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HOWARD UNIVERSITY

SENIOR DESIGN PROPOSAL (SMART BACKPACK)

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1. Introduction

In our daily lives, we have generally come to rely on our memory, reminders on mobile devices, and physical checklists for making preparations to take on our daily tasks; These preparations include knowing the time and location of each task, as well as what materials/items will be required for each engagement. Despite memory reminders and checklists, we still often find ourselves in situations where we either show up for our tasks without required materials or leave important items behind as we move between tasks. Thus, a noteworthy imperfection to the working of a reminder is the reminder's failure to monitor and crosscheck if a user packs all essential items.

For a user to avoid the frustration of losing/forgetting important items, Sigma's project aims to create a smart backpack that accesses a user's daily schedule, deduces the items required for scheduled tasks, and notifies the user whenever these required items are outside a certain range of the backpack. Sigma's solution seeks to alert the user if any required item is missing by integrating the computational power and storage ability of Intel's processor with an RFID reader and tags, an accelerometer, an LCD screen, and a mobile application.

2. Problem Definition

As smart technologies continue to play their part in improving the quality of life, there is a lot more to be achieved in the area of planning and scheduling. Under normal circumstances, the human brain is capable of handling a lot of information. However, a hectic schedule often results in people forgetting little details when preparing for daily tasks. Current tools such as 'reminders' are helpful in giving updates on what needs to be done or what needs to be gathered before leaving a particular place. However, without users checking their input, these reminders fail to monitor if intended actions are completed. Reminder systems that prompt users at a user-defined time have proven to be unreliable because they require update by a user if a scheduled task is not completed. To eliminate such an occurrence, a solution is to have a smart system that monitors the activities of an individual and ensures whether he/she has all the right items needed before setting out to complete a pre-defined task.

Sigma's challenge is to design a system that monitors and keeps track of items needed based on a user's schedule and notifies the user whenever an item needed for any of the day's activities goes outside a certain range of the system. It is crucial that the system is aware of each individual item which the user considers important and be able to determine when a particular item is left behind at any time of the day.

The system must be able to maintain an inventory list of all the user's items. The user should be able to easily edit and modify the inventory to provide all the information regarding the items that are tied to a specific schedule which can be updated anytime.

Similarly, the user's items should be easy to identify and monitor by the system and should follow a generic pattern to allow for easy interpretation by the processor. Furthermore, the system in place must be able to effectively communicate an item missing to the user in more than one medium to ensure the user gets the desired information and appropriate corrective actions are taken.

The system should be able to operate and switch efficiently between three distinguished mode/state: Active state, Sleep state, and Inactive state. The active state should be activated when the bag is in motion and outside of the home location. In active operation, the system is aware of all the user's present items, guaranteeing the close proximity of the users to their items. For the inactive state, the system must be able to lay dormant to conserve energy while the user is within the set home location. The sleep state should be activated when the system fails to detect motion. Hence, putting the system in a temporary inactive mode to conserve energy, the system should be able to resume its active mode whenever it detects motion during the course of the day.

In addition, the system must be able to perform all the desired function without affecting the aesthetics for the user. The entire system's weight must also be accounted for and kept to a minimum to ensure users are not discouraged from using the system. The system should also be easy to use to account for a wide age bracket users and also be able to withstand and function in poor weather conditions.

This system must offer the user a higher level of organization, as well as allowing them to still comfortably function. We do not want this system to be too heavy, and would like to keep it under 2.5 pounds. Given the miniscule size of most processors and low-range RFID systems, this should certainly be feasible. We plan to implement the system using passive RFID tags, as they have a longer life expectancy and do not need to constantly be recharged. Also, we shouldn't need a range any longer than 3 meters, which is the maximum allowed by passive RFID systems. Another requirement for our system is that the RFID reader will be able to interact directly with the user's smart phone. This should be possible because they both transmit information over the same frequency band. Most common RFID bands are 125/134 KHz, 13.56 MHz, and .86/.96/2.4 GHz. These match with Bluetooth frequency bands (2.40-2.48 GHz) and WiFi frequency bands (2.401 GHz-2.473 GHz), so the RFID system should be compatible with any phone that utilizes either of these technologies. We would also like to ensure that the frequency band employed by our systems adhere to FCC regulations.

