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September 16, 2002

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, BC
V5A 1S6

Re: ENSC 340 Project Proposal for a Hand-held Tracking Device

Dear Dr. Rawicz:

The attached document, *Proposal for a Hand-held Tracking Device*, outlines our Engineering Science 340 Project. Our objective is to design a miniature homing device capable of tracking external tags placed on any object. Also, the tracking device will be able to notify the user when the tagged object is a certain distance away from the receiver, such as when the object is stolen or forgotten.

This proposal will provide an overview of our product, a description of our design as well as existing solutions, a tentative projected budget, our sources of funding and information, and a discussion of our project's time schedule and team organization. In addition, the market potential estimate of our product will be provided.

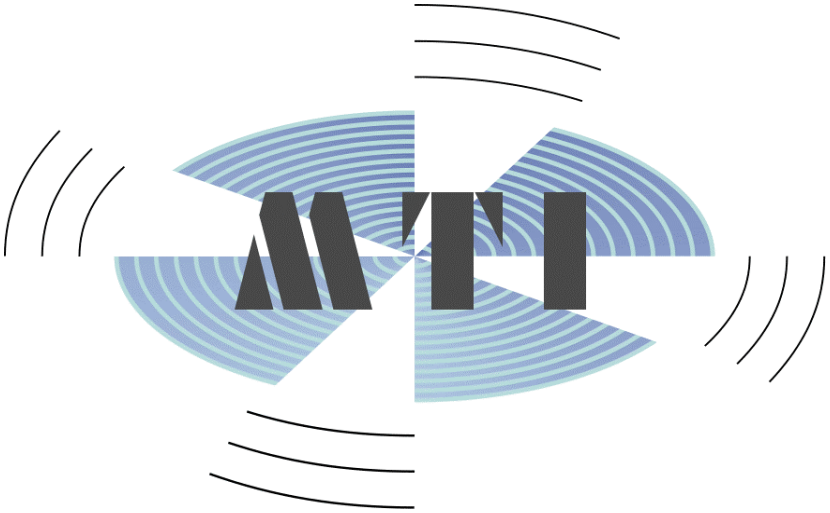
MicroTrak Inc. consists of five enthusiastic, dedicated, fourth-year engineering students: Lawrence Li, President and Chief Executive Officer; James Dykes, Chief Financial Officer; Victor Leung, Chief Operations Officer; Herman Lo, Chief Technology Officer; and Bernard Ng, Chief Hardware Engineer. If you have any questions or concerns about our proposal, feel free to contact us at (604) 525-9185 or via email at 340-group@sfu.ca.

Sincerely,

Lawrence Li

Lawrence Li
President and CEO
MicroTrak Inc.

Enclosure: *Proposal for a Hand-held Tracking Device*



Proposal for a Hand-held Tracking Device

Project Team:	**James Dykes** **Victor Leung** **Lawrence Li** **Herman Lo** **Bernard Ng**
Contact Person:	**Lawrence Li** **340-group@sfu.ca**
Submitted To:	**Dr. Andrew Rawicz - ENSC 340** **Steve Whitmore - ENSC 305** **School of Engineering Science** **Simon Fraser University**
Issued Date:	**September 16, 2002**
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Executive Summary

Ever forget where you left your keys? Cannot find your car in a huge parking lot or even lose your kids in the mall? MicroTrak Inc. (MTI) has a solution for you. Since 1995, the number of missing children in Canada had been on the rise from 56,000 to 67,000 (Garden, 1998). Also, more than 170,000 vehicles were stolen in 2001 (ICBC, 2002). With our product, MicroTracker, these lost or stolen items could have been easily tracked down.

The MicroTracker is a small, handheld tracking device with multiple mini-tags (transmitters) and a tracker (receiver). By placing a tag onto an object, the tracker can direct the user to the object effortlessly. As an added feature, the MicroTracker will also warn the user whenever the mini-tag moves a predetermined distance from the tracker; thus, reminding the user of a forgotten item or helping parents to monitor their children.

Currently, several tracking solutions exist such as GPS, RF multi-receiver, and infrared tracking systems. However, GPS systems on average cost $200, and monitoring services add another $40/month (Wherify, 2001). Likewise, RF multi-receiver systems require multiple matched receivers, which is rather costly. Lastly, infrared tracking systems are short-range and support only line of sight coverage.

The MicroTracker, on the other hand, will be more cost effective and portable. Instead of multi-receiver implementation, our product will consist of only ONE receiver. Through reduction in components, the power consumption will be lowered. Furthermore, it allows for instant access of the tracking information from the receiver and could be used under most environments.

