Package Anti-Theft System

ECE 445 Project Proposal
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1. Introduction

1.1 Objective

In the past twenty years, the emergence and subsequent boom in online shopping has changed the way consumers shop and buy goods. According to a recent survey conducted by the Pew Research Center, 79% of Americans shop online, and 15% buy online on a weekly basis [1]. Consumers now have access to thousands of products with a tremendous degree of selection, all at the convenience of a few clicks and a standard shipping and handling fee. But the convenience and popularity of online shopping has produced an unforeseen problem: it has made it much easier for thieves and people of low moral character to steal packages. According to a survey done by Xfinity Home, Comcast's home security service, more than 50% of people across the United States know someone who has had a package stolen, and about 30% of people have had it happen themselves [2]. Clearly, this is a very pervasive problem.

Our goal is to design and construct a device that stymies package theft through a weight, alarm, and camera-based deterrence and security system. We will use pressure sensors to precisely measure the weight of a package or set of packages, and an alarm system that is triggered when the weight of the package decreases past a small tolerance. As a precautionary level of deterrence, motion sensors will detect if a person gets too close to the package, and trigger a verbal warning that lets them know the package is protected. Each time the alarm system is triggered, a camera takes a picture of the criminal and the user will receive a report with the picture of the potential thief. The user can disable the alarm via an app over Wi-Fi or through an RFID tag. We believe that these measures will provide both deterrence and protection of the user's package at a very affordable price.

Because of our interest in making a startup out of this idea, we also submitted a proposal to the Cozad Startup Competition, and the required report is attached at the end of this proposal.

1.2 Background

Several approaches have been taken to try to prevent the widespread package theft problem across the country. The most common approach to solving this problem is to use a lock-box that holds a person's packages until they open it up with a traditional key. Although simple, and a seemingly good solution, there are several problems with

this approach. First of all, they are expensive. Prices of lock boxes designed to securely hold delivered packages range from $82 [3] to $899 [4]. Secondly, it poses a convenience problem for the delivery service. The UPS or FedEx service must also have a key to your lock-box in order to place items in it. If the person orders multiple packages over the course of a day, this could be a major inconvenience to the delivery service, who has no legal duty to place your package in the lock box. Third, the size of the lock-box inevitably limits what types of packages can be delivered. The lock box does not accommodate for large or irregularly shaped packages. Another problem with lock boxes concerns their aesthetic nature. Boxes are inherently bulky, heavy, and quite frankly, an eye sore when placed on one's front porch. Lastly, a lock box is incompatible with emerging delivery technologies such as drone delivery, which promises to play a bigger role in package delivery in the future.

A second approach to protecting package is a "Smart-Lock" that allows delivery people to enter your home to drop off packages. While a very clever solution, this system costs $300 and requires home installation. Given that most packages are generally not nearly that expensive and that in order for this to work one needs to give a stranger access to your unlocked home, we believe that there is a very small demand for this option.

A third approach is a locker or an Amazon hub. In apartment complexes, where people are very close in a building, the locker approach is superior as it is low cost, safe, and convenient. However, according to the National Multifamily Housing Council [9], only 35% of Americans live in rental units such as apartments, dorms, and condominiums, meaning that there is a very sizable chunk of the population that this option is not viable for. Amazon hubs, on the other hand, are capable of being anywhere. However, they remove some of the convenience of online delivery, especially in rural and suburban areas.

The final approach, which was uncovered in market research for the Cozad competition, is the PackageGuard [8] system. This system is very similar to ours, using a weight detection system to set off an alarm and an app to see if packages have arrived, been stolen, or to disable the alarm. The unit also has the option of being bolted down. Missing are the camera, motion detector with audio warning, RFID/keypad module, and solar cells. Because of the existence of this product, we have decided the best strategy for implementation would be creating a cheaper unit than theirs with 90% of the functionality. Their unit costs ~$80, and we believe by focusing on inexpensive, simple design, the lift sensor, RFID/Keypad access, and the weight sensor we can significantly decrease the cost down to a ~$20-$40 retail price range.

An in-depth analysis of these products is contained at the end of this report, in the supplemental section. We did not create this graphic, but found it very useful for positioning our idea.

Our anti-theft system design will be an improvement in all of the areas listed above. It will be a cheap, convenient, small, and light alternative to the lock-box. It will be effective in deterring package theft, and successful in snapping a picture of the criminal for identification purposes for the authorities who investigate the theft. We hope that in the end, our design is able to eliminate package theft for users who purchase our product.

1.3 High-Level Requirements List

- The device must be capable of taking loads from 0.5lb to 200lb, with a resolution of 0.1 lb up to 10lb and a resolution of 0.2lb above that.

- The alarm must be at least 90dB, which is equivalent to a person shouting at their loudest. The maximum we would do 120dB, which is the sound of a police siren/ambulance, but we need to take into account cost and safety. The alarm does not necessarily have to be a speaker, but any similar loud noise.

- The system must be low power enough to be on standby for over 1 year when run off of 3 AA batteries, or self sustaining on solar power.

