APPLICATION OF ARDUINO MICRO CONTROLLER AND PIEZOELECTRIC SENSORS IN THE DEVELOPMENT OF FOOTWEAR FOR OBESE

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ABSTRACT

In this modern world, one of the biggest problems of humanity is obesity. Now a days is obesity from the young age to the older aged people for both men and women are suffering from this disorder. Obesity is when has too much of unsaturated fat and it's enable genetically or by environment factors. Today's society is all about consumption of junk foods, fast food and cold beverage (ex-pizza, burger, coke etc), are more calories and lack of exercise. A simple machine able to do everything for one is too lazy to do. This is a word wide problem because obesity has nearly double since 1980 and it has reached fifth leading risk of global death. As a whole approximately with 2.8 million peoples were die per year because of obesity it's a main cause of cardiac arrest and diabetes. For reducing obesity here by we suggest to do exercise such as workout, jogging and walking by using perfect shoes. These perfect shoes were developed by using Arduino micro controller and piezoelectric sensors. This is connected to Bluetooth smart watch to measure the walking distance and steps. It allows to measure analyze and improve your physics performance. The aim of our research to develop the informative footwear for obesity people in the world .

Figure 1-Photos showing of obese

1.0 INTRODUCTION

Shoes are not only worn to protect the human feet even to give the final touch to the style you are trying to create. The history of shoes is very long and nobody really knows when the first shoes were created but we do knows when that they were originally made to warm the feet. Now, there are many different types and each kind helps you functions a different way. The shoes are also

made up of many parts and every kind has different parts then other types. Year by year, shoes have been improving and increases popularity. Now, we have all the equipment and shoes better than ever. The very first pair of shoes was created many years ago. Purpose was to protect the foot. But now a day there are many different styles of shoes. Some shoes are just fashion accessory and others help us to different tasks like running, dancing and many others sports and also workouts. Sports shoes for sport players casual and formal shoes for the peoples who are want to complete their fashions of specially designed shoes for disable peoples.

In this modern world, one of the biggest problem of humanity is obesity, now a days is obesity from the young age to the older aged people for both men and women are suffering from this disorder. Obesity is when one has too much of unsaturated fat and it's enable generically or by environment factors. Today's society is all about consumption of junk foods, fast food and cold beverage ex-pizza, burger, coke etc… are more calories and lack of exercise. Obesity is a medical condition in which excess body fat has accumulated to an extent that it may have negative effects on health. People are generally considered obese when their body mass index (IBM), a measurement obtained by dividing a person's weight by the square of the person's heights, is over 30kg/m^2 ; the range 25-30 kg/m^2 is defined as overweight. Some eastern Asian countries use lower values. Obesity increases the likelihood of various diseases and conditions, particularly cardiovascular diseases and conditions, particularly cardiovascular osteoarthritis and depression.

2.0 CAUSES OF OBESITY

Obese is commonly caused by a combination of excessive food, lack of physical activity, and genetic susceptibility. A few cases are caused primarily by genes, endocrine disorders, medications, or mental disorder. The view that obese people eat little yet gain weight due to a slow metabolism is not medically supported. On average, obese people have greater energy expenditure than their normal counterparts due to the energy required to maintain an increased body mass. Obesity is mostly preventable through a combination of social changes and personal choices. Changes to diet and exercising are the main treatments. Diet quality can be improved by reducing the consumption of energy-dense foods, such as those high in fat or sugars, and by increasing the intake of dietary fiber. Medication can be used, along with a suitable diet, to reduce appetite or decrease fat absorption. If diet, exercise, and medication are not effective, a gastric balloon or surgery may be performed to reduce stomach volume or length of the intestines, leading to feeling full earlier or a reduced ability to absorb nutrients from food.

