Panic Button - A Safety Device

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***Abstract*—This paper describes details about a safety device called "Panic Button" . We have developed an end-to-end product which enhances safety of any individual. The device is mainly a small button of size of pack of gum with a android interface. The button has many functionalities. The product also has analytics dashboard which helps in performing analysis to draw insights into the problem.**

I. Introduction

THE crime rate in United States has been going down steadily during the past decade. Despite that the estimated number of violent crimes rose 3.9 percent from 2014 to 2015, violent crime, however, is about 0.7 percent lower than five years ago, and 16.5 percent lower than a decade ago. The violent crime rate – nearly 373 violent crimes per 100,000 inhabitants in the U.S. – is almost half the 20-year high reached in 1996[1].

However, several recent researches show that the number of people that are afraid of walking alone at night, in the fear of getting assaulted by criminals, hasn't gone down a single bit when compared to the statistics almost a decade ago. There's a noticeable gap here between the actual crime rate and people's sentiments on walking alone at night. In fact, there's not much people can do about it especially when they are outside alone at night whether due to late work shifts or office meetings. The device we are building is an initial effort to tackle this problem. The goal is to provide people a viable way to protect themselves against the danger.

This paper consists of five parts. First it will discuss the development and design of the panic button device. It then shifts to the android application and the design choices made there. An introduction on the data analytics platform will be made to demonstrate the possible future use cases. Finally future enhancements will be discussed to show possible improvements and limitations that this project is facing.

II. Panic Button Device

A. Preliminary Investigation

The device is designed to be a wearable component that the user can stick it onto their clothes. It should be no larger than an ipod nano, or the size of a keychain. The device also needs to be able to communicate to the phone. Due to the energy consumption and cost of goods, we decided to use Bluetooth Low Energy(BLE) as the technology to complete the bi-directional communication and data transfer between the device and the phone. This way a coin battery or very small capacity rechargeable lithium battery can be used to cut down both the cost and the size of the actual device.

Three big requirements of making the device available for mass audience is to make it affordable, portable, and usability. The affordable part is easy to achieve with nowadays hundreds, if not thousands manufacturers support customizable circuit boards at a very low price. The portable part too is not very hard to achieve. There are readily in use mature circuit board dips like RF-duino, mini-duino and simblee that are all at a very reasonable cost. After a brief investigation we decided to use RFduino dip as the circuit board. It is at the size of a pack of gum, supports BLE natively, and the cost is on-par with other alternatives.

Lastly, the usability will be achieved by using as few components as possible to make the functionalities that we need. This can reduce the error rate in the mass manufacturing of the final product, and also reduce the failure during the normal usage of the device by the end users.

B. Final Product

The device is a 3 inch x 2 inch x 4 inch circuit board with a built-in button, LED light, and active buzzer. See figure 1.1 below:

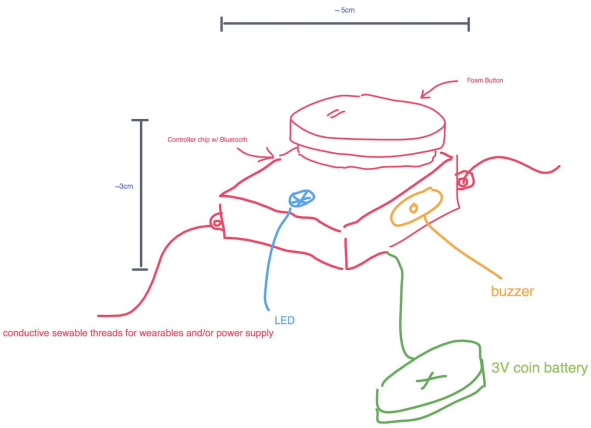


Figure 1.1 A sketch of the device

The device uses a 3.3V coin battery to operate. The battery life is estimated at roughly 30 days. The device also has hooks that can be threaded to the cloth or to a velcro strip for detachable usage. The LED is able to light up in any combination of red, blue and green color. Once stitched to the cloth, it will be hidden under the fabric and only the button is facing outwards so that it can be clicked from over the fabric. See the figure 1.2 below:

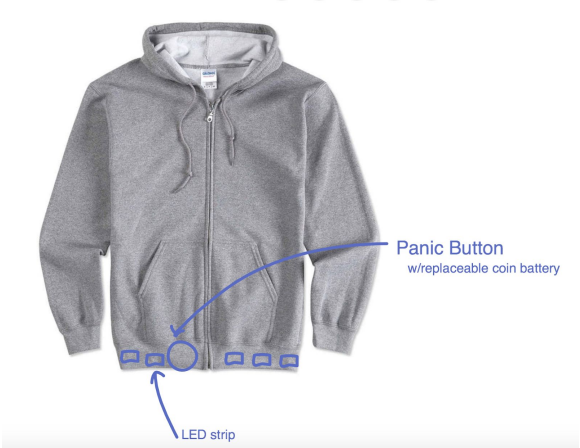


Figure 1.2 A demonstration on the wearable device

C. *The Intended Workflow*

The device works as follows when the user feels any sort of danger when outside:

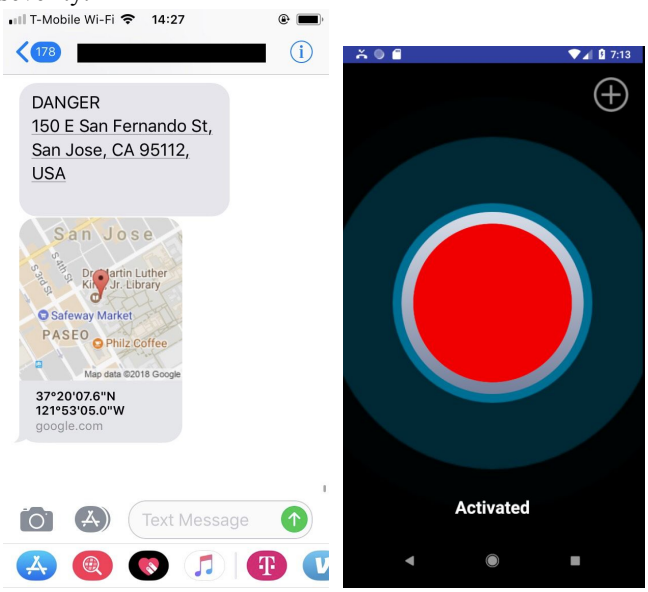
- When press twice, notifies your friend(s) via text of a preset text message. location share once.
- When press three times, the device starts alarming, text friends with a different preset message, location sharing to all.
- When press four times, the LED starts blinking, location sharing in real-time.
- When press six times and hold for longer than 2 seconds, it dials 911 or any preset number on the phone.

III. Android Application

A. Functions

The Android application handles bluetooth signal sent from Panic Button device. Based on the signal received from the device, the application is capable of taking the following actions:

- initiate an emergency call
- broadcast address of the current location via SMS message
- broadcast Google Maps url via SMS message
- communicate with Bluemix to record crime location and severity.



B. Possible Signals

The app triggers actions based on number of clicks on the panic button. We assume that more frequently the user clicks the button, higher is the severity of the situation. Based on this factor the applications reaction is coded as below.

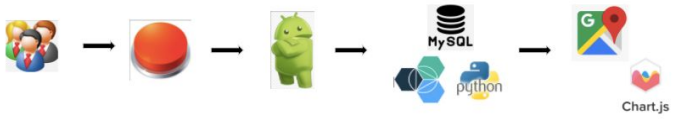
1. two consecutive clicks triggers an Emergency SMS to favourite contact in the saved contacts list and reports incident to bluemix app.
2. three consecutive clicks triggers the same SMS to all contacts in the list.
3. on four consecutive clicks the button starts triggering SMS every 30 secs to all contacts.
4. six consecutive clicks triggers a call to 911 with highest severity.

The app also has a basic contact manager feature where the user can update the contacts he would like to alert in emergency situations. There is a lot of scope for

improvements here to improve the user experience with improved features and battery optimizations.

IV. Data Analysis with Bluemix

A. Architecture



B. Backend Technical Stack

For this project's backend part, there is a Python application being deployed on Bluemix which uses Flask web framework. Flask is a microframework for Python based on Werkzeug , Jinja 2 (Reference [2]). A MySQL database instance is also launched on Bluemix. It is used to log any panic call form the android app. The current database has following schema:

<incidentID, severity, incidentDate, city, country, latitude, longitude, state>

The main backend business logic uses Google Map's reverse geocoding API (Reference [4]) for getting the exact geographical location form the latitudes and longitudes passed to backend by the android app.

The project also queries the database to run few sample analysis. Currently the analysis runs queries to generate following data:

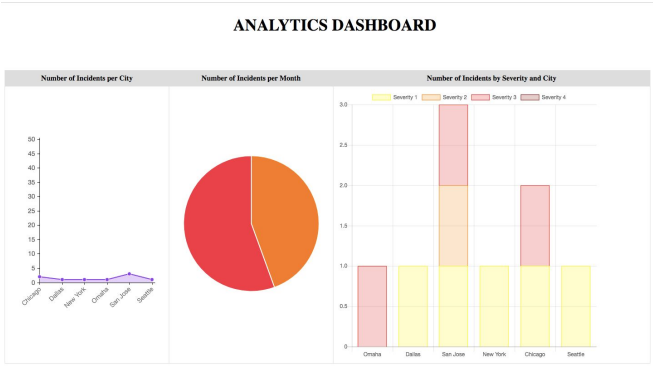
- Number of Incidences per City
- Number of Incidents per month
- Number of Incidents by Severity and City

The results of the analysis are displayed in the form of an *analytics dashboard*. The dashboard uses Chart.js framework (Reference [3]) to generate different types charts like pie chart, histogram etc. Chart.js is a JavaScript library used to draw different types of charts by using HTML canvas element.