2. Design

2.1 Block Diagram

Our system, at its highest level, has four main overlapping blocks. Through this design, we hope to simplify the design process, as well as prepare for possible future iterations of this product. The first, largest block is titled “Deluxe System.” This system refers to the physical product we hope to make in senior design, including functionality such as high-precision weight sensors, motion sensors, audio drivers, speakers, backup power, an RFID tag system, lift sensor, WiFi module, solar cells, and camera, and we expect it in total to cost around ~$100. Included in this design, though not in the physical unit, is an application plan to develop to disarm the unit, contact neighbors if enabled, show/send the photo of the thief, alert the user of theft/delivery and customize settings. The core system contains just the fundamental needs of this design, and we hope to get the price to under $25. It excludes the solar cells, application, wifi, and camera, which we believe significantly drives op cost while providing little extra functionality. Finally, we have the “Alarm-Module” which is a durable separate unit, triggered by the lack of signal from the processor, and sets off if the unit is destroyed to prevent a “smash-and grab” scenario. This enables the unit to be cheaper and less durable, while still protecting.

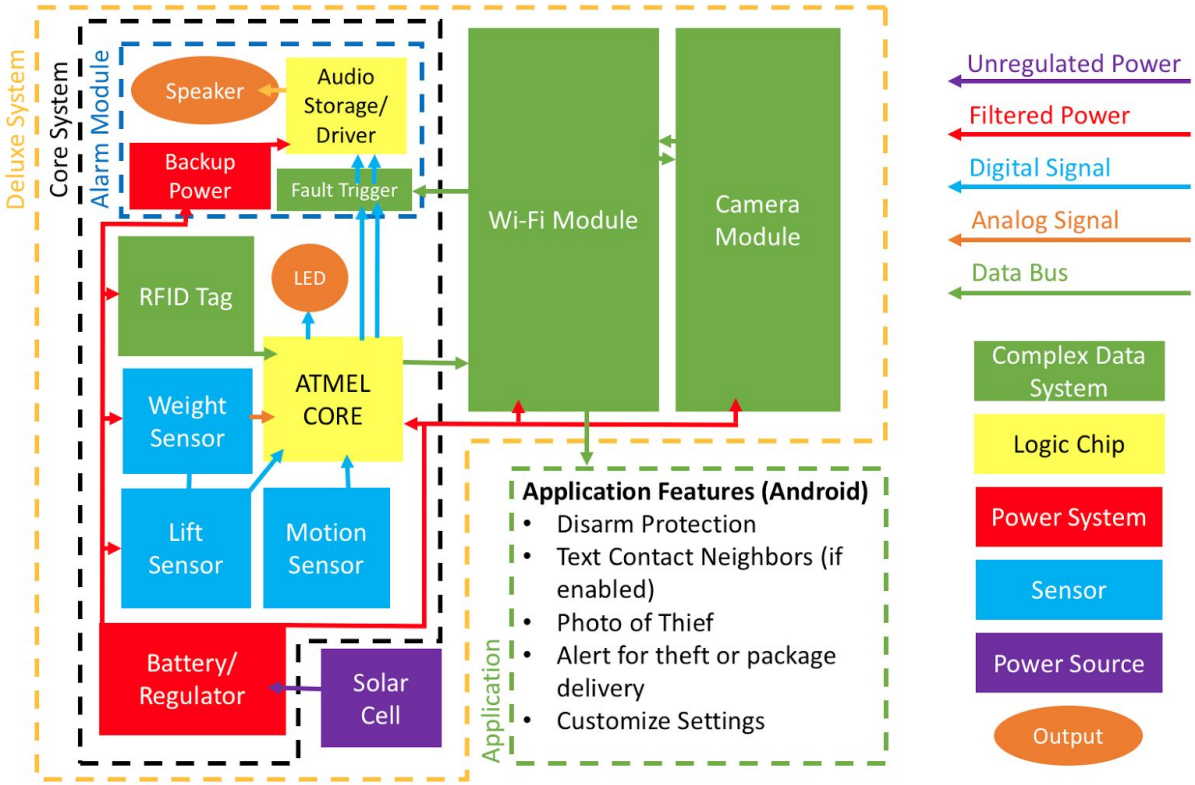

Figure 1: Cozad High-Level Block Diagram of system functionality

2.2 Physical Design

Our design is meant to be as cheap as possible, in terms of both material cost and assembly. Because of this, the physical design is crucial. Our current plan is to create a simply assembled module with only three separate parts: a top glass/metal plate that is very cheap, a single plastic underlying body mounted to this, and a movable “switch” mechanism to prevent the anti-theft system itself from being listed up and stolen. This design must house the electronics, making the system waterproof, as well as allow for accurate weight measurements. We also want the top to be glass/metal and rigid to amplify the alarm noise. In the long term, we plan to make the body via plastic mold injection molding, however for the prototype we hope to 3D print the body. To do either of these, CAD modeling is required. The first iteration of this design is below, though we plan to improve this further before printing, as well as try out different prototype design. The current one is 1x1 feet, with rough estimates on the needed PCB, camera, speaker, and battery sizes. This is shown below in figures 2-7.