Sigma also wants the system to be durable enough to tolerate the daily abuse most backpacks endure, such as when students slam their bags on the desks, drop them on the floor, or expose them to harsh weather. Its durability is very important, as it has a direct impact on the life expectancy of the system, and will be tested daily. This issue can possibly be handled by some type of case to cover the fragile components. **Table 1** shows a comprehensive listing of our performance measures.

	Descriptions
Function	Project must issue audible warning if user attempts to leave their residence without an item that they will need at their projected destination.
Tasks (See Table1)	System must be able to: • Successfully establish a communication link between the RFID reader and a user's cell phone, preferably by using Bluetooth or WIFI • Create a smartphone app that uses the smartphone's digital planner to notify the RFID reader of exactly which items are needed • Embed a shock/scratch resistant LCD screen on the backpack's exterior

	that can quickly give the user a summary of their inventory • Give the user a means to digitally label RFID tags according to which item they are attached to • Connect to user’s digital planner through their smartphone • Use information in digital planner to figure out how many items(20 max) are needed, and the unique IDs of each item’s tags • Allow user to update schedule throughout the day, and sync this schedule in real time • Allow user to view inventory on their smart phone • Allow user to specify which items are needed for each event • Automatically update inventory by realizing which tags are within range of the system’s RFID reader • Allow user to easily give identification to each tag
Cost	• Mid-range RFID reader: $100-500 • Passive RFID tags: 10¢ • Exterior LCD screen: $40
Compliance	• Adhere to the ISO/IEC 15693 standard • These standards apply to RFID systems that are not in close proximity with each other
Noise Level	• Audible reminder tone shouldn't exceed 20db
Weight	• Maximum of 2.5 lbs to ensure user comfort
Battery Life	• Optimal battery life is a minimum of 6 hours per charge, as the product will need to accommodate the average student’s schedule
Interface	• Exterior LCD screen • User's smartphone • RFID reader • Individual RFID tags
Dimensions	Common RFID readers are about 10’’x10’’x 2’’
Ease of use	• 10 minutes set-up, 10 minutes learning • It must require less than 3 minutes of the user’s time for daily setup
Environment	It must be able to withstand inclement weather and not be vulnerable to strong

	winds or rain

Table 1: Performance Measures

Overall, the system designed and installed must be able to communicate information wirelessly between a processor and a detection system to allow a user to track important items. Schedule information must be sent to the processor in order to determine whether items are still in the proximity of the user. The system should be able to recognize when it needs to be in certain modes of operation based on user motion and location. And the system should not interfere with aesthetics of the user's bag or stop functioning in inclement weather.

3. Current Status of Art

There are some similar patents and current solutions that are comparable to Sigma's solution. The "Home Inventory Management System and Method" patent is presented as a means to maintain an inventory of items in any facility. This system works by placing a RFID reader at the entrance of the facility. This reader is connected to a computer that is responsible for constantly updating the facility's inventory. Every time that the reader detects an RFID tag leaving or entering the facility, it sends a command to the system's computer to update the inventory. The author also proposes that if this system is placed in a household, it will be able to automatically detect any new items brought in by the consumer if the items already have a RFID tag attached to them. Assuming that these items are coming from a store, their tags should already have some type of product name inscribed on it. So, the reader can automatically add product names to the household inventory as soon as the user walks through the door with a bag full of groceries or clothes. If an item is consumed and discarded, it can also automatically be removed from the household inventory as soon as its tag exceeds some specified range. Our smart backpack will carry out a similar process that can determine the contents of the backpack's inventory in real time. Our RFID reader will share some similarities to the static reader used here. Ours will automatically identify RFID tags as soon as they pass the reader, and note whether they are being inserted or removed from the backpack. However, our RFID reader will only be activated when the backpack experiences motion, and should require less power.

