# Warning Coverage (Security Blanket)

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## Introduction

### Objective

Everyday people visit public areas, and they stay at public areas for various of reasons. In the public area, it is highly possible that people will leave their items alone for a while, for example restroom usage, pick up a phone call from others, or even a smoke break, then come back keep working. For example, café and libraries are two of the most common places students will stay for study.

Research has shown that on average one person[1] lost 1.24 items a year and people spend 2.5[2] days on average every year trying to retrieve their items yet less than half of those are ever recovered, then on average it cost them 220 dollars to replace the item. But some lost are invaluable, a cell phone lost might be remedied by purchasing a new one while the data in the lost phone will never come back. Weekly, 12000 laptops lost weekly in US. Airports[2], along with the data with it. “I left my bag on the table close to me and my colleagues, but for a few brief seconds we were all distracted[3],” says the writer, he shared his experience on The Guardian about his item stolen in a restaurant. We can see that even the owner is present, he might get distracted by other things and ignore his belongings for a moment, which gives thieves a great opportunity to steal.

Our goal is to eliminate these situations described above as much as possible by introducing our project, the Security Blanket. The blanket consists of various sensors, once armed, will monitor the status of the blanket and the things underneath it. When the anomaly behavior is detected, the blanket will warn the user through paired cellphone and also buzz loudly to draw attention from public, thus force most of the people including the owner to focus on the object. Also, when anomaly behavior detected the twine in the cinch module will contract and tighten the stuff underneath it when applicable. In addition, the blanket can be set to auto arm itself when detected that user has gone out of the preset range, and can warn user wirelessly if the blanket bas been armed for too long time.

### Background

As mentioned above, people lost or get stolen their belongings from day to day, and it costs not only the price of replacing the item, but also the time trying to find and replace the item, and most importantly, the invaluable memories in the electronic devices, notes on the book. According to the statistics provided by FBI, on average only 27.6% of stolen items recovered in 2016[4]. And even if the item is present with its owner, the owner might get distracted by other things and leave the item ‘unintentional’ for thieves to easily take away. “I didn’t see my laptop being taken and I was not confronted or assaulted by the thieves – but it was a shocking intrusion. I felt vulnerable and stupid, and

for a few days, it ate away at my sense of control and security. What really got to me were the little things," says the owner of the stolen items, and he was with the item and got distracted while brainstorming with other colleagues. Another example would be on the plane, while passengers put their carry-on luggage in the cabin and leave it alone for the entire flight and there are more and more thieves are eyeing on the carry-on luggage, the Hong Kong police recorded a 25% rise in the number of cabin robberies in 2015[5].

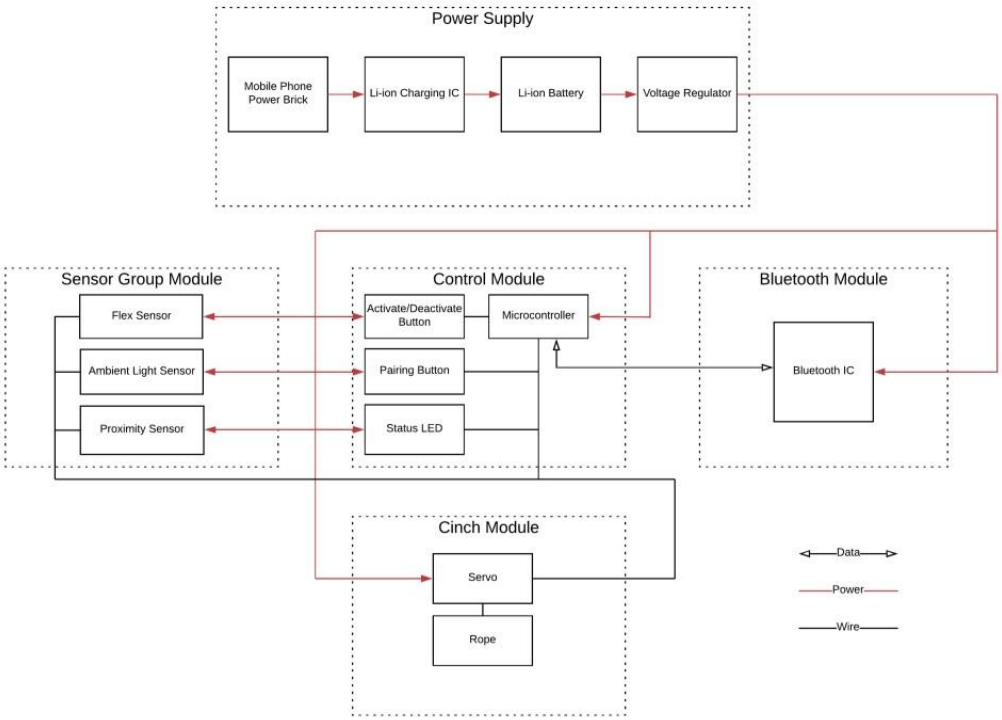
Our project is meant to notice user, get their attention back to the items, or draw public attention if the anomaly behavior is detected with respect to the blanket or the items underneath it.