Obesity is a leading preventable cause of death worldwide, with increasing rates in adults and children. Millions of adults (12%) and 100 million children were obese in 195 countries. Obesity is more common in women than men. Authorities view it as one of the most serious public health problem of the 21st century. Obesity is stigmatized on much of the modern world (particularly in the western world), though it was seen as a symbol of wealth and fertility at other times in history and stills is in some parts of the worlds. In 2013, the American medical association classified obesity as a disease.

2.1 CLASSIFICATION

The classification of obese people are listed in the below table1

Table 1- Classification of obese

BMI(kg/m^2)		Classification
From	Up to	
--	18.5	Underweight
18.5	25.0	Normal weight
25.0	30.0	Overweight
30.0	35.0	Class I obesity
35.0	40.0	Class II obesity
40.0	--	Class III obesity

2.2 CAUSES

The causes of obese people are listed in the below table 2

Table 2- Causes of Obese

Specialty	Endocrinology
Symptoms	Increased fat
Complication	Cardiovascular diseases, type 2 diabetes, obstructive sleep apnea, certain types of cancer osteoarthritis, depression
Causes	Excessive food, lack
Diagnostic method	BMI>30kg/m^2
Prevention	Societal changes, personal choices
Treatment	Diet, exercise, medication, surgery
Prognosis	Reduced life expectancy
Frequency	700 million/12%(2015)

Obesity is a medical condition in which excess body fat has accumulated to the extent that it may have adverse effects on health. It is defined by body mass index (BMI) and further evaluated in terms of fat distribution via the waist-hip ratio and total cardiovascular risk factors. BMI is closely related to both percentage body fats. In children, a healthy weights various with age and sex. Obesity in children and adolescents is defined not as an absolute number but in relation to a historical normal group, such that obesity is a BMI greater than the 95th percentile. The reference date on which these percentiles were based date from 1963to1994, and thus have not been affected by the recent increases in weight. BMI is defined as the subject's weight divided by the square of their heights and is calculated as follows.

$$\mathbf{BMI=m/h^2}$$

Where m and h are subjects to weight and height respectively. Being overweight or fat is having more body fat than is optimally health. Being overweight is especially common where food supplies are plentiful and lifestyles are sedentary.

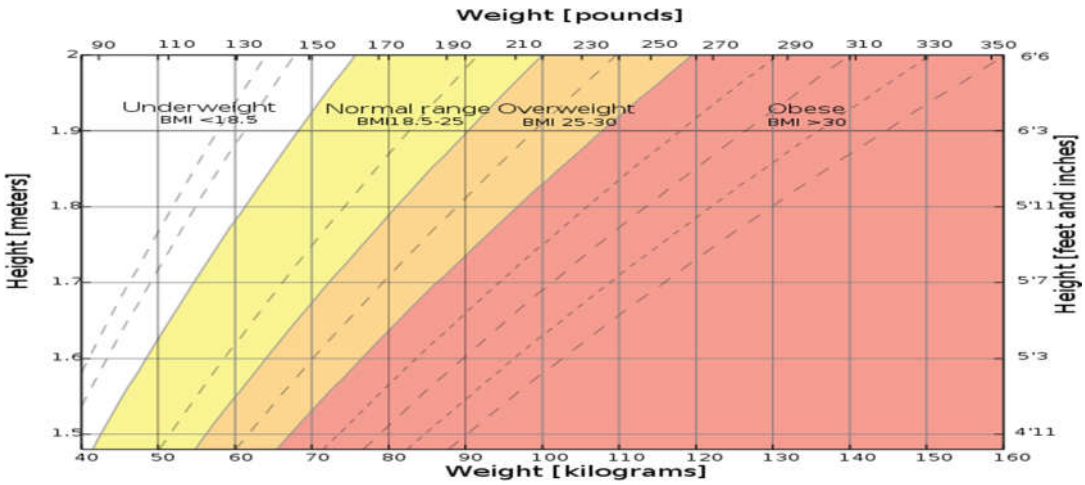


Figure 2-Obese Chart

The overweight range according to the body mass index (BMI) is the area on the chart where BMI > 25.As of 2003, excess weight reached epidemic proportions globally, with more than 1billion adults being either overweight or obese. In increases have been observed across all age groups.A health body requires a minimum amount of fat for proper functioning of the hormonal, reproductive, and immune system, as thermal insulation, as shock absorption for sensitive areas, and as energy for future use. But the accumulation of too much storage fat can impair movement, flexibility, and alter the appearance of the body.