In the "Radio frequency identification (RFID) household system for tracking and managing RFID tags" invention, a computer controlled RFID system is implemented by combining a short range RF transceiver and a user controlled apparatus. The purpose of the short range RF transceiver is to identify and track all RFID tags in a household. The purpose of the apparatus is to allow the user to specify which tags they would like to track, and give names to the specified tags. There is also supposed to be a feature in which the apparatus prompts the user each time a new RFID tag enters the transceiver's range. Following this prompt, the user will then have the choice of either saving/naming the RFID tag in its database or dismissing it. This system also has the capability of alerting the user when certain items leave the transceiver's range. Similar to the previous patent, this system also has the capability to alert the user when tagged items leave the RFID reader's range. This is useful, as it can prevent a user from leaving their items. Another useful feature is the automatic prompting that occurs whenever a new RFID tags enters the range of the transceiver. Implementing this feature with our backpack will be rather useful, because every time they enter a new tagged item into their backpack, they will receive a prompt to name the new item and add it to the processors database. This will make the identification process a lot smoother, and ensure that there aren't any unidentified tags. Our system should be considered an improvement when compared to this invention, as we will use a static reader instead of a scanner. This is considered to be an improvement because static RFID readers use much less power than RFID scanners, and risk less radio interference. Low radio interference is a necessity because our system will be mobile and must avoid picking up other RFID tags.

The patent titled "RFID Lost Item Locator, Home Inventory Utility" allows a user to easily locate valuables that they can't afford to misplace. This system works by placing passive RFID tags onto any of the item in question. These passive RFID tags should cost no more than 10¢ each. To set up these RFID tags for usage, a user interface device (UID) must be used. This UID can be in the form of a smart phone or tablet. This is feasible because RFID's use the same frequency band (2.45 GHz ISM) as Bluetooth and Wi-Fi. The UID must have the capability to scan the RFID tag, and then assign it a name ("Organic chemistry book", "TV Remote", etc). Once the tag has been assigned a name, the user can then stick the tag on the specified object. So, the user can create a list of items, and add and remove them from the list with ease. When the user cannot locate the item, they use the UID to send out a beacon to search for its associated tag. When the correct tag has been identified, the user can use the accelerometer on the UID to triangulate the position of the lost item. Again, our system is better than this invention because it uses a static RFID reader instead of a scanner.

4. Engineering Approach for Solution

Sigma's proposed solution tackles the challenge of disorganization and tracks one's valuable items as a user navigates through his/her daily activities. Sigma achieves this by creating a system which utilizes data pulled from the user's daily scheduler and information from an inventory. The user creates both the schedule and the inventory of items. The items are then tagged with specific RFID information. The system will also incorporate the use of accelerometers which will play a vital role as in serving as a trigger that activates certain components or functions of the system. The backpack will come with the Intel Atom board processor, RFID reader, accelerometer and vibrating electric motors, installed in its compartments. Finally, there will be an LCD screen installed on the exterior of the backpack to display the output from the processor's operations. These operations will also be displayed in an application (which we will create) on the user's mobile phone.

In implementing this system, an inventory must first be created for all the items that the backpack will be expected to monitor. The user will be required to provide information regarding what items are needed for each standard task on their daily organizer. For example, a student will indicate the textbooks and notebooks needed for each class on his daily schedule. This inventory will be stored on the user's phone and will serve as a baseline for the day-to-day list of required items for the backpack. The list will be made flexible enough to be easily updated any time as the user's needs change. After this is done, unique RFID tags will be created for the items. Each tag will bear a name (identifier) which follows a generic name-pattern in order to simplify the interpretation by the processor and a special RFID tag will be placed in the doorway of the user's home. The processor will then store the corresponding list of tags.

RFID systems are usually implemented as either a fixed-point monitor or a wide-area scanner. The fixed point monitors are usually set up at the entrance of a facility, and used to manage its inventory by scanning items as they enter/leave a specific area. A RFID system that has the capability to scan an area for RFID tags is advantageous because it can tell whether a specific item is within its range, as well as pinpointing its location using a triangulation method or reference points. However, these are generally more expensive, as both the transmitters and tags have to be capable of generating much more power than the passive system. Due to the high costs of RFID systems, it appears that they are most commonly employed in industrial or commercial settings to keep track of high value assets. Sigma will utilize a passive RFID system to reduce cost and risk of radio interference while trying to maintain the advantages of this RFID technology to implement the Smart Backpack in a residential setting.