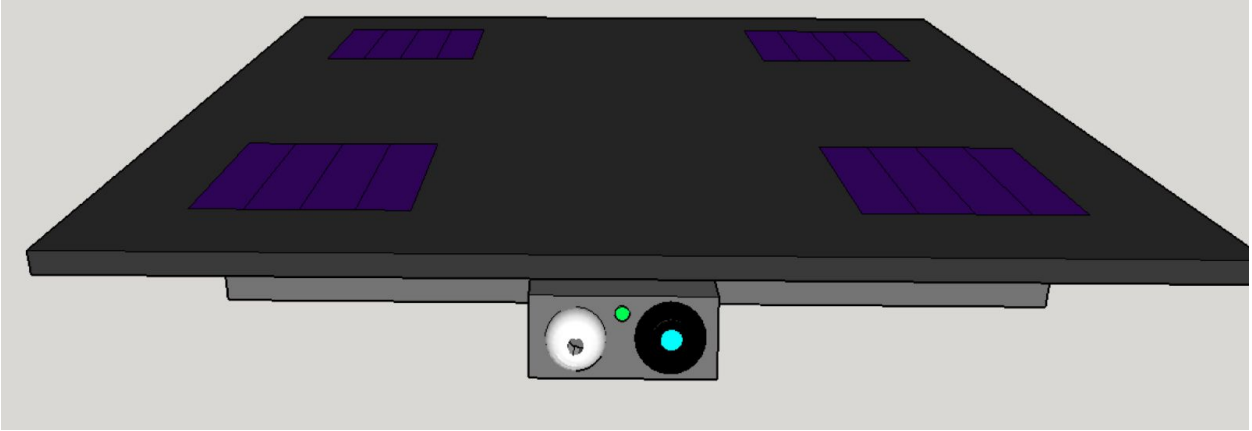

Figure 2: Top angle view showing solar cells, camera, LED, and IR sensor

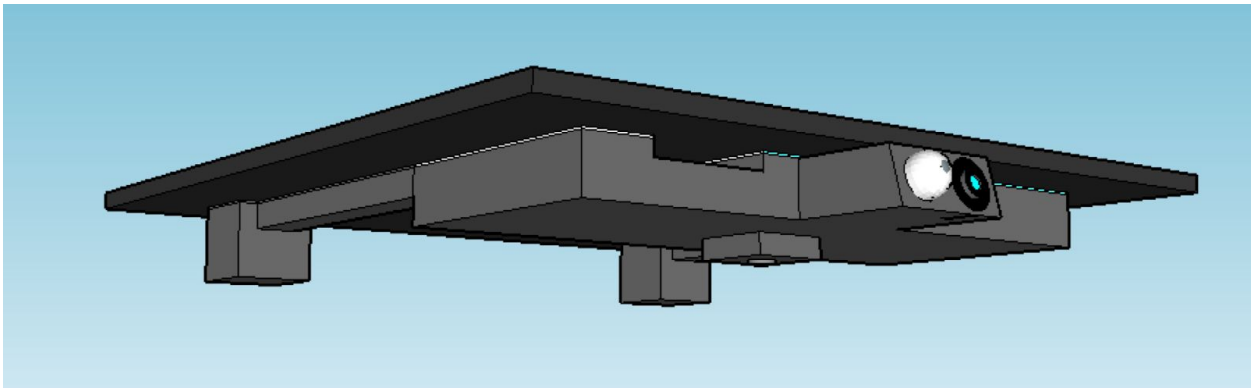

Figure 3: Side View, showing bottom 3D-Printed chassis, lift sensors

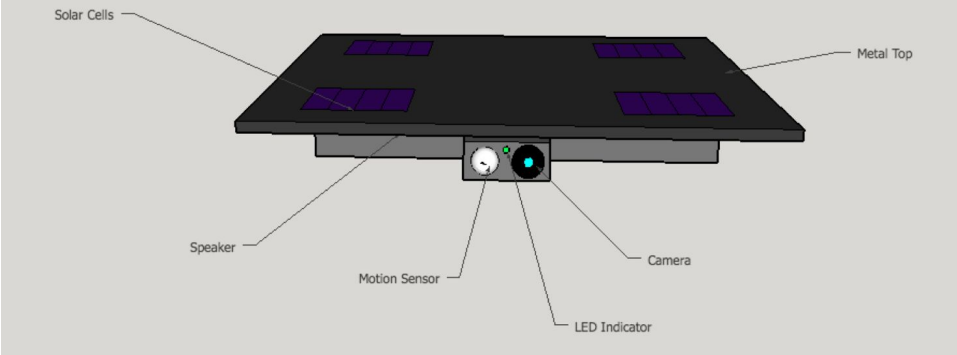

Figure 4: Labeled Front View

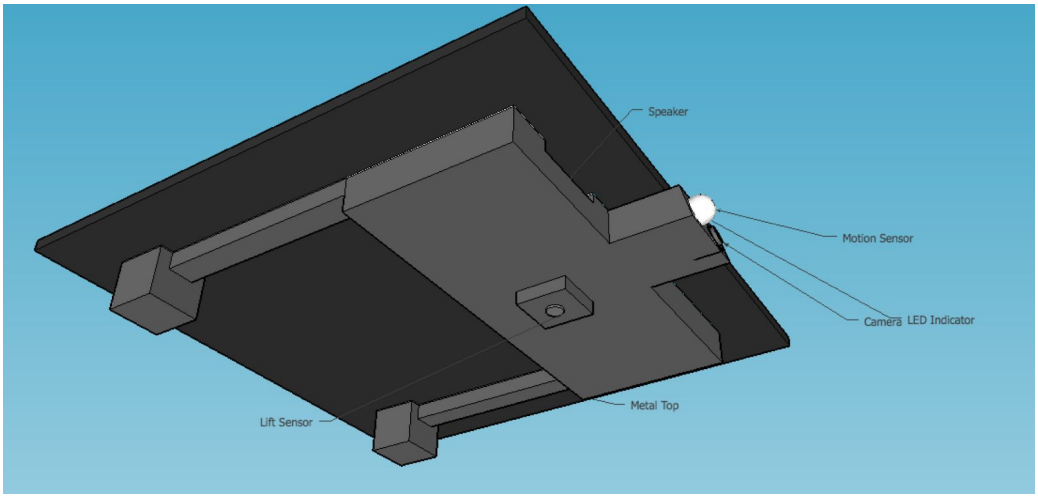

Figure 5: Labeled Bottom View, showing components

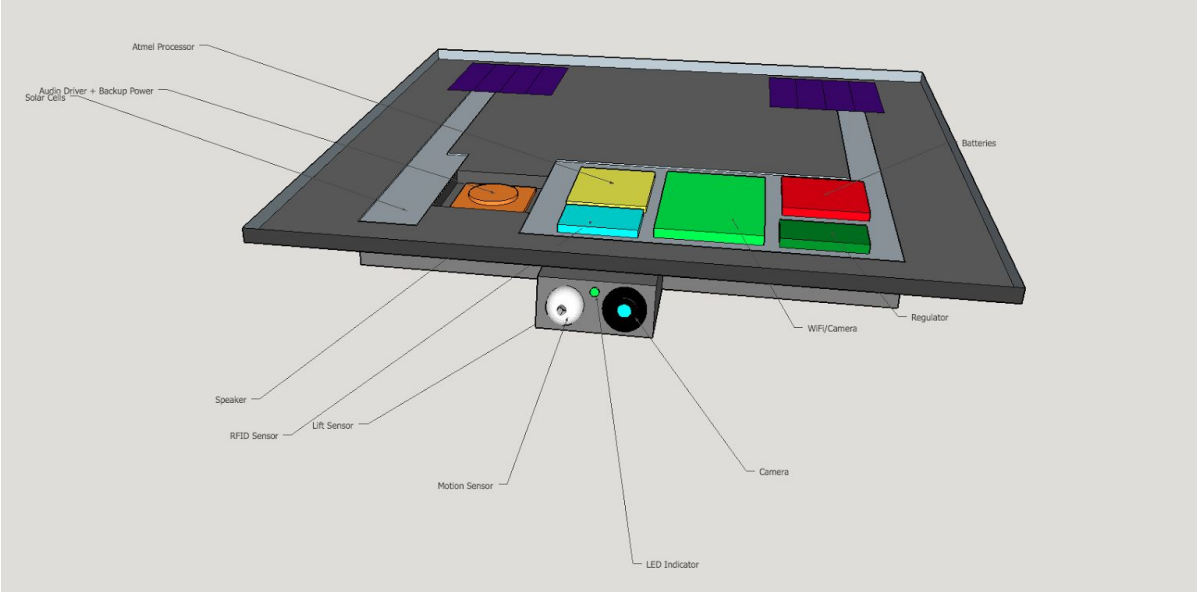

Figure 6: Internal Layout Plan

2.3 Functional Overview and Block Level Requirements

The above design block in figure was made for our explanation at the Cozad competition, and for easy explanation for non-engineers. Our more technical report is below, where we break down what exactly each feature includes.

2.3.1 Control Unit

- **Atmel Microprocessor -** We will get the minimum viable Atmel chip to do everything required - not determined yet
