

The TrakPak

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Introduction

Our idea is a backpack that will assist not only busy students, but also those adults in the real world who can be forgetful at times in preparing for the workday. We will include many simple yet helpful devices that are found in many familiar products today, including GPS tracking, as well as a simple scanner that will assign RFID addresses to the everyday supplies that assist the customer in their normal day-to-day activities. An LED-interface will let the user know what items are currently inside their TrakPak or and which materials they are still missing. A simple phone app will let the user plan out the needed materials for the day and tell their TrakPak what it needs to keep track of.

Problem

Our team's idea stems from the needs of busy college students, many of whom are found on Notre Dame's campus. Preparation is key, with every student having to make sure that every day, they have everything they need to stay on top of their studies and extracurricular activities. Every student can fall victim to faulty alarms and late starts in the morning and may not have the time to ensure that they have everything in their backpack that they need for the day. Not only that, but students and professionals alike should be prepared and feel safe about knowing where their backpack/satchel/purse is at all times. Honesty isn't everyone's policy, and our product looks to help in times of duress.

Proposed Solution

Our team has decided that in order to solve the issue of stolen backpacks, people forgetting items in their backpack that they think they already have packed, and missing the everyday essentials in their backpack, we will design the TrakPak. The TrakPak will have many useful functions that solve these daily issues, including a GPS locator in the backpack, status LED's to let the user know if they have the essentials in their backpack (computer, calculator, pens, etc...), and a compatible cell phone app that allows the user to specify what is needed in their backpack the next day (can be synchronized to class schedule) and to receive notifications if they don't have the specified materials when they leave for class.

GPS Feature: This is the feature that will help prevent your backpack from getting stolen, lost, or forgotten somewhere. This feature allows you to open up the TrakPak App on your phone, select the "Find My Backpack" button, and then view the GPS location of the backpack. After getting the location from the GPS and transmitting it to the phone via WiFi, the user can use the location and locate their bag.

Status LED's: In order to give the TrakPak users the ability to know that they always have their personal essentials in their backpack, the status LED feature is available. This allows the user to customize what three items in their backpack they always want to know they have with them. This varies for each user, so we are proposing an LED screen that will display what item the user wants tracked at all time, while the LED lights will display if the user has each particular item in the backpack. It is really just a quick sanity check for the user to make sure they have the essentials for their day. A typical engineer may want the three status LED's to show if they have their computer, calculator, and phone charger while a physical education major may want their status LED's to show if they have their whistle, water bottle, and gym shoes. The status LED's show a green light if the items are present and a red light if the items are absent. This feature ensures the user always has their essentials.

User App: To allow the user to be notified if they have everything they want or need in their backpack, we will create the TrakPak user app. This app will be compatible with the user's smartphone so that the user can specify what items they want in their backpack at certain times the next day. If the items are not in the TrakPak at the time the user specified earlier, the user will get phone notifications showing their missing items. This will solve the problem of someone forgetting their folder to history class or their textbook to digital signal processing class. An advanced function within this app would allow students to upload their class schedule for the week and then get notifications before class if they are missing their folder, notebook, or textbook. This app would communicate via WiFi to the TrakPak to determine what items are in the backpack. The app also will have a component where you can tag items and put them in your inventory, allowing you to use them with the TrakPak.

Demonstrated Features

As mentioned above, we want the TrakPak to have features such that it solves the problem of lost backpacks and forgotten materials.

- Item Tagging - The TrakPak will integrate RFID technology to allow the user to “tag” key items such as laptops, notebooks and calculators. Once these items are tagged with passive RFID stickers, an active RFID reader within the TrakPak will determine which items are within the backpack at any given time. This information will be communicated to the user in two different ways.
 - LEDs: We will have labelled status LEDs mounted on the straps of the backpack that will light up “green” if the labelled item is in the backpack and “red” if the item is missing.
 - User App: The user will have the opportunity to upload which items they will need on which days. The app will send an alert if certain items are missing or are unnecessarily included for the day.
- GPS Tracking - An integrated GPS chip will allow the user to locate their TrakPak by simply checking an app. This feature is ideal for locating a misplaced or stolen TrakPak.

If properly implemented, these features will allow a user to always know where their backpack is and determine if they are properly equipped for the day.

Available Technologies

Note: All links to hardware are tentative selections. We just want to show the type of device we are looking to use.