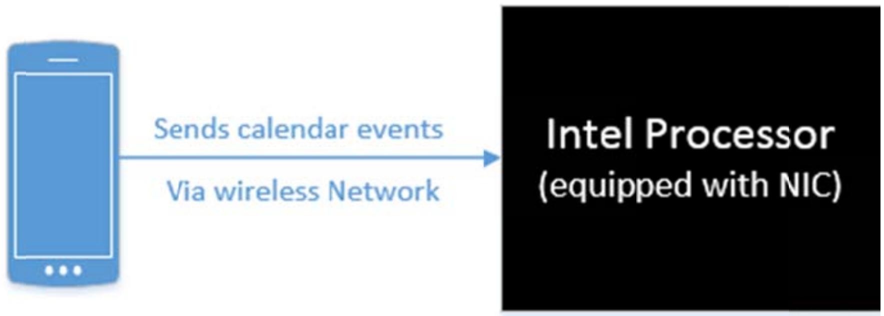

Figure 1: Calendar Events Sent to Processor

At a specified time every evening when the user is home, the user's phone wirelessly communicates the schedule for the day ahead to the microprocessor. The list of required items is generated based on the tasks in the schedule and communicated to the microprocessor as seen in **Figure 1.**

Figure 2: RFID Reader Tells Processor Which Tags It Senses

In this system, the accelerometer serves as the activation trigger for the RFID tag reader; hence the reader will be in an active state only when the backpack is in motion. Whenever the user crosses the doorway to leave the house, the doorway tags will be read to indicate that the user is outside of the home location. As seen in Figure 2, the tag reader sends the tag numbers in the reading range to the processor. The processor compares the list of expected tags (based on the list previously retrieved from the user's phone) and the items currently in the backpack. A mismatch of items will trigger the vibration of the motor and a transmission of this mismatch to both the LCD screen and mobile application.

When outside the home environment, a stationary positioning of the backpack as determined by the accelerometer will keep the RFID reader in standby mode. As seen in **Figure 3**, when motion is detected, the reader will again scan for the tags in the reading range and make a comparison to the expected tags that should be in close proximity to the backpack.

Figure 3: RFID Reader Tells Processor That It Senses Motion. Processor Then Activates RFID Reader

A mismatch between what is expected and what is actually read will, as stated earlier, trigger the vibration of the backpack, the display of the identifier/name of the "missing" items on the bag's LCD screen as well as a notification sent to the user's phone on what items are missing. Should there be a match between the items, none of these 3 actions will be triggered. Continued motion will keep the reader in its active state and there will be no change of state recorded by the processor until the RFID reader stops detecting any of the tags. This could occur, for example, in a situation where the student walks out of class and leaves a textbook behind. As seen in **Figure 4**, as the reader moves out of range and stops reading the tag for the textbook, the processor will send a signal that will trigger the vibration motion of the backpack, the display of the "identifier" of the missing item on the bag's LCD screen and a notification sent to the user's phone.

Figure 4: Processor sends signal to the vibrators, and also sends list of missing items to the user's phone, and the LCD screen on the backpack.

This asset monitoring continues through the day as the user navigates his/her tasks up until when the user finally returns home and crosses the doorway. When the user crosses the doorway this time, the processor will determine that the user is home and the tags will be read again. The tags of the backpack's current contents will then be cross-referenced with the record of the tags that were read when the user stepped out through the doorway initially. A mismatch will trigger the backpack's vibration and notifications, both displayed on the backpack's LCD screen and sent to the user's phone. Items identified to be missing at this stage will be saved in a log.

This backpack system will be designed to target valuable items that are both large enough to be tagged and small enough to fit in a backpack. Since the holding container for our system is a backpack, we are only concerned with items which are small enough in size to fit in the backpack such as phones, wallets, books, sunglass cases and so on. The focus is further streamlined to non-disposable items and items that do not diminish over time. However, it won't be able to assist with items that have not been tagged. Furthermore, the scope of the RFID reader will be limited by the strength of the reader. The processor will focus on accessing the user's day-ahead schedule from the user's mobile phone/organizer, calculating distance of reader to tags, and controlling the vibrator, LCD screen, and mobile app.