- **Crystal Oscillator -** For clocking our processor, may choose lower clock speed to decrease idle power consumption
- **Pin Drivers -** For some lower-end units, pull-up/down resistors and buffers may be required

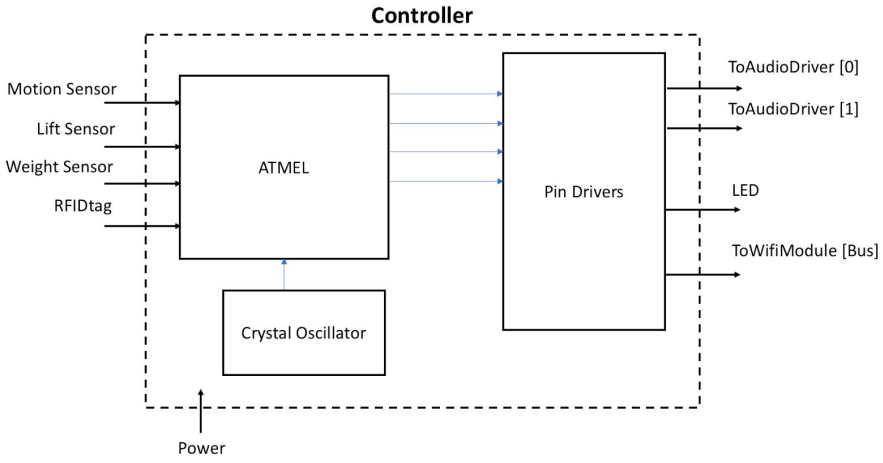

Figure 7: Very high-level controller layout

2.3.2 External Programmer

- Build off-chip Programmer for our Atmel Chip, saves cost for production and space

2.3.3 Audio Driver

- **Storage Chip** - 10s of audio at a 30k sampling rate for voice recording
- **Oscillator Alarm** - Simple capacitor/inductor oscillator circuit we can choose a frequency for to drive our alarm
- **Fault Trigger** - Sets off the alarm if the input goes to zero (just an inverter) to make the alarm go off if the system is purposely broken
- **Signal Multiplexer** (tentative)- Choose between alarm and warning audio from speaker