3.0 ARDUINO MICRO CONTROLLER

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.0) or ATmega168 (Arduino Nano 2.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one. The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external powersupply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source.The FTDI FT232RL chip on the Nano is only powered if the board is

being powered over USB. As a result, when running on external (non-USB) power, the 3.3V output (which is supplied by the FTDI chip) is not available and the RX and TX LEDs will flicker if digital pins 0 or 1 are high. The ATmega168 has 16 KB of flash memory for storing code (of which 2 KB is used for the bootloader); the ATmega328 has 32 KB, (also with 2 KB used for the bootloader). The ATmega168 has 1 KB of SRAM and 512 bytes of EEPROM (which can be read and written with the EEPROM library); the ATmega328 has 2 KB of SRAM and 1 KB of EEPROM.

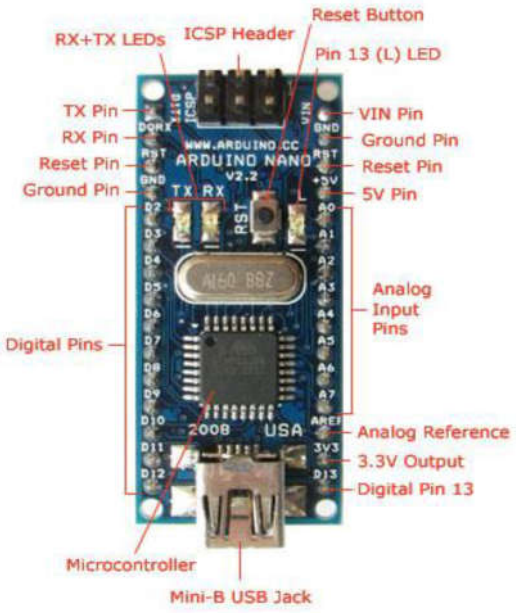
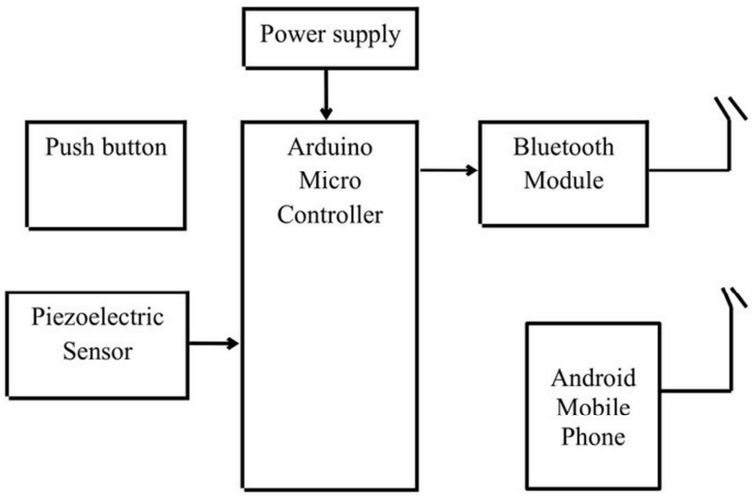


Figure 3-Actual image of ARDUINO micro controller



BLOCK diagram of this work

3.1 **SPECIF ICATIONS:**

The specification of ARDUINO MICRO CONTROLLER used in this research is mentioned in the below table 3