Sigma's Smart Backpack will serve as a good solution because it ensures that users have their vital items for their daily activities before they leave home. Also, the Smart Backpack will also help to ensure that users can keep track of their tagged belongings throughout the day with minimal effort and in real-time. In contrast to electronic copies of documents which can be backed up and recovered from the internet, losing physical items typically necessitates that the owner backtracks to wherever they think they left their belongings. Backtracking becomes a real burden when one is very far away from their last location As an alternative to this backtracking solution, this backpack notifies the user that something is amiss while within a very reasonable range. Finally, the materials to be utilized in this solution allow for simplicity, are relatively cheap (cost-efficient), and can be easily installed without disturbing the aesthetic qualities of the backpack.

The Smart Backpack solution will showcase the power of the Intel board by demonstrating the multi-dimensional communication abilities of the processor. For our project, the Intel Board liaises with software (smart phone calendar events), and hardware (vibrating motors and accelerometers) components to achieve our solution. Sigma will seek to demonstrate how the smart backpack will take an organizer a step further, by ensuring that the a user has all the intended materials for a pre-defined engagement before stepping out of a set home location hence showing the workings of RFID technology and its application. In addition, we hope to use the smart backpack to demonstrate the alerting system we will have in place, to ensure users are notified when leaving an important item intended to be in the backpack that is needed for the day's activities. Finally, we plan to demonstrate full understanding of all technologies used to create our smart solution.

With RFID technology becoming increasingly popular in departmental stores, international passports, and toll gates, it is Sigma's intention to learn how to can incorporate RFID technology into its everyday activities. Sigma will also understand better how to integrate the daily functional usage of the smart phone with the Intel Atom board to serve as an information source as well as an alert system for our project. In addition, we hope to learn and understand the working of an accelerometer and methods to conserve energy by supplying power only when needed. On a broader scale, we will understand the communication links/methods between a smart phone, vibrating motors, RFID tags, an accelerometer, and the Intel atom board to create a desired solution for users while understanding the system integration of different technologies to create a smart solution.

5. Tasks and Deliverables

For ECE day, Sigma will have a working solution that has the functionality to successfully alert a user if he or she is forgetting a critical item when they are outside of their home. To accomplish this goal, Sigma will follow closely to the timeline that is shown below. See next the list of assignments that each team member has been given.

Hardware Team - Samuel Omosuyi, Ellwood Lane

- Develop electrical simulations
- Decide specific parts, order parts, and inventory received parts
- Develop integration plan for all of components(hardware and software)
- Integrate hardware components
- Test and refine hardware
- Verify that relevant standards are met

Software Team - Jennifer Okafor, Kalonji Bankole, Paul Alade

- Help develop mobile application
- Write software to allow Intel board to control components
- Test and refine software

Note: No team member is limited to their individual tasks. Each member will be working closely to learn as much technical information as possible.

6. Project Management

	Duration	Expected Completion Date	Status
Develop Detailed Simulations and Algorithms	**45 days**	1-Dec-12	
Develop simulation for motion sensor communication			
Develop simulation for LCD and vibrator response			
Develop algorithms			
Calendar data acquisition			
Separation calculation + vibration			
Mid-term review sign up		27-Nov-12	
Order Parts w/ lead time	**30 days**	31-Dec-12	
Order RFID reader			
Order tags			
Order motion sensor			
Order LCD screen			
Order small DC motor + weight(vibrator)			
Develop Prototype	**45 days**	14-Feb-13	
Configure RFID tags for items			
Assemble backpack			
Integrate motion sensor with RFID reader			
Integrate RFID reader with Intel Board			
Integrate vibrator with Intel Board			
Integrate LCD screen with Intel Board			
Write software to create app			
Write software that allows Intel Board to control components			
Mid-term review		23-Jan-12	
Test and Refine Prototype	**45 days**	31-Mar-13	
Ensure proper association between tags and items			
Ensure home location is correctly identified			
Ensure motion sensor activates RFID reader			
Ensure correct data is acquired based on given day			
Ensure vibrator, app, and LCD screen properly respond			
Proposal Development	**22 days**	22-Apr-13	
Develop final proposal			
Revise final proposal			
Submit final proposal			