- **Audio Amplifier** - Simple NPN or OP-Amp based amplifier circuit
- **Backup power** - Small, low-power backup cell to drive alarm even if power is disconnected (3V, low capacity button cells stacked to 6v likely)
- **High Power Regulator -** For driving Audio Amplifier very loudly, low stability needed

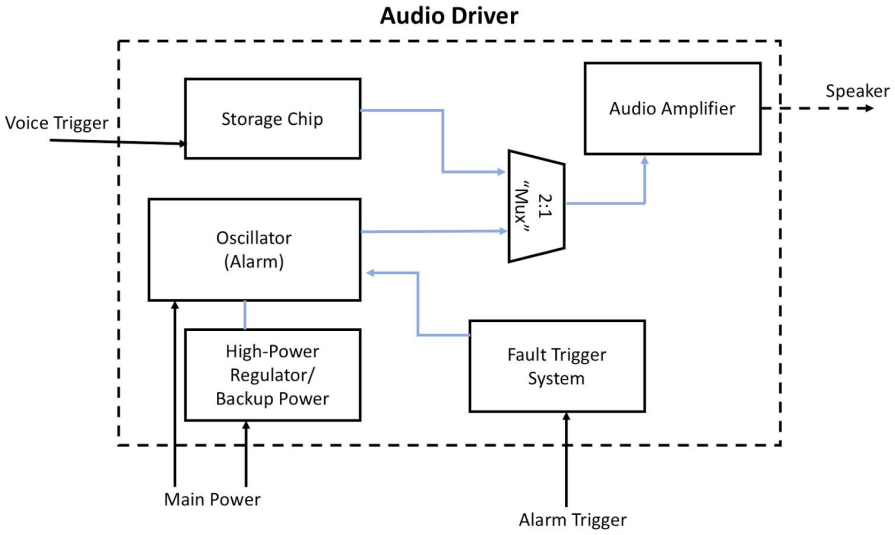

Figure 8: Audio Driver

2.3.4 Weight Detector

- **Load cell/resistor cells -** For weight sensing
    - Physical design crucial for optimizing sensitivity
- **Filter (Tentative) -** Possible solution to reducing noise from quick jostles to the apparatus when putting on the package or bumping it
- **Amplifier (Tentative) -** For boosting the voltage signal efficiently to a larger range for the code

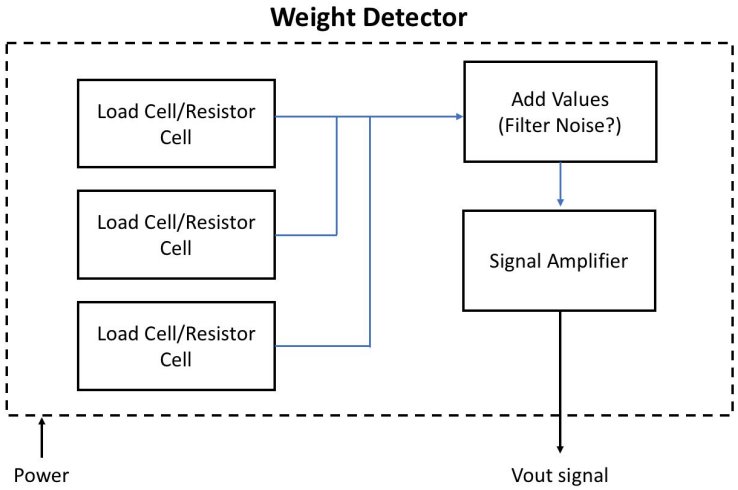

Figure 9: Three-sensor weight detection system

2.3.5 Power Regulator/Charger

- **Battery Charger -** Regulates input power from solar cell to safely charge batteries
- **Batteries -** Nickel-Metal Hydride Batteries (Cheap, AA cell type)
- **Low-Power Voltage Regulator** - For sensors, ATMEL, etc.

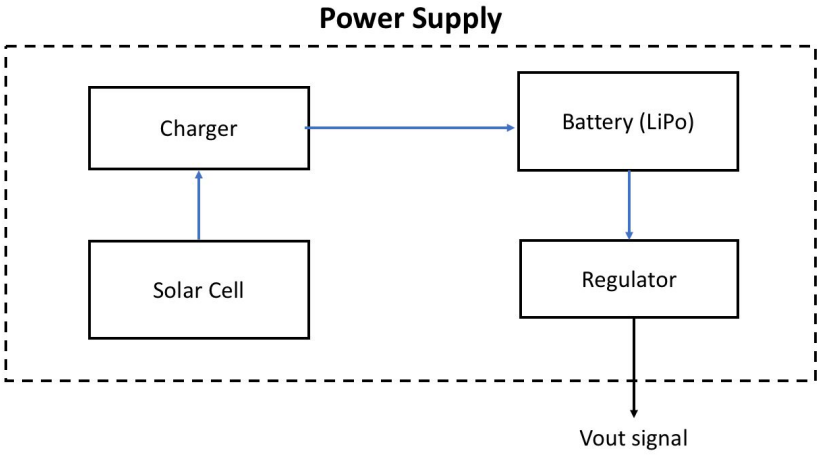

Figure 10: Basic Power Supply Schematic

2.3.6 RFID Module (Purchase)

- Using a key-fob or wallet card, can quickly disarm the alarm unit for a minute to remove packages and reset the system