Table3-Specification of ARDUINO MICRO CONTROLLER

Microcontroller	Atmel ATmega168 or ATmega328
Operating Voltage (logic level)	5 V
Input Voltage (recommended)	7-12 V
Input Voltage (limits)	6-20 V
Digital I/O Pins	14 (of which 6 provide PWM output) Analog Input Pins 8
DC Current per I/O Pin	40 mA
Flash Memory	16 KB (ATmega168) or 32 KB (ATmega328) of which 2 KB used by boot loader
SRAM	1 KB (ATmega168) or 2 KB (ATmega328)
EEPROM	512 bytes (ATmega168) or 1 KB (ATmega328)
Clock Speed	16 MHz

4.0 PIEZOELECTRIC SENSORS

The proposed work portrays the concept of Piezoelectric Exercise Monitor System. The piezoelectric sensor works on the principle that gives voltage when it's pressed. In our system the sensor is placed in the shoes, when we walk it gives voltage that is interfaced with microcontroller, the controller calculates it's as steps count and converts to distance and calories using the formulae that pre-defined in it. The Bluetooth module is used to make a communication bridge with our unit and android mobile. The controller sends the data's to the android mobile which can be seen in app with the help of Bluetooth module.

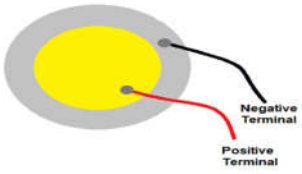


Figure 4-Photo of Piezoelectric Sensor

4.1 EXISTING SYSTEM

- In existing system Piezoelectric sensor is used for charging
- Piezoelectric sensors are used to transmit and receive ultrasonic "pings"
- we cannot store the data's and the details can only displayed in LCD module

4.2 PROPOSED SYSTEM

- We use piezoelectric sensors for counting foot step and microcontroller is used for calculating calories and distance walked.
- Android app is used to see the values.
- Calorie and distance walked will be stored and using a button we can see the details in app.

In this work we used a push button switch, when we press on it an LED glows for a second. Push Buttons are mechanical switches. Then can make or break connection between two terminals and comes back to stable state when released. They are called as Push to ON or Push to OFF switches respectively. Although most people burn around 100 calories per mile of walking or running, that's only a generalized estimate. The true number of calories you burn depends on a variety of factors, including how much you weigh and how hard you're working or how fast you're walking. Wearing a pedometer, which counts your steps, can increase your motivation to hit the trails, and Harvard Health Publications reports that people increase their overall physical activity by 27 percent after they began wearing a pedometer regularly.

Figure 5-Push Button used in this stud

4.3 Bluetooth Applications

Bluetooth network consists of electronic devices like mobile phone, smart watch etc.. It will have about 8 maximum devices communicating in a small network referred as piconet. About 10 such piconets exist in the Bluetooth radio coverage area. It supports data rate based on different versions from 720 kbps to about 24 Mbps. It will have distance coverage to about 1 to 100 meters based on power class supported on bluetooth devices. In this work bluetooth watch is connected with the device to count the stride.

Figure 6-Wireless Bluetooth Device

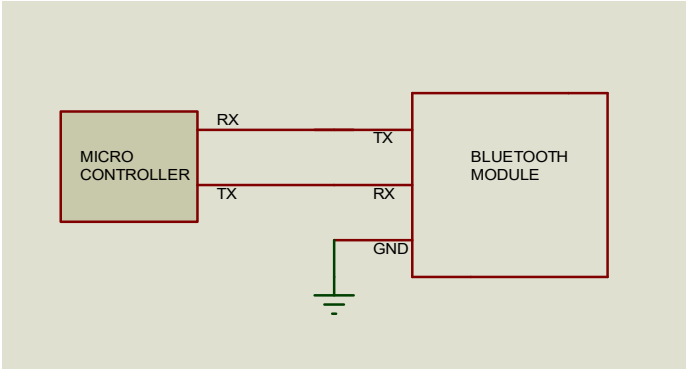


Figure 7-Block diagram of blutooth and micro controller

5.0 FABRICATION OF OBESE FOOTWEAR

Footwear is usually made up of leather or synthetic, and rubber material. In fact, leather was one of the original materials used for the first versions of a shoe. The soles can be made of rubber or plastic, roman sandals had sheets of metal on their soles so that it would not bend out of shape. More recently, footwear providers like Nike, have begun to source environmentally friendly materials. The other important materials used in the footwear fabrication is