The potential market for our product is enormous. Search and rescue units, nursery homes, hospitals, crime enforcement units, and the general public would love to have this product. In fact, MicroTracker can be used for tracking forgotten or stolen items, missing or kidnapped people, wandering kids, Alzheimer patients, and even convicted criminals.

MTI consists of five creative fourth-year engineering students, who together possess the expertise needed for this ambitious project. With rich experience in electronics, communication systems, and digital system design, the MTI team will be able to complete the project smoothly.

Our proposed project will involve a rapid 3-month engineering process, which comprises of research, implementation, testing, and prototype phases. Our projected budget for this project is $800. Our funding will come from various sources, such as the Engineering Science Endowment Fund and the Wighton Development fund.

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1 Introduction

"Find it, before you lose it"

Let's face it; we lose and leave things behind all the time. In fact, the idea of our project came from one of our group members who consistently leaves his lunch bag behind. In this fast pace world, people with a million things on their minds could very easily lose track of where they placed their belongings. Therefore, having an economical and easy to use tracking device to ease the pain from long, tiresome searches would definitely be very useful.

Many existing tracking devices, such as GPS, RF multi-receiver, and infrared tracking systems, are available, but they all have some drawbacks. GPS systems are large scale, expensive, and require a fixed station for reception of satellite positioning information. Also, GPS systems have a positioning error of at least a few meters (Trimble, 2002); thus, making pinpoint positioning of objects very difficult. Imagine yourself having to pay expensive monthly fees for a monitoring service which only informs you that your lost keys are somewhere in your house. Also, GPS only supports outdoor usage and cannot operate indoors. As for infrared systems, only short range, line of sight tracking is supported, which greatly restricts the environment under which the device could be used. RF multi-receiver systems solve the line of sight limitation, but as the name suggests, require multiple matched receivers, which is very costly. MicroTracker is the answer to all these problems.

Besides being small in size, MicroTracker is very easy to use. It consists of a palm size tracker and multiple tags. In our proposed design, the tracker will contain only ONE receiver, while each tag will consists of a transmitter, an antenna and a few passive components. The communication between the tags and the tracker will be established through RF signals, which solves the line of sight problem present in infrared implementations. Using the simple signal strength indicator on the receiver system, the user can effortlessly determine the direction of the tagged objects. Also, the various LEDs on the tracker will indicate the user's relative distance from the object. Furthermore, the MicroTracker will automatically alarm the user when his or her tagged belongings have been left behind.

MicroTracker has many useful applications, ranging from locating vehicles in a parking lot to tracking stolen items or finding missing children. This proposal provides a brief description of MicroTracker, several existing solutions, the advantages and limitations of our design, a tentative projected budget, our sources of funding and information, and a discussion of our project's time schedule and team organization.

2 System Overview

Our wireless tracking system, MicroTracker, consists of mini-tags and a tracker unit. Operating MicroTracker involves placing tags onto objects or people to be tracked, and using the tracker unit to locate these tags. The tracker unit can track multiple, uniquely identifiable tags enabling users to monitor several objects or people. Figure 1 below shows the system's components.

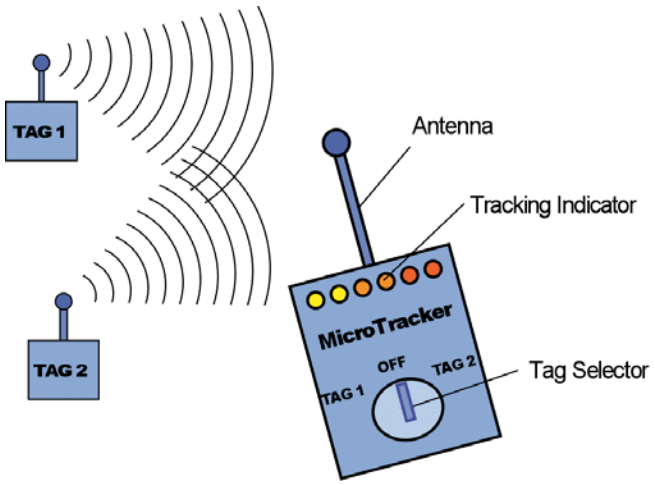

Figure 1: MicroTracker System Diagram

A secondary function of MicroTracker is to warn users that the tracker unit has become separated from the tags by a preset distance. Thus, MicroTracker can be used to detect theft, remind users of left behind belongings, and even help monitor young children.