2.3.7 Solar Cells (Purchase)

- On the top of the scale, to provide supply varied power via solar cells
- Not in the final project, I just had solar cells and thought it would be nice to not recharge the system ever

2.3.8 Camera (Purchase)

- Takes a low-resolution image of the perpetrator, that will be sent to the phone application via WiFi, to be sent to others or the police for identification

2.3.9 Motion Sensor (Purchase)

- When someone approaches the package while weight is on the system, it will set off the motion sensor, triggering a warning message

2.3.9 Camera Driver (Construction Tentative - May Buy)

- Currently looking into chips - would like to integrate onto one main board along with the WiFi module to make it more efficient

2.3.10 Wifi Module (Construction Tentative - May Buy)

- In order to connect our device to Wi-Fi and the app, we intend to use a Wi-Fi shield that is compatible with our Atmel chip.
- Currently looking into chips - would like to integrate onto one main board along with the camera driver

2.3.11 Android Application

- Disarm Protection
- Text Contact Neighbors (if enabled)
- Photo of Thief
- Alert for theft or package delivery
- Customize Settings

2.3.12 Arduino Code

- Programmed into ATMEL chip
- Drives WiFi, camera, RFID modules via libraries
- IR Motion-Sensor Input/Control
- Binary Audio and LED signal outputs
- Weight code, that sets off alarm if weight removed without access permission, with internal tolerances to account for perturbations to the package

2.4 Risk Analysis

While we have a clear vision for the product we intend to create, and are confident that we will be able to deliver a working project, there are a few uncertainties with the implementation that pose a risk to the completion of the project. First and foremost, we must ensure that all of our sensors operate within a tight tolerance. We must then design our system to react to changes in sensor readings past the tolerances. For example, if a pressure sensor reports a weight of .1lb and the error of the pressure sensor is +/- 1%, we must program the control unit to not react to changes within +/- 1%, and probably +/- 2-3% to give a small buffer in case the reported tolerances are not completely accurate. It is important that our tolerances are tight and our sensors are accurate, because if they are not, a clever thief could quickly swap out a package for a object of similar weight ("Indiana Jones" style[1]), and "trick" the system.

Pressure sensor hysteresis and drift are separate undesirable effects we need to account for. If the weight sensor accuracy or precision drifts from its original baseline, it may trigger many false alarms, or sense that there is a package there when in fact there is no package on top of the device. If we run into this problem, we can add an offset to the eight sensor reading, or add a filter (lowpass, bandpass, or highpass) to attenuate signals that the sensor is picking up. Hysteresis is defined as positive or negative output deviation, and it will limit the responsiveness of the sensor. Selecting durable sensors from manufacturers who claim a lower degree of hysteresis will allow us to avoid this error.

The second major risk that this project entails is the risk of false alarms as part of the multi-level alarm deterrence system. While motion sensor triggered warnings are only slightly irritating, setting off the loud alarm by accident when adding packages or the owner removing packages is a significant issue that needs to addressed. We also must consider environmental factors like wind, rain, or loud noises/vibrations nearby to make sure that it doesn't go off all of the time, making the protection mechanism invalid and annoying. This will be a significant design challenge and a balance between safety and annoyance must be tread.

[1] Refers to the film "Indiana Jones and the Raiders of the Lost Arc, when archaeology professor and explorer Indiana Jones swaps a golden idol off a weight-sensitive rock with a bag of sand that has the same weight as the idol.

3. Ethics and Safety

We must be cognizant of several potential safety hazards while constructing this device. First, and perhaps most obviously, we must ensure that our alarm system and speaker does not exceed the limit of a safe noise level exposure for the public. Hearing loss has become more prevalent in the United States, having increased from 13.2 million (6.3% of the US population) in 1971 to 48 million (15.3%) in 2011 [5]. We do not want our device to contribute to that statistic, so we need to keep our alarm at a reasonable volume.

This device will be displayed outdoors, and outdoor electronics present a risk, especially in wet conditions. We intend to waterproof the protective layer for the electronics by adhering to IP68 guidelines [6], which keeps the equipment suitable for continuous immersion in water. This means that we will most likely keep our internals hermetically sealed.

From an ethical standpoint, we must design our device to deter crime in such a way to scare away criminals from stealing packages, but not make people fear for their lives. We are not the authorities, and it is not up to us to determine the punishment for the criminal. An alarm system that is so loud that is causes permanent hearing loss, or so jarring that it causes heart palpitations is not in accordance with IEEE Code of Ethics #1, “to hold paramount the safety, health, and welfare of the public” [7]. Furthermore, we must consider the health and safety of the neighbors and of people passing by. Especially in urban neighborhoods where houses are clustered close together, a loud and jarring alarm system could be detrimental to the health of the public.

Another ethical consideration is to test and figure out the limits of our device, and avoid making claims that exceed the limits. For example, although we have not done a formal calculation yet, we may find that our system is not able to handle packages that weigh more than two hundred pounds. We must not claim that our device can support packages higher than this threshold. We will quote realistic and accurate claims, pursuant to IEEE Code of Ethics #3, “to be honest and realistic in stating claims or estimates based on available data” [7].

