## **Purdue ECE Senior Design Semester Report**

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| **Course Number and Title** | ECE 477 *Digital Systems Senior Design Project* |
| **Semester / Year** | Spring 2018 |
| **Advisors** | Prof. Thottethodi, George Hadley |
| **Team Number** | 16 |
| **Project Title** | Track-on-Track |

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| Senior Design Students – Team Composition | | | |
| **Name** | **Major** | **Area(s) of Expertise Utilized in Project** | **Expected Graduation Date** |
| Nicholas Geirland | CmpE | Firmware, Soldering | Spring 2018 |
| Nathan McNally | CmpE | Software | Spring 2018 |
| Yunsheng Li | EE | Schematics, PCB Layout | Spring 2018 |
| Aaron Kaiser | CmpE | Software, Design | Spring 2018 |

**Project Description:** Provide a brief (2-3 page) technical description of the design project, as outlined below:

1. Summary of the project, including customer, purpose, specifications, and a summary of the approach.

## Track-on-track is a project designed to create a device which is capable of transmitting its location to the user through SMS messages, and which is also able to communicate relative distance to the user through bluetooth. In addition, the device will contain a speaker which will be used for finding the device audibly. The project also included a smartphone application, which is the primary means of communicating with the user. The purpose of the device is to locate lost or stolen bags, luggage, or other containers which may contain valuables. This product is designed for anyone who carries valuables with them in bags that they would not want to lose, and in particular, it is designed for travelers. Some specifications for the project were to make it small and light enough to be able to fit into most bags and not be difficult to carry. Another major concern was battery life, as the device was supposed to go into a bag and stay there for multiple weeks at a time. Other considerations included the strength of the signal of both the cell modem and the bluetooth, as more power means a more reliable device. In the end, the GSM cell modem and bluetooth module were both chosen to balance the need for power with the need for battery life. A microcontroller was selected based on its ability to preserve power, as not many heavy calculations were required for this design.

1. Description of how the project built upon the knowledge and skills acquired in earlier ECE coursework.

## Multiple courses helped the team prepare for this design. The whole device was designed around using a microcontroller to control flow between the different communication devices, and also to interpret and answer requests from the user. ECE 362 was the introductory microcontroller course at Purdue, and it covered the basics of programming a microcontroller and using it to interface with various devices. That course also had an opportunity to learn about and produce a PCB, which was the team’s first introduction to custom making PCBs. ECE 264 is a CompE required course which covers advanced C programming. This course also introduced many structures, methods, and concepts used in computer programming. The app for this design was an android app and was programmed in Java, but even so the concepts taught in ECE 264 assisted with developing the app. ECE 201 is an introductory circuits course which teaches the basics of circuit design with components such as capacitors, inductors, and resistors. While the concepts taught in this course are very basic, they were still required when calculating values of current limiting resistors and decoupling capacitors in the circuits.

1. Description of what new technical knowledge and skills, if any, were acquired in doing the project.

In order to make progress in the project, new skills and knowledge was learned. For the hardware, the skills to use EAGLE CAD to design schematics and PCB layout were learned. Soldering is another skill that was learned and practiced a lot for each team member when building the board. Moreover, the important skill to debug hardware in a systematic way was acquired.

For software, the knowledge of how to communicate through Bluetooth module and GSM cell modem was learned. Also, the development of phone app required team members to learn the skills to program for android systems. The knowledge of using Google Maps in project’s app was also learned.

1. Description of how the engineering design process was incorporated into the project. Reference must be made to the following fundamental steps of the design process: establishment of objectives and criteria, analysis, synthesis, construction, testing, and evaluation.

During the establishment of objectives and criteria stage of our project, we formulated a solution to a problem that was inspired by a situation in which a team member was directly impacted. We analyzed similar solutions and defined objectives that would meet the requirements for developing a product to solve the specific problem. As the project progressed, we conducted analysis on which hardware components would best fit our needs for meeting our objectives. Continuing with synthesis and construction, we began developing initial software, firmware, and schematics. Each separate hardware and software module was tested and brought online independently until the complete system was brought to fruition. As the various components were evaluated, there arose the need to return to the construction and testing stages until we could successfully demonstrate our complete design. The device was tested in an outdoor environment to ensure the testing modeled a real life situation.

1. Summary of how realistic design constraints were incorporated into the project (consideration of most of the following is required: economic, environmental, ethical, health & safety, social, political, sustainability, and manufacturability constraints).

## **Economic:** The design took the cost into consideration to ensure the device is affordable for users by choosing relatively inexpensive parts and PCB manufacturer.

## **Environmental:** The device was designed to have a low environmental impact, creating no waste materials and no harmful radiation. This is achieved by choosing Lithium-ion rechargeable battery which results in no wasted batteries.

## **Ethical:** The device has the potential to be used for unethical purposes such as stalking because the purpose of the device is luggage tracking. Although this kind of use cannot be directly prevented, the design will include warning tags that outlines the lawful results of using it for criminal purposes.

## **Health & Safety:** The safety problems on the device come only from the battery because the Bluetooth module and the cell modem used are certified to be harmless. The design prevents the battery from bringing harms by utilizing a sturdy package.

## **Social:** During the development of project, it was brought to our attention that it was illegal to carry devices with lithium-ion batteries in checked luggage; however, through research, it was discovered that this is not the case. Traveling with spare (non-installed) lithium-ion batteries in checked luggage is prohibited, but devices with installed batteries are accepted in checked luggage.

## **Political:**

## **Sustainability:** The device was designed to communicate with user’s smartphone with Android system. Since Android smartphones have a large popularity in users, the device can be used by tons of users and as long as the app is downloaded, the device can be used to the end of its life cycle.

## **Manufacturability:** Assuming that all chips and passive components can be soldered onto the PCB via an automatic process. The manufacturability of the device is great. Since most of the components are on board except the battery and antennas, once the board is manufactured, the only work left is to plug in the battery and antennas. Not only the assembly of the device is simple, it is also simple to swap the battery and antennas when they stop working.

1. Description of engineering standards utilized in the project

Both the Bluetooth and GSM cell radio used in our project are certified by the FCC and CE. These components also utilize their respective standard communication protocols allowing for communication between the device and any mobile device that communicates using the standard communication protocols for cellular or Bluetooth, or both.

1. Description of the multidisciplinary nature of the project.

## This project required computer engineering knowledge and skills. The microcontroller is programed to interface with modules and process the commands to achieve desired functionalities. The phone app required knowledge of Java language to work together with the device. Moreover, electrical engineering knowledge was also required for the project to determine the circuit schematics design and values of passive components. Finally, some technical skills were used in building the prototypes such as soldering and EAGLE CAD software to design the PCB schematics and layout.

1. Description of project deliverables and their final status.

The final prototype was able to achieve all the desired functions. It was able to communicate with smartphones via the phone app and show the location of the device using GPS. The device was able to send text messages to smartphones. Also, the device can be controlled to make sound through Bluetooth via the app. The pushbuttons and switches can successfully communicate with the microcontroller and enable the user to interact with device’s menus.