3 Possible Design Solutions

With the current technology available, there are many possible solutions for the proposed tracking device. Our major concerns when selecting a specific technology will be accuracy, reliability, range, size and price.

3.1 Global Positioning System (GPS)

The Global Positioning System consists of a network of 24 orbiting satellites, which can accurately determine the position of a GPS receiver anywhere on earth accurate to a few meters (Garmin, 2002). Already in existence is a GPS tracking device, which can be used to locate stolen automobiles or vehicles in distress. Although, this technology is highly reliable and accurate, the price for GPS units prohibits its widespread use as a tracking device.

3.2 Radio Frequency (RF) Locators

Radio frequency locator system is made up of a RF transmitter placed on the object to be located. The transmitter sends out a radio signal that is detected by an array of fixed RF receivers. The desired object's location can then be triangulated via further processing. This technology is used in regional and national parks where large areas have to be covered. Some places also use smaller versions of this system. While transmitters can be inexpensive, the greater fixed cost of the receiver array and the processing unit for triangulation makes it undesirable for personal use.

Another kind of RF locator system involves no processing unit. Here, the receivers act purely as sensors independent of one another. Each receiver would send a signal to a monitoring device when the transmitter's signal is detected. Such systems are used in elderly care facilities. Once again, the greater fixed cost of the receiver array makes it undesirable for personal use.

3.3 Infrared (IR) Systems

Another type of positioning systems is based on infrared communication. (Hightower, Borriello & Want, 2000) The idea is similar to RF locators, but can only work in an indoor environment due to its limited, line-of-sight only capability. Thus IR systems are highly inadequate and inefficient for large distances especially in an urban setting.

4 Proposed Design Solution

Our proposed design is to build a miniature tracking device that can locate multiple tags. By placing tags onto objects, they can be easily tracked down. MicroTracker will have a selectable warning mechanism, alarming users that an item being tracked is a certain distance away.

MicroTracker has many applications. For the general public, it could be used for positioning misplaced or stolen items. By simply placing tags onto objects that can be easily lost or stolen, the tracker will direct the user to the objects. If a user wants to be reminded to bring an object with them, they can put a tag on that object and set the tracking device to the alarming mode. For people who are in hazardous environments, attaching a tag onto them can definitely benefit search and rescue units in finding these people in the event of an emergency. In addition, tags can be put on pets and kids, who may wander off or be kidnapped to an unknown location. Furthermore, the tracker may be fixed to a certain location near a tagged object or person; thereby, preventing the object from being stolen or the person from wandering off without notice. With this function, MicroTracker can be used for surveillance purposes in places such as prisons, museums, nursing homes, day-care facilities, shops, and personal homes.

MicroTracker will have several advantages over existing tracking systems. Our tags will be small and can be conveniently placed onto any object. Our miniature tracking device will be lightweight and much easier to use than existing devices. MicroTracker will provide users with direct, real-time, and simple information about the location of tagged objects allowing users to locate these objects quickly. Our RF solution will provide both short and long-range tracking in indoor and outdoor environments, which combines the advantages of GPS and infrared systems. Since MicroTracker will be simpler in structure than most existing tracking systems, it will be more reliable and easier to maintain.

However, our design solution will have some limitations. The tracking device will not guarantee the shortest path to the destination since each transmitted RF signal from the tag may travel in multiple paths. Also, our device will not be able to differentiate between a line-of-sight signal and a deflected signal. Furthermore, because our tags are differentiated by frequency, our tracking system may be prone to interference from signals of similar frequency. In addition, because the propagation distance is dependent on the power consumed by the transmitter, the tag's power source has to be replaced regularly. Lastly, given the limited funding and time frame to implement the project, the performance of our system may not be as good as anticipated.

5 Budget, Funding, and Information Sources

5.1 Cost Analysis

Table 1 provides a list of the items that would possibly be used in developing our product as well as the estimated cost.

Table 1: Proposed Budget and Costs

Item	*Estimated Cost*
Printed Circuit Boards	$350
Transceivers	$100
Antennas	$100
Operational Amplifiers	$25
Passive Components	$25
Vibrating Motor	$15
Buzzer or Mini-Speaker	$15
LEDs	$10
Miscellaneous	$160
Total Budget	**$800**

(All Electronics, 2002)

Based upon the estimates above, our project would cost approximately $800.