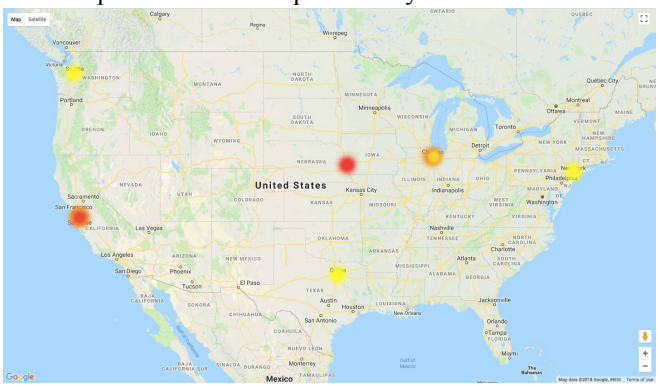
Using Google Map's heatmap API (Reference [8]) the application generates heatmap with respect to severity of incidents at various locations. There are 3 different colors for 3 different severities; red - severity 3, orange - severity 2 and yellow - severity 1.

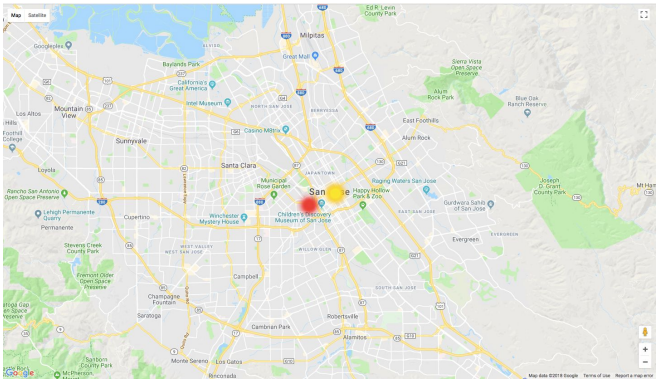
C. Analytics Dashboard & Heatmap

Analytics dashboard can be of great help for crime analyst to analyze patterns in crime and develop strategies. The analytics dashboard looks as below:



Heatmap generated using Google Map APIs marking different panic incidents as per severity looks as below:





V. Future Enhancements

Future enhancements on the physical device can be summarized into three categories. Firstly, the coin battery at the moment is attached to the circuit board via a short wire. This can eventually break due to the daily wear of the cloth. One solution is to solder the battery to the back of the device. Secondly, the LED is not very visible from outside of the cloth, if possible a LED strip should be built and attached to the outside of the cloth so that it's more visible to

other people on the streets when the danger happens. Thirdly, at the moment the cost of goods is too high, the prototype costs around $80 and it needs to be lowered to be at least below $30 in order to attract consumers. We believe this can be achieved by mass produce the circuit board.

The analysis can be extended in the future by gathering more data and then using Machine Learning (ML) to derive patterns and develop preventive measures to avoid such incidents in the future.

In Future this platform can be integrated with the police/security department of the organization associated with the end user. University police is the best example of this. Current our school campus has “Blue Phone Booths” installed all over campus which can be used to reach university police in case of emergency. Such installation can be replaced with panic button issued to each student which can improve the effectiveness of campus security.

The android app will also be improved with many battery optimizations and features like leveraging machine learning to adapt to user behaviour and severity of situations. Configuration of android applications reaction based on number of clicks.

VI. Acknowledgment

The preferred spelling of the word “acknowledgment” in American English is without an “e” after the “g.” Use the singular heading even if you have many acknowledgments. Avoid expressions such as “One of us (S.B.A.) would like to thank ... .” Instead, write “F. A. Author thanks ... .” **Sponsor and financial support acknowledgments are placed in the unnumbered footnote on the first page**.

VII. References

[1] https://www.fbi.gov/news/pressrel/press-releases/fbi-releases-2015-crime-statistics
[2] Flask Python Web Framework -http://flask.pocoo.org/
[3] Chart.js Framework - http://www.chartjs.org/docs/latest/
[4] Google Map APIs for Geocoding - https://developers.google.com/maps/documentation/geocoding/start
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[7] Google Map’s Heatmap API - https://developers.google.com/maps/documentation/javascript/examples/layer-heatmap