### High-level requirements

- Blanket must foldable and portable so that it can be used on daily basis and carry around by the user.
- Blanket must be easy to recharge and could still working during the process of charging.
- Blanket must be able to continuously working 24hrs without recharge.

## Design

### Block Diagram



## Functional Overview

Our blanket requires 5 modules for complete and successful operation: a power module, a Bluetooth module, a control module, a sensor group and a cinch module. The power module ensure that the coverage will operate at least 24 hours without recharging and it will provide enough power for the servo in the cinch module to work when malicious behavior is detected. The control unit handles the incoming data from sensor group and transfer the coverage status through Bluetooth to the user. The Bluetooth module will not only be used for coverage status update, but it will also enable user to remotely pull the alarm on the blanket. The sensor group contains different types of sensor to monitor the status of coverage, for example, flex sensor will be used around the edge of the coverage to detect the shape change of the coverage. The cinch module will try to cover and wrap around all of your personal belongings underneath the coverage when the malicious behavior is detected.

## Block Requirements

### 1. Power Supply

A power supply is required to keep the coverage function continuously. Power from a cell phone charger brick will charge the battery, which is then regulated to 3.7V for the rest of the system.

#### *Mobile Phone Power Brick*

Battery will be charged by the normal iPhone or Android phone power brick, this will provide enough voltage for charging IC to charge the battery.

Requirement: Must provide 1A 5V or 2A 5V.

#### *Li-ion Charging IC*

This charging will charge the battery and be able to charge the battery fully less than an hour.

Requirement: Must provide <1.2A between 4.15~4.25 V.

#### *Li-ion Battery*

The battery must be able to keep the circuit continuously powered.

Requirement: The battery must be able to store enough charge to provide at least 83 mA at 3.7V for 24 hours without recharge.

#### *Voltage Regulator*

The voltage regulator supplies 3.7V to the system. This chip must be able to handle peak input from the battery(3.7V) at the peak current draw (160 mA).

Requirement: The voltage regulator must provide 3.7V +/- 5% from a 3.7V source.

### 2. Bluetooth Module

Data from the control module is sent via UART to be accessed by user on a mobile phone.

### *Bluetooth IC*

We have chosen our Bluetooth IC, WT11i-A. This chip features Bluetooth 2.1 with integrated chip antenna and line of sight range of 350 meters. It has data input communication with the ATMega328 via UART.

Requirement: Must be able to communicate over IEEE 802.15.1 at > 100kbps.

Requirement: Must be able to communicate over UART with host.

Requirement: Must be able to operate with voltage less than 3.7V.

## 3. Control Module

### *Activate/Deactivate Button and Pairing Button*

Activate/Deactivate Button on the coverage allow user to arm/disarm the coverage without using the phone. Pairing button allow user to pair his/her phone with the coverage to monitor the status of the coverage.

Requirement: The button must be easily-pressible.

Requirement: The button must not have accidental mechanical failures when dropped.

### *Status LED*

The status LED will display whether the coverage is armed or not. It will also display whether the coverage is successfully paired with user's phone.

Requirement: The status LED must be clearly visible from 1 meters away with a drive current less than 10mA.

### *Buzzer*

The Buzzer is used when the micro-controller detects the unintended movement of the coverage, it will alarm and try to get as much attention from nearby people as possible.

Requirement: Must be able to reproduce sound louder than 70 db.

