of pollution in this type of power generation ,There is no need of any kind of power from mains and it is important to the areas, all tracks where footsteps are used to generate non-conventional energy such as electricity ,The contribution of Non-conventional energy to our primary energy is 11% that is a common fact, If this project is activated it will not only add and overwhelm the energy deficit problems but this will also form sound global environmental change.

5.2 Recommendations

- Power generating boots or shoes ,Energy harvesting which attempts to power battlefield equipment by piezoelectric generators embedded in soldiers' boots . However, these energy harvesting sources put an impact on the body. effort to harness 1-2 watts from continuous shoe impact while walking were abandoned due to the discomfort from the additional energy expended by a person wearing the shoes
- Floor mats, tiles and carpets, A series of crystals can be laid below the floor mats, tiles and carpets which are frequently used at public places like mosque and crowded places
- Gyms and workplaces, Researchers are also working on the idea of utilizing the vibrations caused from the machines in the gym , At workplaces, while sitting on the chair, energy can be stored in the batteries by laying piezoelectric crystals in the chair Also, the studies are being carried out to utilize the vibrations in a vehicle, like at clutches, gears, seats, shock-ups and foot rests.
- Mobile keypad and keyboards, The piezoelectric crystals can be laid down under the keys of a mobile unit and keyboards, With the press of every key, the vibrations created can be used for piezoelectric crystal and hence can be used for charging purpose.

- piezoelectric system underneath highway pavement that can be activated by the wheels of traveling cars. This energy could then be used light stoplights and other nearby devices. Couple that with a road filled with electric cars and you'd find yourself in net positive energy situation.

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APPENEDIX

MICROCONTROLLER CODE

```
sbit LCD_RS at RB4_bit;
sbit LCD_EN at RB5_bit;
sbit LCD_D4 at RB0_bit;
sbit LCD_D5 at RB1_bit;
sbit LCD_D6 at RB2_bit;
sbit LCD_D7 at RB3_bit;

sbit LCD_RS_Direction at TRISB4_bit;
sbit LCD_EN_Direction at TRISB5_bit;
sbit LCD_D4_Direction at TRISB0_bit;
sbit LCD_D5_Direction at TRISB1_bit;
sbit LCD_D6_Direction at TRISB2_bit;
sbit LCD_D7_Direction at TRISB3_bit;
int Adread;
float voltage;
char volt[15];
void main() {
ANSEL  = 0x04;              // Configure AN2 pin as analog
  ANSELH = 0;                 // Configure other AN pins as digital I/O
  C1ON_bit = 0;               // Disable comparators
  C2ON_bit = 0;

PORTA = 0;
TRISA = 0X01;
PORTB = 0;
```

```
TRISB = 0;
LCD_Init();
ADC_Init();
LCD_Cmd(_LCD_CURSOR_OFF);
LCD_Cmd(_LCD_CLEAR);
LCD_Out(1, 1, "Foot Step Power");
delay_ms(1000);
while (1)
{
Adread = ADC_Read(0);
voltage = (Adread *4.88);
floattostr(voltage,volt); // it converts integer value into string
Lcd_Out(2,1,"Voltage=");
Lcd_Out(2,11,Ltrim(volt));

Lcd_Out_cp("V");
}
}
```