Lastly, in doing market research for this idea for the Cozad competition, we found another company with a very similar product “The Package Guard” [8]. While very similar in concept, we believe we can significantly improve on their design, making a simpler and cheaper version of what they have. Informing the Senior Design staff that

we found this is an ethical decision, since they had the core same idea and we wanted to make sure everyone is aware of that, so that we can all act accordingly.

4. References

[1] http://www.pewinternet.org/2016/12/19/online-shopping-and-purchasing-preferences/

[2] https://www.usatoday.com/story/tech/news/2017/11/20/package-theft-hits-nearly-one-third-americans-video-surveillance-answer/874554001/

[3] https://www.officedepot.com/a/products/871469/Mail-Boss-Locking-Security-Drop-Box/?cm_mmc=PLA-_-Google-_-Mailing_Packing_Shipping-_-871469-VQ6-51194742236-VQ16-c-VQ17-pla-VQ18-online-VQ19-871469-VQ20-101647056356-VQ21--VQ22-624117016-VQ27-10575817556&mrkgcl=1104&mrkgadid=3115174695&rkg_id=h-d0ea7d5061ddbe32ef89a7e4aff38416_t-1518044028&adpos=1o5&creative=51194742236&device=c&matchtype=&network=g&gclid=EAIaIQobChMIm-mpq_KU2QIVy4KzCh03aAJ6EAQYBSABEgLEWvD_BwE

[4] https://www.budgetmailboxes.com/dvault-dvcs0015-grey-column-or-post-mount-delivery-vault.html?gclid=EAIaIQobChMIm-mpq_KU2QIVy4KzCh03aAJ6EAQYBCABEgJqGvD_BwE

[5] Lin FR, Niparko JK, Ferrucci L. Hearing loss prevalence in the United States. Arch Intern Med. 2011;171(20):1851–1852

[6] http://www.dsmt.com/resources/ip-rating-chart/

[7] https://www.ieee.org/about/corporate/governance/p7-8.html

[8] https://www.thepackageguard.com/

[9] www.nmhc.org/Content.aspx?id=4708

5. Supplemental Material

Solution Comparison- <u>WE DID NOT MAKE THIS!</u>

PACKAGE GUARD

Package Theft Prevention Comparison Chart

Product (image / hyperlink)	Name	In Home / Out of Home	What	Price	Description	Cost	Convenience	Security
	Nothing	In Home	Hope	$0	No camera, no package container, no alarms.	$	★★★★★	★
	Stuff Delivered to Your Work	Out of Home	Work	$0	Packages delivered to your work are monitored, signed for and usually delivered right to your desk.	$	★	★★★★★
	Package Guard	In Home	Alarm	$69	First product specifically designed to protect packages delivered to your home. Simple-to-use device, the size of a Frisbee and sits on your front porch. It notifies you instantly via your smartphone when you get a package or if a package is removed.	$	★★★★★	★★★
	Ring Video Doorbell	In home	Video Surveillance	$199	Ring Video Doorbells lets you see and speak with visitors at your door, from anywhere. Each doorbell is equipped with an HD camera with night vision and smart motion detection. 720p	$$$	★★	★★
	August Home Doorbell Cam	In Home	Video Surveillance	$199	Most residential burglaries take place during the day, when burglars think you're not home. With August Doorbell Cam, appear to be home from anywhere.	$$$	★★★★★	★★
	Skybell	In Home	Video Surveillance	$199	Home Security Made Easy! Always know who's at your door with the SkyBell HD Wi-Fi Video Doorbell, 1080p	$$$	★★★★★	★★

	Skybell	In Home	Video Surveillance	$199	Home Security Made Easy! Always know who's at your door with the SkyBell HD Wi-Fi Video Doorbell, 1080p	$$$	★★★★★	★★
	August Smart Lock	On Site	Home Access	$299	No more fumbling for keys. August Smart Lock auto-locks behind you for peace of mind and automatically unlocks as you approach. Turn on or off whenever you want.	$$$	★★★★★	★★★★★
	Garageio	On Site	Home Access	$109 (1 Door) $209 (2 Door) $219 (3 Door)	Garageio is the simple and secure way to control and monitor your garage door from anywhere in the world, all without needing to replace your existing opener.	$$$	★★★★★	★★★★★
	Eneighr	Off site pickup	Personal Delivery	$2.50/delivery (avg. $67.50 / 27 packages per year)	A platform that allows you to find a trusted neighbor or local business that's willing to accept a delivery on your behalf.	$$	★★★★	★★★★
	Vylage	Off Site pickup to On Site delivery	Personal Delivery	$2.99-$3.99 per package (avg. $108 / 27 packages per year)	A community of background verified homeowners that can accept package deliveries for you, and store them securely until you can pick them up.	$$	★★★★	★★★★
	Doorman	Off Site pickup to On Site delivery	Personal Delivery	$29/mo or $19/mo $3.99 per package	On demand package delivery and returns, 7 days a week. Packages are sent to background verified Doorman drivers and kept securely, until you're ready to schedule it to be delivered (evenings, weekends).	$$	★★★	★★★★★
	PMB (Private Mailbox)	Off site	Lockbox	$21/mo (small) $24/mo (large)	Keep your home address private. Package Acceptance from private carriers: UPS, FedEx, DHL, etc.	$$$	★★	★★★★★
	UPS Store Lockers	Off site	Lockbox	$22/mo (small) $35/mo (large)	Personalized mailbox service, with package acceptance from all carriers, a deliverable street address (instead of PO Box) and email or text notification that delivery has been made.	$$$	★★	★★★★★
	Land Port	In Home	Lockbox	$459 - $799	Strong, stylish lockbox is made of 16-gauge steel, can be bolted to any porch, deck, or driveway. It's opened using a unique access code. Allows owner to feel safe knowing that they can securely receive packages.	$$$$	★★★★★	★★★★★
	Porch Box	In Home	Lockbox	$199 (big/parcel box) $139 (medium/porch box) $89 (small/milk box)	Rugged, lockable storage box that is secured to your porch, and comes in three sizes for home deliveries.	$$$	★★★★★	★★★★

