In a Heartbeat: Pulse Sensing in Context

INFO 4871: Personal Health Informatics, Fall 2020

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This project aims to address the lack of pulse sensing applications with a user-friendly visual interface that not only take and display the user's pulse but display that data in the context of that of a general populace, including a visible range of heart rates that are generally considered to be healthy and how the user's pulse fits into that range. We went about solving this issue by creating an application using C++ that takes the user's pulse using an Arduino and a connected pulse sensor, then displays that information back and allows the user to "zoom out" and view their heart rate data in the context of others' data. The main things that we found were that devising this application proved to be surprisingly difficult, and that it would take quite a bit more time to adapt this application for use on a mobile phone interface.

CCS CONCEPTS • Human-centered computing~Human computer interaction (HCI) • Applied computing~Life and medical sciences~Health informatics

Additional Keywords and Phrases: Pulse sensor, heart rate, heartbeat

ACM Reference Format:
Leo J. Strong. 2020. In a Heartbeat: Pulse Sensing in Context: INFO 4871: Personal Health Informatics, Fall 2020. 4 pages.

1 INTRODUCTION

The problem I have chosen to solve is that of the lack of information visualizations and sonifications in the field of pulse sensing – more specifically, within applications that are intended for users to view and take into account when determining or revising an approach to their own personal health. I would argue that this is an important topic because information about one's resting heart rate, despite being a relatively simple piece of data, can be a solid indicator in determining one's overall health, and a way for the user to gather this information quickly and easily could potentially be highly beneficial. Additionally, the function of the application that puts the user's data in context and shows it within the range of heart rates that are average and/or generally considered healthy provides a meaningful reference, rather than simply displaying the individual data alongside information about whether it falls within that range, without providing the context of what that range looks like.

This assignment "riffs" off of my original HW4 assignment, in that it is essentially an extension/application of that project using an actual pulse sensor to gather information from the user, building upon the original design framework to ideally lead to further application in the real world. I wrote an application using C++ and an Arduino board to develop my original design ideas and provide a rudimentary example of what the fully-developed app might look like.

I consider the main contributions of this project to be a rough prototype of a pulse-sensing application that has the capacity to capture and display not only the user's pulse data but that of a general sample populace as well. I think that having accessible context for one's personal information can be very beneficial, especially when determining whether to make certain lifestyle changes – or how those changes might impact your overall health and wellness. Although my design work isn't necessarily groundbreaking, I would suggest that it could be

potentially useful for others who are considering developing similar projects and are looking for a subject to build off of.

2 Background/Related Work

My design work was inspired by the information visualization on how Americans spend their time, which uses the dataset of American Time Use survey responses. The primary design element that stood out to me was the use of individually colored dots to represent subsections of the population as well as how the designer used movement to showcase the data in a visual that catches the viewer's attention and provides unique information every second. While I wasn't able to replicate every aspect of this design that I felt was eye-catching and useful, it provided me with some valuable insight that I was then able to apply to my own design work.

For the user, collecting data about their heart rate could potentially have a number of benefits, especially in cases where they are concerned about a potential health issue that might be linked to a higher or lower resting heart rate. Since heart rate data is relatively simple and easy to collect, keeping a log of one's resting heart rate – using the pulse sensor that makes up part of this project – could not only be useful for the user's reference but for presenting to a healthcare provider. Visiting a doctor once a year only provides a brief snapshot of the patient's life and doesn't necessarily indicate their overall health, and while current doctors may shy away from patients bringing in their own self-logged health information – with some even suggesting that the patient logging this data implies an underlying psychological issue – the pulse data is arguably more useful than not [1]. In addition, what works for some users may not work for others, and while some doctors and researchers might be more likely to apply a certain metric to each patient, engaging in reasonable levels of self-experimentation has the potential to lead to new discoveries and beneficial results – spurred on by the initial data [2]. Ideally, observations and conclusions made by the doctor would be in agreement with the user's pulse data, similarly to how the sensor-based measurement was in agreement with the direct observations made by the medical trainee in Rabbi et al. [3]. Additionally, this data collection may lead to lifestyle changes in terms of stress and self-reflection; by taking the time to sit or stand still to collect their most accurate resting heart rate, the user may be stepping back from their busy day for at least a moment of calm, a break that could not only be beneficial in terms of recording consistent, accurate measurements, but may also encourage the user to take more scheduled time to step back and learn to better manage the stress they may be dealing with. In any case, much of the prevalent research in the field involves designing for reflection, as is expanded upon in the Fleck and Fitzpatrick article, with one of the primary goals of digital technologies being to encourage the user to examine the information and acknowledge relationships between pieces of experience or knowledge, then revisiting those elements with the intent to reorganize and/or do something differently [4].