1. To implement the Item Tagging feature, we plan to use the same RFID identification technology that is common in access control applications such as badges. An active, powered reader will be built into the backpack. This reader will periodically send out a signal to check if any passive tags are within the range of the reader i.e. inside the backpack. The passive tags can be applied in the form of stickers to a laptop, notebook, calculator or any other item of interest in the backpack. Each passive ID has a unique ID. The user can input which sticker they have placed on which item, and then the app will be able to know which item is present.
 - Active Reader Option: SparkFun RFID USB Reader (cost about \$35)
 - https://www.sparkfun.com/products/9963?gclid=Cj0KEQjwkeiwBRCzmo-wiKL49pEBEiQAhvGKYyO9u8DBY_9OU0dBFthUYhfAri83kcWn6uav9f-NklwaApsa8P8HAQ
 - Passive Reader Option: 28141 Parallax Inc. (cost about \$5 max for all IDs)
 - <http://www.digikey.com/product-detail/en/28141/28141-ND/1774533>
2. To implement the GPS tracking feature, there are many GPS chips available that can be placed in our backpack. In all likelihood, we will consult GPS solutions from past Senior Design projects to determine our final solution.
 - GPS Chip Option: (cost about \$30)
 - <http://www.embeddedworks.net/sat1142.html?gclid=Cj0KEQjwkeiwBRCzmo-wiKL49pEBEiQAhvGKYeMCXor7SjPXRf0XIH3TYzVKLWoITIFzx55KEYqKbJ0aAtFo8P8HAQ>
3. To power the TrakPak, we are planning to use a rechargeable battery pack of some kind. This choice will be critical for us because we need enough power for the devices, but a light enough load to keep the weight of the backpack low.
 - Battery Option: (cost about \$30, weight about 1.5 lbs)
 - <http://www.custombodyart.com/BEL-RBS-12.html?gclid=Cj0KEQjwkeiwBRCzmo-wiKL49pEBEiQAhvGKYX9e9r3jHwGER4YIDxvUX4iPeB12XKrDCmGrc7zPWb0aAo3T8P8HAQ#.VhqNT7RViko>
4. Finally, to implement the WiFi connectivity, we plan to use the ESP8266 device (about \$5) that has been recommended in class. The WiFi connectivity is vital to making the item tagging feature work because it will communicate the information about what is in the backpack to the user. Additionally, we plan to use the same PIC32mx695f512I (about \$50 for a circuit) (or something very similar) that we have been working with in class. The microcontroller will act as the brains of the TrakPak and coordinate all necessary signals.

Engineering Content

The engineering content involved in the TrakPak can be split into two main sectors. The first sector is hardware. In the hardware sector, we will have four main engineering objectives. The first hardware objective is to configure the components that will be constantly active, namely the GPS and Wifi components. These components will, by necessity, always be providing information and communication capabilities to the microcontroller. The second objective is to configure the components that are active when a given event occurs, such as the RFID scanner and LEDs. These components will be waiting for an input from the RFID status and then will show the result of the input on the LEDs depending if the correct item was placed in the bag or not. The third objective is to design a microcontroller that can handle the I/O of the above components and has sufficient logic capabilities for the software we plan to implement. The fourth and final objective is to find a portable battery. Main factors in the selection of a battery include battery life, sufficient constant voltage, weight, and a recharging function. These are the main objectives we will need to address in the hardware sector of the TrakPak.

The second sector is software. The software sector itself can be split into four main objectives. The first objective is to create an app and establish communication between the app and the TrakPak microcontroller. It will be necessary for our project to transmit GPS location information and RFID scanning information from the TrakPak to the app. It also will be necessary for the app to send information detailing which RFID tags the user is looking for. The second objective is to create a system that will record the RFID tags that are put on each item to be placed in the bag. It will be necessary to have a library full of relevant tags so that the TrakPak can differentiate between items. This is critical in determining which items are needed and which items are extraneous. The third objective is to establish quality interfaces with which the user will be able to check and edit various statuses of the TrakPak. Firstly, the user will have to be able to check the GPS location of the bag and it will need to be displayed on a map of some kind, possibly Google Maps, to make sense of the location. Secondly, the user will need to be notified if they do or do not have all of their necessary belongings in their bag. Thirdly, the user will need to be able to set a schedule which would determine which RFID tags the device is looking for in order that the user will have a full pack. The final software objective is to configure the appropriate core code and functions in the microcontroller. Besides being as robust as possible, the code will also have to be sufficiently flexible to handle changing several key variables depending on the potential daily changes that the user would declare on the app. These are the main objectives of the software sector. This was a fairly high view of what design and development will be involved in the TrakPak.

The next phase of the engineering process is testing our product. Initial testing will most likely be done without the full configuration of the hardware inside of the backpack. This will allow us easy access to pins on the microcontroller and to any other piece of hardware that we may need to work with. The implementation of the hardware into the backpack will be a challenge. Creating a professional grade product will require careful planning and much forethought. We will need to balance optimal placement of parts with the ascetic and practical properties of the

backpack. Once we pass this phase and encase the hardware inside of the backpack, we will be able to more practically test the RFID scanner and the GPS capabilities. This will most likely be done by simply inserting and removing items from the bag and by walking around campus. This was a high view of what our testing and build process will look like.

Conclusions

In conclusion, we believe that the TrakPak is a viable Senior Design project. We believe that the technology that is required for this project (GPS locator, RFIDs, battery, etc.) is readily available and cheap enough to stay under budget. We believe that this project would require us to perform some real engineering work and problem solving in order to make it work. It will be a tricky task to implement all these features into a sleek final design, but not an impossible one. This project also satisfies the “Internet of Things” requirement for this year by including Wifi communication as a vital part of the design. Finally, we believe that the TrakPak would solve a real world problem for busy students and professionals. We are excited about the idea, and we hope to get approval so that we can start working on it right away.