Table 2: Timeline

Note: Weekly 1-hour review sessions with our advisor will be held

Sigma's idea is market feasible because a vast demographic can benefit from a detection system that prevents them from leaving an item at home or forgetting an item at say the airport when they are rushing to catch a flight. And surveying different students at Howard University, a large number of students think a smart backpack is a great idea and would be willing to retrofit their backpack with our system in order to monitor important items on a daily basis. Also, many other bags can be fitted with a system similar to ours. Women's purses and men's briefcases also can utilize a similar set-up to Sigma's Smart Backpack.

Sigma's Smart Backpack is also achievable within the allotted budget. The RFID reader and tags ($300), accelerometer ($30), LCD screen ($40), and vibration system ($15) will be no more than $500. We do know that replacement parts and shipping costs must be taken into account, but we do not expect these items to cause our part costs to exceed our budget. As a preventative method to avoid having to replace parts, we will make sure to operate components within their provided specifications. Table 3 shows a listing of our budget.

Budget	
Component	**Cost**
RFID reader and tags	$300
Accelerometer	$30
LCD screen	$40
Vibration System	$15
Total	**$385**

Table 3: Budget

Sigma's idea is technically feasible because there are existing systems that use the individual components of our proposed project. RFID readers to track items are currently in use. Acquiring data from calendars also exists in current applications. Motion sensors and vibrators also have common applications. In addition, mobile apps are now experiencing a large amount of popularity as well. Accordingly, Sigma integrates these existing components with a backpack to help ensure that users have their necessary items on a daily basis and do not leave valuable items behind as they move around under any circumstance. Most importantly, these components can easily fit into a conventional backpack and users will maintain the majority of their backpacks functionality.

It is also feasible for Sigma to use RFID tags for asset tracking and to pull data from a calendar in order to make further computations. The use of RFID readers to locate items has vast applications in asset tracking. These applications include tracking a patient in a hospital to tracking an asset of a company to ensure that correct preventative maintenance occurs on a piece of equipment. Available readers such as the Phidget RFID reader come with interfacing software for different computer platforms which would allow Sigma to use a language such as C++ to configure the RFID tags. Acquiring data from calendars is also readily used in applications such as Microsoft Outlook. Synchronization takes place between one's email account and Microsoft Outlook to transfer appropriate information from say a Gmail calendar to the Microsoft Office calendar.

Motion sensors can also be widely seen in various applications today. These sensors are at the basis of many security systems, smart hotel Heating, Ventilation, and Air Conditioning (HVAC) systems, cars, and many other applications. Accelerometers, a specific class of motion sensors, have the functionality to detect acceleration and will allow our smart backpack to sense when it is being moved in order to wake-up the RFID reader to check the position of items in its vicinity. Vibrators are also common in today's world. In most cell phones, a vibrator alerts users for incoming calls, text messages, etc. The smart backpack would be using this vibrator for a slightly different purpose but the overall functionality exists for our backpack to vibrate to alert a person that they are leaving something important behind.

Utilizing the computational power of the Intel Atom processor, Sigma's smart back pack will be able to make the appropriate calculations as to which day of the week and thus which items will be needed for this day. Intel's processor, based on the location of the backpack in relation to relevant RFID tags for a given day, will determine whether an alert needs to be sent to the phone and LCD screen. Also, the Intel atom processor is capable as a memory storage location to store past alerts that have been sent to the user and whether a user is inside the proximity of the designated home location. And through a user-friendly app and LCD screen, a user would receive the alert that they should recover the item that's being left behind. With over 425,000 apps now available at the Apple app store, an app creation is very feasible.