3 (For Design Studies) Design Proposal(s) and Rationale

My designs were aiming to elaborate upon existing heartbeat sonifications and visualizations. I sought to address the lack of applications to place the user's heartbeat in a contextual framework that are currently available in the commercial product space. While other pulse sensing apps exist, there did not seem to be very many that fit into this particular niche.

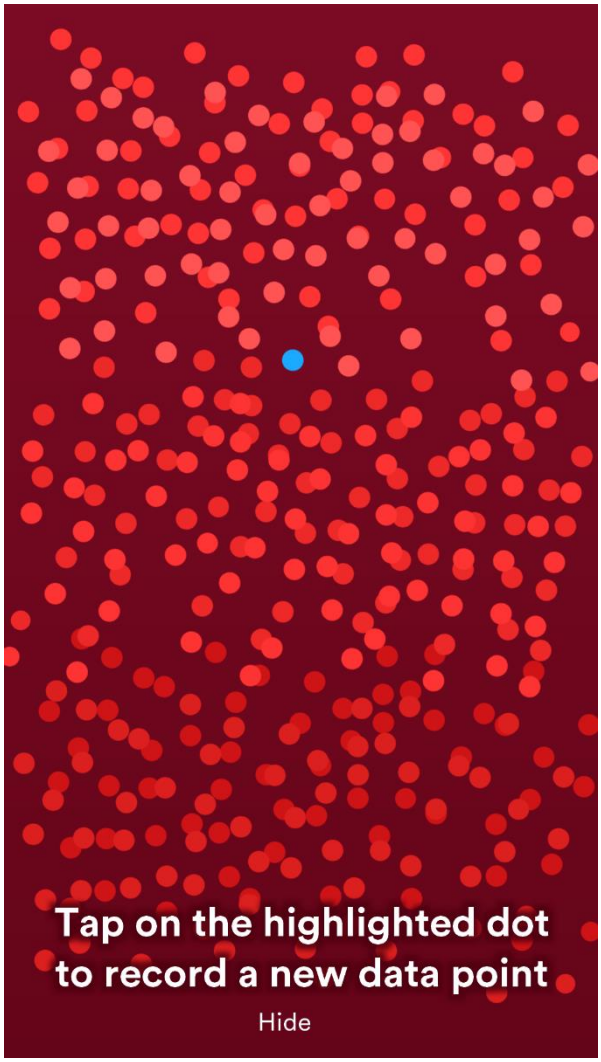

Figure 1. The main menu of the proposed pulse sensing app, shown here in static format. Each red dot scattered across the screen represents another user's data; the dots are distributed by their associated heart rate information. The "highlighted dot" specified in the instructional text at the bottom of the screen is a bright blue dot in the upper part of the screen. The smaller "Hide" text at the bottom refers to the message displayed above.

Figure 2. Screen that is displayed after the user selects the highlighted dot on the main menu, shown here as a static image. The user's name and blood type are to be entered when initially logging data and stored as a way to keep track of the person using the app. After taking the user's pulse, the application repositions the highlighted dot on the main menu in the part of the heartbeat 'map' where it now belongs.

4 Conclusion

Ultimately, the product of my design didn't exactly turn out the way I would've liked it too; I had a lot of difficulties attempting to merge the Arduino board and pulse sensor with my original design concept, especially since the code I wrote for the animations that were intended to serve as the basis for the information visualization had a lot of issues that I was unable to fully resolve. However, I think that even without the accompanying effects, the primary overall goal of the application – collecting the user's heart rate data and placing it in context – is still met. While these issues might limit the audience for my solution, I don't think that they would uncover some

higher-level issue with PHI systems, since the errors were mostly technical on my part and wouldn't necessarily translate to further development of this project once the relevant issues with the code were resolved.

This project taught me that while designing an application for personal health informatics may seem simple enough on paper, actually creating that design and implementing it in such a way that it provides the user with information that they wouldn't already know or be able to find out easily is surprisingly difficult. From this final project, I took away that knowledge as well as the experience of attempting to create a complex application in C++, something that I had never attempted before. I'd argue that working on this project has helped me to improve my C++ skills as well as my ability to merge different pieces of technology in a project and develop an application using multiple different tools. This assignment has taught me a lot about personal health informatics, and I look forward to potentially continuing work on the subject in the future.

ACKNOWLEDGMENTS

Thanks to Stephen Voida for loaning me an Arduino SparkFun RedBoard and an accompanying pulse sensor for this project.

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