5.2 Sources of Funds

Funding for our project would likely be provided through the Engineering Science Student Endowment Fund (ESSEF) and Wighton Development Fund. However, we will also seek funding from other sources connected to our team members. If external funding is insufficient to cover all costs, any remaining costs will be divided among our team members.

5.3 Sources of Information

Information that will benefit the development of our product will come from various sources. We can consult several of our school's faculty members for technical guidance. Shaun Stapleton and Jacques Vaisey can help us with their expertises in RF communication systems. Ash Parameswaran and George Austin can counsel us in the electronics aspect of our project. Industrial contacts through our team members' previous employments can provide meaningful information for our project. Learning materials from our courses, existing publications in telecommunications, electronics periodicals, and internet websites also serve well as excellent technical references in the research and development of MicroTracker.

6 Schedule

Table 2 below shows the expected time to be spent on the various task required for our project, while Figure 2 shows when particular tasks are expected to be completed.

Table 2 - Gantt Chart of Expected Tasks

ID	Task Name
1	Research
2	Proposal
3	Functional Specification
4	Design Specification
5	Assembly of Modules
6	Integration/Prototype Testing
7	Debugging/Prototype Modification
8	Documentation
9	Post-Mortem Report

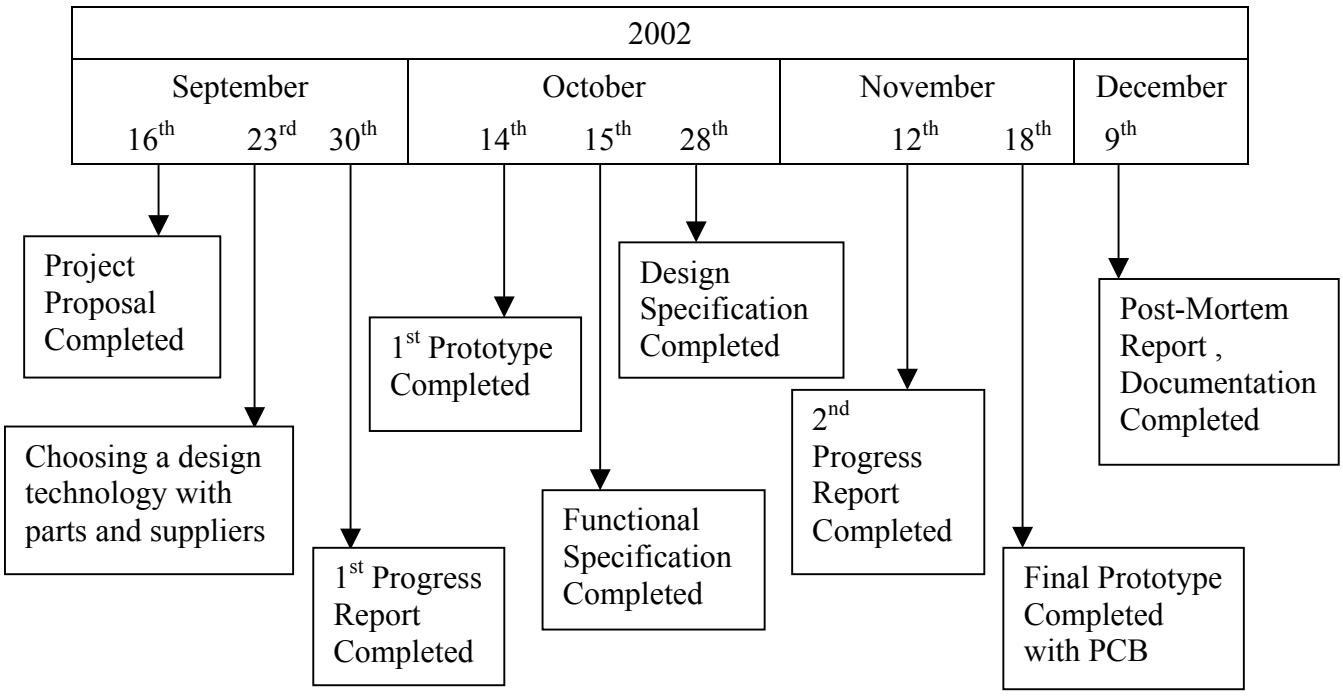

Figure 2 - Completion Dates for Specified Tasks

7 Team Organization

At the core of our design is a group of dedicated and experienced engineers. Each team member has their own specialty, personality and background which adds to the overall creative process of the project and ensures a successful project completion. Our project encompasses a wide variety of tasks, where each team member will be assigned a specific task to reduce the completion time of the project. However, in order to ensure the smooth integration of the various parts, all team members will be required to familiarize themselves with the details of the overall project. This work philosophy ensures that each group member is sensitive to the needs of another group member, thus avoiding major design and group conflicts.