Table 4-Materials used in this development

Description	Material
Style name	Derby
Upper Leather	Cow softy Nappa Leather
Lining Material	Sheep Lining Leather
Back Counter	Back strap
Accessories	Gun Metal
Insole Material	Micro cellular Rubber
Threads	Polyester(Tkt-120)
Adhesive	Synthetic rubber solution
Out sole	Rubber sole

Initially the upper and lining components were prepared by clicking machine. The cutted components were assemble as per the steps in the below chart. The Piezoelectric Sensor were placed between the insole and bottom socks in the fabrication process.

Figure 5-Flow diagram of this work

6.0 WORKING PRINCIPLE AND STRIDE LENGTH CALCULATION

In this research push button switch were used, when we press on it an LED glows for a second. Push Buttons are mechanical switches. Then can make or break connection between two terminals and comes back to stable state when released. They are called as Push to ON or Push to OFF switches respectively.

6.1 CONVERT PEDOMETER STEPS TO CALORIES

Although most people burn around 100 calories per mile of walking or running, that's only a generalized estimate. The true number of calories you burn depends on a variety of factors, including how much you weigh and how hard you're working or how fast you're walking. Wearing a pedometer, which counts your steps, can increase your motivation to hit the trails,

and Harvard Health Publications reports that people increase their overall physical activity by 27 percent after they began wearing a pedometer regularly.

You can purchase a relatively inexpensive pedometer to gain the motivational benefits, but it may not have all the features of more expensive products. If your pedometer can't do it for you, you will need to know how to convert the number of steps your pedometer counts into actual calories burned. You can accomplish this conversion with a few simple calculations.

6.2 CASUAL WALKING

To start, multiply your weight by 0.57 to calculate how many calories you burn in 1 mile of casual walking, which is around 2 mph or a 30-minute mile. For example, if you weigh 175 pounds, the calculation would look like this: 0.57 x 175 = 99.75 calories per mile.

To get that number down to how many calories are burned in each step, walk casually for exactly 1 mile while wearing your pedometer. Record the number of steps it took you to walk that mile.

For example, it may have taken you 2,200 steps. Divide the number of calories you burn per mile by the number of steps it takes you to walk a mile. The result is a unique-to-you conversion factor you can use to calculate how many calories you burn from the number of steps you take as you walk.

For example, the calculation would look like this for a person who burns 99.75 calories per mile and walks a mile in 2,200 steps: 99.75 calories per mile / 2,200 steps per mile = 0.045 calories per step

Multiply the conversion factor by the number of steps you take, as indicated by your pedometer, during any given walk to figure out how many calories you burned. For example, if the person from the example walked 7,000 steps, the calculation would look like this: 7,000 steps x 0.045 calories per step = 318 calories

6.3 BRISK OR POWER WALKING

When you increase the pace, you also increase the calorie burn. Multiply your weight by 0.5 to calculate how many calories you burn in 1 mile of brisk walking. This factor is based on a formula that calculates calories burned when a person walks at a rate of 3.5 mph.

For example, if you weigh 175 pounds, the calculation would look like this: 0.5 calories per pound per mile x 175 = 87.5 calories per mile

Again, walk briskly for exactly 1 mile while wearing your pedometer. Record the number of steps it took you to walk that mile. For example, it may take you only 1,400 steps because you usually take larger strides while walking briskly.

Divide the number of calories you burn per mile by the number of steps it takes you to walk a mile to find the conversion factor you can use to calculate how many calories you burn from the number of steps you took each time you walk.