### *Micro-controller*

We plan to use ATMega328 as our microcontroller. It analyze incoming data of the sensor group from analog inputs and communicate with the Bluetooth module through UART. Since the number of sensors could change during the design finalization stage, the model of microcontroller is subject to change.

Requirement: the microcontroller must be able to read at least 6 analog input at the same time.

Requirement: the microcontroller must be able to communicate over UART.

## 4. Sensor Group

### *Flex Sensor*

Flex sensor is used on the edge of the coverage to detect the shape change.

Requirement: Maximum 1W of peak power

Requirement: Minimum 2 times greater than the flat resistance at 180$^{o}$ pinch bend.

### *Ambient Light Sensor*

Ambient light sensor is used on the inner side of the coverage to detect the light condition change when the coverage is operating.

Requirement: Spectral bandwidth should at least have range from 460nm to 655nm.

Requirement: Sampling rate must be larger than 5Hz

Requirement: Interface must be voltage based or using I2C.

### *Proximity Sensor*

Proximity sensor is used on the inner side of the coverage to detect the change of distance between the coverage and the underneath objects.

Requirement: Sensing method must be optical based and sensing distance must be at least 0.5m.

Requirement: Interface must be using I2C.

### 5. Cinch Module

### *Servo*

Servo is used to tighten the ropes and wrap around the items underneath the blanket when malicious behavior is detected.

Requirement: Must be able to contract the rope at least 0.1 m/s

Requirement: The servo must be able to operate under 3.7V

## Risk Analysis

The sensors are the key competence for the project to be successful, since the sensors need to be flex enough, and not to impede folding and cinching process.

In addition to the positioning of the sensor, the ability to accommodate the reliability on the run is also crucial to the success of the project. For instance, in a low light condition, the ambient light sensor will have low reliability and we need to tune up the sensitivity of other sensors dynamically to compensate for the loss of ambient light sensor. Besides tuning toward compensation of sensors, we also need to tune all the sensitivity dynamically so that we can minimizes the false positive rate and thus make our product more reliable. We plan to test situations thoroughly during the production stage, and include dynamic control code into controller, as well as testing different sensor arrangements in the PCB design stage.

Also the servo used in this project needs to be able to cinch the blanket successfully and the speed should meet the requirement mentioned above. In order to fulfill the requirement, we need to do some tests on different servo and different materials as the cover, in the initial implementation stage.

## Safety:

As mentioned above, the project will contain a 3.7v lithium-ion battery. Li-ion battery is very volatile comparing to other kind of electric sources. If the battery is over charged significantly, it may lead to rapid, exothermic degradation of the electrodes[6]. Also when the battery is shorted, temperature to

rise, leading to a thermal runaway, also referred to 'venting with flame.'[7] So before connecting the battery to the circuit we will test the circuit thoroughly to ensure the charging circuit not to exceed 4.20v which is the maximum charging voltage given by the battery's datasheet, and the short will be tested as well. In addition, the battery could experience thermal runaway, which continuously to degrade when the certain temperature is exceeded. To avoid this condition, the battery needs to be monitored with a thermal sensor, which will cutoff the power supply when battery exceeds certain temperature(70°C[8]).

We believe the project will comply the IEEE Code of Ethics #5[9], which improves the individual's understanding of conventional and emerging technologies, since this project benefits the society by making personal belongings safer than before. Also the controller mentioned above will operate on the sensor's data and analyze them to conclude all the results, then returned to user, which complies the IEEE Code of Ethics #3[9]. Also if time allows we can make the controller OTA updatable, which could potentially fix bugs in our software design and improve the performance of the product, so that the IEEE Code of Ethics #7[9] would be applicable.

The controller might give out false alarms when sensor has false values read, or the blanket was accidentally moved by others unintentionally. To solve this issue, we have the wireless(Bluetooth) module which will allow user to turn off alarms manually, and also the sensitivity of the blanket is tunable by user through cell phone, so that the possibility of false alarm can be lowered further. This design strategy will allow this project to comply with the IEEE Code of Ethics #8[9].

In the cinch module, the blanket will tighten itself when anomaly behavior is detected, this might have a potential hazard which might restrain human bodies, for example hands, inside the blanket, however we don't currently have a good solution to this, since this might also affect the performance of the cinch. We could improve this by talking with experts in this area during the final design and production stage.

## References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