Our President and Chief Executive Officer, Lawrence Li, will be responsible for the overall organization of the project while making certain that all other team members are well informed and adhere to the outlined schedule. Victor Leung, our Chief Operations Officer will be responsible for maintaining communications and resolving design conflicts between our Chief Hardware Engineer and Chief Technology Engineer. Our Chief Financial Officer's main responsibility will be to track an up-to-date budget and to make certain that the company has sufficient funding when the need arises. The CFO's role will be fulfilled by James Dykes. Our Chief Hardware Engineer and Chief Technology Officer are Bernard Ng and Herman Lo, who will work together in the development of the product.

In order to keep every member well informed, an internal website will contain the latest scheduling information and timely technical information. In addition, group meetings will be held at least weekly to ensure that each team member is on schedule and to resolve organizational and technical conflicts.

Because of the importance of creativity and cooperation in a project of this magnitude, each team member will be given every opportunity to express their own opinions. Thus, we maintain a friendly but focused working environment for our members.

8 Team Profile

Lawrence Li – ***President and Chief Executive Officer***

I am a fourth year Systems Engineer with experience in the hardware field. From previous courses, I have acquired programming and design experiences with various programmable logic devices, FPGAs and on various platforms. Through my previous coop terms at Epson Research and Development, I have become knowledgeable in testing and validation of IC designs. In addition to my technical experience, I have a well develop set of organizational and leadership skills thanks to the many years that I participated in the Air Cadet program.

James Dykes – ***Chief Financial Officer***

I am a fourth year Electrical Engineering student at Simon Fraser University with previous co-op experience at PMC-Sierra and Adapt Systems. In addition, to my experience in both hardware and software design and testing, my position as Assistant Instructor at the Canadian Martial Arts Academy has allowed me to develop excellent communication and interpersonal skills. Furthermore, having taken courses in financial accounting, I am more than ready to take on the position of Chief Financial Officer.

Victor Leung – ***Chief Operations Officer***

I am a fourth year Computer Engineering student at Simon Fraser University with previous co-op experience at the university's Underwater Research Lab. My skills comprise of both hardware and software. I have experience with integrated circuit design, PCB layout using EAGLE CAD, use of common lab equipment, software programming in C, Java, Visual C++ and low level assembly. My knowledge in hardware and software integration along with my communication skills will enable the smooth operation of this company.

Herman Lo – ***Chief Technology Officer***

I am a fourth year Systems Engineering student at Simon Fraser University. My creativity and enthusiasm will constantly drive my passion in thinking of novel ideas that will contribute to the design of the product. Known for my interpersonal skills and easygoing nature, I will work in harmony with the rest of the team to lead efforts in the technological development of the MicroTracker. With rich industrial experience in both hardware and software at PMC-Sierra, WebCT, and Perceptronix, I am a technically suitable person to be the Chief Technology Officer.

Bernard Ng – ***Chief Hardware Engineer***

I am a fourth year Electronics Engineering Student at Simon Fraser University. From my study and work terms, I have gained great experience with circuit design and analysis. More specifically, during my work at Broadcom, I was involved with circuit prototyping, testing, and debugging. I am also familiar with electronics reliability prediction and various circuit design tools.

9 Conclusion

MicroTrak Inc. is devoted to the goal of developing an affordable and easy to use tracking system. Our flagship product, MicroTracker, will offer users the ability to safeguard their personal belongings, as well as save them time and undue stress in locating lost items. With applications ranging from child-care to finding escaped convicts, MicroTracker potential market is boundless.

In terms of functionality, MicroTracker will offer many advantages over existing solutions. MicroTracker could be operated under both indoor and outdoor environments, as well as track objects both near and far. With its simple interface, anyone will be able to operate MicroTracker without difficulties. Also, MicroTracker will be small scale and lightweight, allowing it to be conveniently carried around. Furthermore, using a single receiver implementation, the cost of MicroTracker will be much lower than other existing solutions; thus, making it affordable to the general public.
MTI's team of well-trained and organized engineering students are more than ready to tackle the development of the MicroTracker. Having a clear view of our objective and project schedule, we are confident that MicroTracker will be completed by December 2002.

With MicroTracker, never again will your keys go missing, your car lost in a sea of steel, or your child nowhere to be found.

10 References

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