	Amazon Locker	Out of Home	Lockbox	Free (w/ Amazon purchase)	Amazon Lockers are self-service delivery locations where customers can pick up and return Amazon.com packages. Lockers are available in and around major cities, and allow customers to pick up their packages at a time and place that's convenient for them.	$	**	*****
	iBin	In Home	Lockbox	$999 for largest container $929 for medium $889 for small	A securite, lockable parcel delivery box that takes care of all your home deliveries.	$$$$	*****	*****
	USPS PO Box	Out of Home	Lockbox	Starting at $10 / mo.	Maintains personal privacy, and secure delivery of mail and packages to a convenient USPS location where packages are stored securely in a lockbox until you're able to retrieve it.	$	**	*****

For more info on how to end package theft, please visit our website at www.thepackageguard.com.

hello@thepackageguard.com

Cozad Venture Competition

One-Line Pitch – “Create a convenient, low-cost system for protecting packages from Amazon and other online retailers from theft”

Team Names/Capabilities/Objectives
John Simonaitis - Leader - In charge of overall design and business strategy
John Graft - Member - In charge of custom logic/control units
Joe Bianco - Member - In charge of modules such as weight sensors, audio drivers, etc.

Summary
The main problem is that approximately 11 million Americans have had packages stolen last year, and many more are concerned about it. Our solution is to have a simple scale-based device that detects when packages arrive, and sets off a very loud alarm if taken without the system being disarmed. While this system is not perfect at stopping, our hope is that it will fill a similar role as a car alarm or bike lock, by drawing attention to potential thieves in busy areas (such as the suburbs), causing them to drop the package in order to avoid being conspicuous or caught, and by providing just enough of a deterrent to prevent theft in the first place. Currently we have a prototype designed, with a parts/assembly cost estimate of ~$18, and are improving it via a Senior Design project.

Customer Segment
Customers concerned about package theft, but want a cheap and easy fix. In other words, we hope to hit the low-priced end of the package protection market, which I believe will be the majority.

Value Proposition
Our product could be an inexpensive way to deter theft. While more safe methods exist, these are expensive (>$80) and inconvenient (including the need for installing locks, boxes, and/or applications or coordinating with delivery people). Our hope is to be the "bike lock" or "car alarm" of package security, that doesn't protect the valuable that well but simply deters people from even trying, or draws attention to them if they do.

Target Market
According to TechCrunch, 79% of Americans shop online, and according to PWC the total sales value of online delivery packages has risen over 6% in each of the last 4 years, and 10% in the latest period. Also, according to a less reputable package protection companies market reseach (http://augusthomeinc.staging.wpengine.com/wp-content/uploads/2016/10/August-Package-Theft-Report-Infographic-FINAL-102516.pdf), over 50% of people who order packages are concerned about theft. Taking these numbers at face value, that would imply 40% of Americans are looking for a convenient system, or 128 million people. Knowing that there are ~2.58 people per household, and only one system is needed per household, this would indicate that a maximum 50 million anti-theft products could be sold in the US. While this share of people does

not seem to be growing rapidly, the value of packages (and thus the value our system may impart) is, meaning system will likely become more pertinent as time goes on.

Competitors
Other competitors have had four strategies for solving it. The primary solution is the simplest -- creating "lock-boxes" for the packages, where the delivery person drops off the package.

The second solution is very similar to ours, and to my knowledge is only implemented by one company, "PackageGuard." Their system is to use a weight-based alarm pad that goes off if packages are taken without the system being disabled via an iOS application. When packages arrive, the app also informs the owner and any neighbor the owner would also like to inform to pick up the package.

The third is having shared lockers that people can pick up packages from with a code or application. However, this requires people going to a "hub" or living in an apartment.

The fourth is having "smart" locks that allow delivery people to put the packages inside of homes directly.

Competitive Advantage
Our system aims to be the cheapest, easiest solution on the market, meant for people concerned about the problem but not willing to spend a lot of money or install a box on their porch. Our product is meant to be easily purchasable on Amazon in the "impulse-buy" range of under $20, while still providing adequate protection. Its advantage over the other two options are covered separately for clarity:

Lock-Box: These systems are unable to accept large packages, ugly, expensive (>$100), and a hassle to install/coordinate drop-offs with delivery people.

PackageGuard: While very similar to ours, this product is over-engineered, including WiFi capabilities and an app that is used to notify the user/neighbors of theft/delivery needed to disable the system. This drives the cost up to >$80 and increases the hassle while barely adding protection.

Lockers: Good, but inconvenient, misses many customers

Smart-Locks: Privacy concerns, logistically difficult, expensive.