Digital Braille Watch

Team Members: Joel Gaston, Ryan Kimmel, Allison McArton, Robert Bjerregaard
Department of Biomedical Engineering
Advisor: Walter Block, Ph.D, UW-Madison
Client: Holly and Colton Albrecht

Abstract

Currently, the only portable devices that allow for the visually impaired to tell time are audible watches that "speak" the time and analog watches that have different dots at the 3, 6, 9, and 12 o'clock positions where the individual uses touch discrimination to determine the time. While these methods work, audible watches can be disruptive and tactile analog watches can easily be misread. Digital Braille clocks that exhibit Braille numerals do exist, yet these are not portable and are meant to stay at a stationary location. Previously, a design team utilized four vibro-motors, and it created a device that displayed the time in Braille using a computer and a personal measurement device. This system was not portable, and it was hard to distinguish the different vibrations. This prototype focuses on a portable unit that utilizes code written in C with CodeVisionAVR for microcontroller functions, while considering two-point discrimination.

Problem Statement

Motivation

People who are visually impaired have limited options for telling time. Younger people who are not good at reading analog Braille watches can only use talking watches that are disruptive.

Background

Braille letters are printed using combinations of dots. The platform for these dots is two rows of three columns. Braille numbers only use the top two rows, which means they are displayed using four dots (Figure 1).

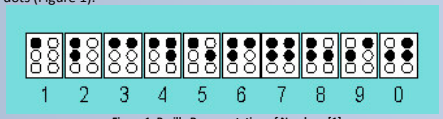

Figure 1. Braille Representation of Numbers [1]

Most audible watches appear very similar to popular digital watches, but contain a button that activates an audio output of the current time. The advantage of this design is that it is almost impossible to misread the time, because it is read aloud to the user. The disadvantage is that the sound that enables the user to tell time can also be distracting to others, especially in a quiet setting. The Kentucky Department for the Blind has designed and built a "Digital Braille Clock Calendar" using six Braille cells [2]. It is easy to read, and it is not disruptive, but it is not a portable device. Finally, many analog Braille watches are made commercially, but they can be difficult for some younger people to be able to read (Figure 2).

Figure 2. Example of an analog Braille watch [3]

Client Requirements

- Digital military time watch
- Time displayed in Braille
- Watch must fit on the wrist or in a typical pocket
- Silent system that is not disruptive
- Battery life of 10 years

Final Design

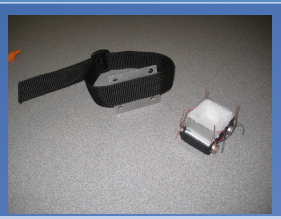

Figure 3. The digital Braille watch (on the right) and the strap.

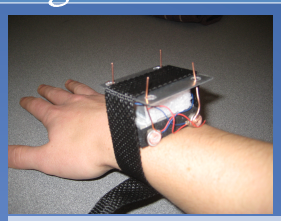

Figure 4. The watch being worn on a wrist. It could also be kept in a pocket.

Method of displaying time

The watch displays the current time by using four vibration motors in conjunction with Braille numbering. The vibration motors are arranged in a square with one motor in each corner of the square, as seen in figure 3. When the user pushes the activation button, the braille numbers corresponding to the time are "scrolled" across the vibration motors, with each digit causing the motors to vibrate for about 1 second, with about a second between digits.

Microcontroller Control

An Attiny24 AVR microcontroller is used to store and increment the time, as well as cause the vibro-motors to vibrate in the correct order. The microcontroller uses an external 32.768kHz quartz crystal to increment the time with a high degree of accuracy, losing only a couple milliseconds per year. When activated, the correct motors are powered on directly from the microcontroller.

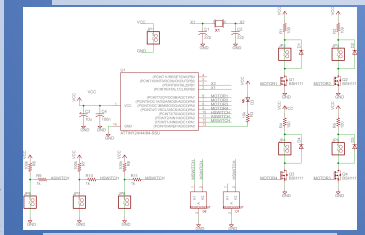

Figure 5. The circuit diagram connecting the vibro-motors to the microcontroller

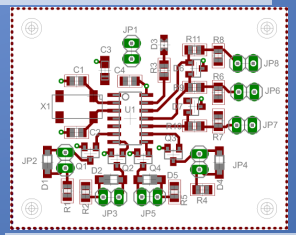

Figure 6. The circuit diagram connecting the vibro-motors to the microcontroller

Programming the microcontroller

In order to program the microcontroller, the CodeVisionAVR application was utilized. This program has extensive functionality and allows the user to program the microcontroller in the C language rather than the assembly language. Using the finite state philosophy, the program loops between two states: buttonOff (no output necessary) and buttonPushed, which displays the output and then returns to the buttonOff state. This allows for continual looping, which saves power by eliminating the need to always have motors on. By tracking the seconds, the program increments the minutes and hours when needed. The minutes and hours were divided into two variables each, one for the tens and one for the ones digit for each. This provided an easy method for converting the time into four digits and executing the different motor sequences.

Acknowledgements

A very special thanks to Professor Mike Morrow and Erick Oberstar for helping us develop the circuit diagram and program the microcontroller.

Testing

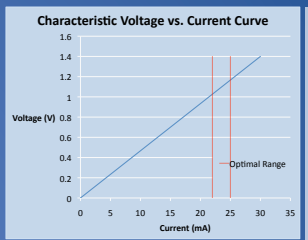

Figure 7. This graph shows the relationship between voltage and current for the vibro-motors. The optimal operating range is 22 to 25 mA, which corresponds to 1 to 1.18 V.

- Tested the vibro-motors for the amount of current to be sent through each motor
- Determined if able to discriminate between vibrations on the finger
- Tested whether or not a vibration in one motor was transmitted to another motor
- Calibrated the time pause between each display of a number
- Tested if able to put on the watch and locate the pulses with eyes closed

Future Work

Now that the watch keeps track of time on its own, a future team can start adding functions to the watch. The watch can theoretically display the date using a sequence of numbers. The team can add date functionality to the time-keeping program, and either use the same prompt button or add a second button that tells the watch to display the date. f the team decided to use the same button, they could have the watch display four numbers – two for month, two for date – following the four numbered time sequence. t would be more difficult to integrate a second button to be used for displaying the date, but this would be more convenient and less confusing for the user.

Another thing that can be improved upon is the housing of the motors. Currently the motors are on the outside of the watch, which is not the most structurally sound design. The circuit components could also be embedded in the anti-static foam to reduce the overall size of the product.

Cost Analysis

4 Vibromotors	$27.80
Microcontroller	$3.00
2 Design Platforms	$160.00
Nylon Strap	$1.43
Printed Circuit Board	$33.00
Total	**$225.23**

References

[1] http://www.datamath.org/Related/Schoenherr/IMAGES/Braille_Digits.jpg
[2] Wayne D. Thompson, Kentucky Department for the Blind, <http://www.blind.ky.gov/Technology/BrailleClock/clock_description.txt> Retrieved 24 Sep. 2008
[3] http://www.geocities.com/Eureka/Concourse/3294/cortblind.jpg
[4] http://www.sparkfun.com/commerce/product_info.php?products_id=8449