Preliminary Design Report with Diagram(s)

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Project Title:

3PM

Team Name:

The Beatkicks

Project Abstract:

Our project consists of building a pedometer that will go under a user’s shoe insert. Every time the user takes a step a pulse will be sent out wirelessly to a music device (mp3 player). The frequency of the pulse sent will depend on how fast the user is stepping, which could be at a running, jogging or walking pace. Our music device will interpret this information and will pick up a song closest in tempo to the speed of the user. Furthermore, we can display and log the information like: average pace of the run and distance traveled. Our sensor will include some kind of piezoelectric device that will produce a small amount of current when a stress/strain is applied. This information will be transmitted wirelessly by using either a Nordic chip or some other wireless data transfer protocol. On the receiver side an mp3 decoder in slave with either an ATMEL or PIC micro-controller will receive this information and will decide on which tune to select.
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Table 1. Division of Labor
Overview of 3PM Process

Figure 1: Overview of the 3PM Process
**Project Features/Objectives**

The main objective of this project is to design a sensor and a music device such that both modules can communicate wirelessly to pick up a song closest in tempo to the speed of the user. There are two parts to *3PM*:

**Shoe/Calf/Belt Sensor**

- A piezoelectric sensor or an accelerometer. As the transducer is displaced from the mechanical neutral axis, bending creates strain within the piezoelectric element and generates a voltage (we are considering either Piezoelectric sensor or an accelerometer.)
- When the piezoelectric element generates voltage, an interrupt is fired within PIC (we have not decided what kind of PIC we will use.)
- The information regarding the pace of the user is sent wirelessly to the music device probably through an Xbee chip.

**Music Device**

- The music device receives information from the sensor.
- Goes through the play-list stored in MMC/SD card and picks out a song closest to the pace of the user.
- Displays current pace of the user, distance traveled on the LCD screen and the BPM of played song.
- If time permitting we will also try to incorporate other mp3 player functionality, for example skip a track, display track information, raise or lower the volume.
**Concept/Technology**

The overall objective in our project is to develop a pedometer that will wirelessly transmit a reading of the amount of times your feet hit the ground, or the pace of your stride, to an MP3 decoder controlled by a microprocessor that will associate the pace of the user with the beats per minute (BPM) of a song from a predetermined selection of songs, each having their respective BPM’s tagged.

*Piezoelectric / Accelerometer*

The main component of the pedometer we are intending to design is the piezoelectric sensor or an accelerometer. Several considerations must be made in the choice of selecting between these components as the essential data-acquiring element. The piezoelectric sensor generates a voltage proportional to the force exerted on the sensor. This may create a problem in maintaining a voltage steady enough to generate a pace, perhaps relying on an op-amp or a voltage regulator to limit the output voltage. Because the accelerometer is not dependent on the amount of force exerted on the component but rather on the acceleration of the pedometer, a feature that can facilitate the detection of a pace from our user. This may also open up more options for our pedometers placement on our user’s foot, calf, or belt.

![Figure2: Nike+iPod Piezo](image)

*PIC*

We intend to incorporate a PIC microprocessor in our pedometer design. The PIC will be used to generate or fire interrupts at a given interval to provide a time reference in order to measure the user's pace off of the piezoelectric/accelerometer acting as a counter. The processor will need to have the necessary specifications to interface between the piezoelectric/accelerometer and the transmitter, considering using a Xbee. We have looked into using a 32bit PIC but have realized that this may be more than needed.
Microcontroller for Music player

In order to provide above proposed features for the music device, we will have to choose some type of controller to process the wireless signal from the sensor, be able to interface it with mp3 encoder chip and SD/MMC card. At this point we will be using an Atmel ATMEGA chip; however, we have not finalized which chip will be used. The Atmel chips have a built in UART and A/D.

Mp3 Encoder

Since, the main goal of our project is not to build an mp3 player we will be using a breakout board designed by SparkFun Electronics with a vs1002 mp3 IC. The vs1002 IC does all meaningful communication over the SPI port.

Figure3: vs1002 mp3 encoder chip

microSD Transflash

Compatible with the SPI interface found on any SD card, will be used as a storage device for mp3’s.

Figure4: Breakout Board for microSD Transflash

Wireless Protocol

We will probably be using Xbee for our wireless needs of the project. Not only Xbee is one of the cheaper options but also the easiest one to configure. Since, the project is quiet complex we might have to make some sacrifices on the size limitations of the sensor.
Power

We are planning to have the sensor part run on a 3V battery hopefully and the music part from a 5V battery. Both parts will be demoed using portable batteries.

The Competition

There are many pedometers in the market, which calculate the number of steps taken, or distance traveled by a person. However few of these pedometers integrate music with their device. Even though Apple Inc. has partnered with Nike to bring the Nike + Apple pedometer into the market, we would like to incorporate a new functionality into its operation. We wish to provide the user with a device that automatically selects a song matching the closest tempo to his or her pace. Therefore, we not only want to design and build a pedometer but also a music device that will select a play list according to the pace of the jogger/walker. We believe that this functionality will provide instant motivation for the user to interactively listen to music as they exercise. Below is Apple’s Nike + iPod Sport Kit:

![Image](image.png)

Figure 5: Nike+iPod Competition

Technical Concepts

Our project is quite challenging. Both the team partners have to research and learn some new electrical engineering concepts. For example, wireless communication, using mp3 encoder. Following are the technical difficulties we will have to overcome in order to have a successful project:

- Delivering the necessary power to the board. We still have to determine which module will draw the most power. We presume that the Xbee modules will draw the most power.
- We have to consider the size of both the sensor and the music player. Since this is mean to be a portable device we will have to mindful that the device is in fact portable. However, due to time limitations and budget restrictions our device may accrue some extra size.
- The third challenge would be how to get accurate information from the sensor, we will have to program some interrupts in the sensor side of things to calculate the pace of the jogger accurately.
- Wireless transmission of data. Both of us have no prior experience in using wireless chips.
- Using the vs1002 mp3 encoder chip. Some good documentation is available for this IC.
**Figure 6: Overview of the Software**

**Division of Labor**

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*Table 1. Division of Labor*