Also, Sigma's project is feasible within the time constraints we have been given. For each given task, we will be working as a team to meet our deadlines and produce our deliverables. Detailed simulation and algorithm development have been allotted 45 days. Relying on past experiences with developing simulations and algorithms, Sigma will be able to meet our deadline. In a past internship, Ellwood was tasked to develop algorithms, learn C++ programming, and then implement this C++ programming to collect data from a measurement instrument and build a graphic user interface (GUI). This task took approximately 30 days of full-time effort. With the five of members of Sigma working collaboratively part-time, we will be able to finish the algorithm portion of our Smart Backpack project in less than 30 days. For simulation development, each member of Sigma has experience utilizing PSPICE and MATLAB software to develop simulations.

Sigma believes that ordering and receiving our parts for the system will take no more than 30 days, including any lead time, as the parts needed for the system are readily available. RFID readers and tags, LCD screens, motion sensors, DC motors, and weights are items that are sold by many vendors. And on the receiving end, all orders will be mailed directly to a Sigma member's. Thus, we will not be dealing with any bureaucratic processes to slow down obtaining our items.

Next, Sigma has given 45 days to developing a rough prototype. This includes configuring the RFID tags and fitting the backpack with a RFID reader, motion sensor, and vibrator. Also, writing the software that will allow the motion sensor to backpack communication as well as developing our app will fall within 45 days. Each member of Sigma has experience using a breadboard to implement electrical simulations. Jennifer Okafor, Sam Omosuyi, and Kalonji Bankole have practical corporate experience with writing complex software. At Microsoft, Jennifer created an app for the windows phone that enabled users to download template documents from the office.com site to their mobile device. At the Army Research Laboratories (ARL), Kalonji implemented an orthogonal matching pursuit algorithm in CUDA, an extension of C. Also, he used MATLAB to implement an augmented reality system for mine detection. In this case, he was given a test video, coordinates of the camera, and coordinates of the "mines". His program processed these coordinates in order to place markers over the screen that showed exactly where the mines throughout the whole video. Working for Goldman Sachs, Samuel created and automated the process of monitoring, reporting and controlling user access levels for all applications across the firm during feed gaps. Thus, Sigma has the expertise to develop our necessary software including our app.

With an additional 45 days, we will produce a working model that meets our performance expectations. Previous lab courses have required Sigma members to test electrical designs. Also, Ellwood has practical corporate experience with testing and troubleshooting electronics. He has experience with walking through test procedures and understanding complex schematics to test products and ensure that the products meet given specifications. In the past, Jennifer has used C# to develop automated testing for user-accessibility of Microsoft's Office 2013 suite's sign-in pop-up dialog. Because Sigma has relevant prior electronics and software testing experience, the allotted time for testing will be sufficient to develop a working prototype. Table 4 shows a summary of verification plan. Table 5 shows a listing of our resources.

Steps	**Function**	**Test**
Calendar information	Information is making it from app/phone to processor	Information is properly showing on processor
System state	Motion turns on RFID reader	Does RFID reader turn on as a response to movement
Tag identification	Reader is recognizing tags within region	Tags are being read
Tag proximity	Error message is sent when tag moves outside of region	Processor correctly realizes that a certain tag is missing
User notification	Error message is received by user through each outlet	App/Vibrator/LCD screen correctly function
Home location	RFID reader goes to sleep when inside home	RFID reader turns off once home tag is read

Table 4: Verification Plan

Physical Resources	**Technical Resources**
Matlab	Classwork background
PSPICE	Practical corporate experience
Microsoft Visual Studio IDE	
Intel Board	

Table 5: Resources

7. Conclusion

Sigma's Smart Backpack will provide a useful solution for the many people who forget required items or important materials when moving between tasks. On completion of this project, the Smart Backpack will be able to assist the user in being organized in packing items. From the development of its solution, Sigma will gain knowledge on the modes of operation of the Intel atom board and its integration with existing technologies like Radio Frequency transmission using the RFID tags and readers. Most importantly, Sigma has a well-thought out timeline with milestones that will allow the solution to be completed by ECE day. Developing detailed simulations and algorithms, ordering parts, developing the prototype, and testing and refining the prototype are the major milestones to timely product completion.

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