For example, the calculation would look like this for a person who burns 87.5 calories per mile and walks a mile in 1,400 steps: 87.5 calories per mile / 1,400 steps per mile = 0.063 calories per step

Multiply the conversion factor by the number of steps you took, as indicated by your pedometer, during any given walk to figure out how many calories you burned. For example, if the person from the example walked 7,000 steps, the calculation would look like this: 7,000 steps x 0.063 calories per step = 437 calories

6.4 STEPS ARE IN A MILE

The average person takes between 2,000 and 2,500 walking steps per mile as counted by a pedometer, fitness band, or your phone's motion sensor. Running steps have a longer stride length and you may take between 1,400 and 1,700 steps per mile. A total of 10,000 steps equal 4 to 5 miles. The number of steps per mile varies from person to person and depends on your stride length. See ways to estimate your typical steps per mile.

6.5 TYPICAL STEPS PER MILE WALKING AND RUNNING

For a quick rule of thumb, a research study found these average steps per mile at walking and running speeds:

- Walking 20 minutes per mile (3 miles per hour): 2,250 steps per mile
- Walking 15 minutes per mile (4 miles per hour): 1,950 steps per mile
- Running 12 minutes per mile (5 miles per hour): 1,950 steps per mile
- Running 10 minutes per mile (6 miles per hour): 1,700 steps per mile
- Running 8 minutes per mile (7.5 miles per hour): 1,400 steps per mile

Using these averages, here is how far you might go using various step totals.

Steps	Walk (Shorter Stride)	Brisk Walk/Jog (Moderate Stride)	Run (Long Stride)	Fast Run (Very Long Stride)
1,000	0.4 miles	0.5 miles	0.6 miles	0.7 miles
2,000	0.9	1.0	1.2	1.4
3,000	1.3	1.5	1.8	2.1
4,000	1.8	2.1	2.4	2.9
5,000	2.2	2.6	2.9	3.6
6,000	2.7	3.1	3.5	4.3
7,000	3.1	3.6	4.1	5.0
8,000	3.6	4.1	4.7	5.7
9,000	4.0	4.6	5.3	6.4
10,000	4.4	5.1	5.9	7.1
12,000	5.3	6.2	7.1	8.6
15,000	6.7	7.7	8.8	10.7
20,000	8.9	10.3	11.8	14.3
25,000	11.1	12.8	14.7	17.9
30,000	13.3	15.4	17.6	21.4
40,000	17.8	20.5	23.5	28.6

6.6 STEPS PER MILE ESTIMATED BY HEIGHT

A widely quoted estimate of stride length is 42 percent of height, although further research shows that ratio is only moderately accurate. Many pedometers use these estimates and ask for your height during setup. Rough estimates of steps per mile based on a stride to height ratio are:

Height	Steps per Mile
4 feet 10 inches	2,601 steps
4 feet 11 inches	2,557 steps
5 feet even	2,514 steps
5 feet 1 inch	2,473 steps
5 feet 2 inches	2,433 steps
5 feet 3 inches	2,395 steps
5 feet 4 inches	2,357 steps
5 feet 5 inches	2,321 steps
5 feet 6 inches	2,286 steps
5 feet 7 inches	2,252 steps
5 feet 8 inches	2,218 steps
5 feet 9 inches	2,186 steps
5 feet 10 inches	2,155 steps
5 feet 11 inches	2,125 steps
6 feet even	2,095 steps
6 feet 1 inch	2,067 steps
6 feet 2 inches	2,039 steps
6 feet 3 inches	2,011 steps
6 feet 4 inches	1,985 steps

7.0 CONCLUSION

This method of using piezoelectricity principle has been successfully incorporated to monitor the exercise at run time in terms of walking / jogging performed by a obese person. Thus, the number of calories burnt is obtained as a result. On fly, the target for the day can be set and current number of calories burnt against the required can be displayed. Thus, this will be extremely useful for athletes, professional sportspersons and even in gymnasiums for people participating in weight loss programs.

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