February 8th, 2010

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

Re: ENSC 440 Functional Specifications for a System to Track Athlete Performance

Dear Dr. Rawicz:

The attached document outlines the functional specifications for our proposed product the PosiTracker. Our device is a precise diagnostic tool that will analyze many different aspects of an athlete's performance. This tool will allow coaches to better train athletes in an objective manner and also to detect potential injuries. The product can also be used as a tool for sport broadcasters by giving them information that has never been available before.

This document outlines general, physical and electrical requirements and also addresses the reliability and durability of our product. Environmental considerations are also addressed.

We believe our system has market potential, and the nice-to-have features outlined in this document would definitely increase the marketability of our product. However, we are only attempting to implement a working prototype in the context of the ENSC 440 class; this prototype would have all the main features implemented and would serve as a proof of concept.

PosiTrack Systems consists of four hard-working and motivated team members: Andreea Hrehorciuc, Jeff Anderson, Jaime Valdes and Ryan Lynne. Should you have any questions about our functional specifications of the PosiTracker, please feel free to contact me by phone or email.

Regards,

Ryan Lynne

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PosiTrack Systems

Enclosure: *Functional Specifications for a System to Track Athlete Performance*

Functional Specifications for a

System to Track Athlete Performance

A highly precise diagnostic tool to analyze all aspects of an athlete's performance

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Submitted to: Dr. Andrew Rawicz
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Executive Summary

Each year sports teams spend millions of dollars to have the best players, equipment, coaching staff, and training facilities just to gain the slightest competitive edge over other teams [2]. We believe that even the best players can become better, through innovative and cutting edge training.

For this reason, we propose to make an athlete performance tracking system that will allow coaches to monitor player statistics such as X-Y position, distance traveled, acceleration, speed, and heart rate in real-time. This information will be gathered from a small lightweight module located on the back of each athlete and the data will be communicated back to a main computer or laptop over a wireless connection.

This device, called the PosiTracker, will help coaches to better analyze each player's physical condition and to create customized training to suit each player's individual needs. The PosiTracker will do this by providing information in real time to coaches and broadcasters during a game. Undoubtedly, this will help coaches to make better informed decisions on player interchanges and give broadcasters a means to bring fans closer to the game.

Our competition, GPSports [1] is currently selling a product that provides all of this functionality but it relies on GPS signals in order to function. Likewise, it cannot be used indoors or anywhere else with poor GPS coverage. Our product will solve this problem and fill this market gap by using a simple Wi-Fi triangulation technique using the signal strength.

This document outlines general, physical and electrical requirements and also addresses the reliability and durability of our product. Environmental considerations are also addressed.

PosiTrack Systems expects to have an operational prototype of the PosiTracker built by April 16th, 2010.

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Glossary

Actions	An athlete's movements and biological information such as heart rate.
Anchors	A signal source with a known location
AP	Access Point
A/D	Analog to Digital
CPU	Central Processing Unit
DT	Diagnostic Tool
GPS	Global Positioning System
GUI	Graphical User Interface
IEEE	Institute of Electrical and Electronics Engineers
OS	Operating System
RSS	Received Signal Strength
RAM	Random Access Memory
RSSI	Received Signal Strength Index
RoHS	Restriction of Hazardous Substances
SD	Secure Digital
USB	Universal Serial Bus
VAC	Volts Alternating Current

1. Introduction

The PosiTracker is a system that will be used to track the relevant statistics of athletes during game play or training. The system has applications in athlete physical training, sport coaching and sport broadcasting. This system will contain three main components, the diagnostic tool, the access points, and the graphical user interface. The development of the system will take place in two phases. First the proof-of-concept device will be completed by April 16th 2010. Then if the project has marketable potential, development of a prototype for commercialization will take place.

1.1. Scope

This document outlines the functional specifications which will be achieved by the PosiTracker system and they are the base requirements for the prototype. Further enhancements will need to be taken into consideration in order to produce a production model. Minor modifications may have to be made during the development of the proof-of-concept device after practical testing.

1.2. Intended Audience

The functional specification document is intended to be used by the members of PosiTrack team throughout the design and development stages. Members of the team will use this document to ensure that the design implements the desired functionality. This document will also aid in the creation of a test plan in order to analyze the systems ability to function.

1.3. Conventions

The requirements in this document follow the following numbering:

[R# - x]

Where # is the requirement number and **x** is:

- 1 – for features included in our prototype (proof of concept)
- 2 – for features included in both the prototype and a marketable product
- 3 – for features included in the final marketable product (nice to have)

2. System Requirements

2.1. System Overview

A high level functional view of PosiTrack system is shown below in *Figure 1.* The systems inputs consist in two parts: the game or training plan and the athlete's physical actions. The game or training plan is inputted by either the coach or athlete. This plan outlines information about the athlete and the athletes target goals. The athlete's physical actions are tracked along with biological information such as heart rate. The PosiTracker will measure and analyze these actions and display them in a useful fashion.

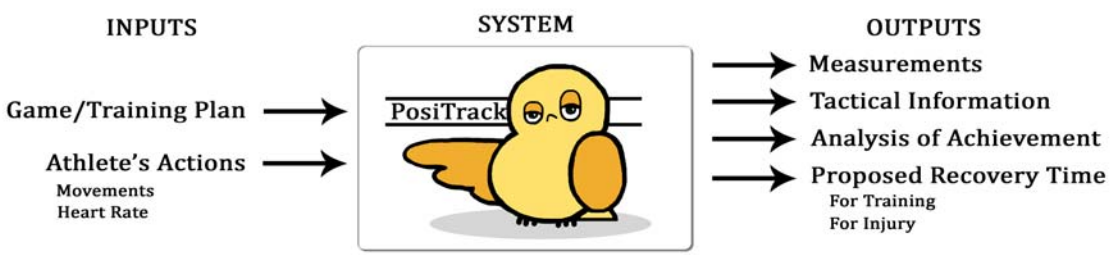

Figure 1: High level functional view of the PosiTrack system

The outputs of the PosiTrack system include the measurements of action, tactical information, analysis of achievements, and proposed recovery time. The measurements of action will include position, velocity, acceleration and heart rate. If there are multiple players, the system will track each player's position, speed and acceleration in order to produce tactical information. Comparing the athlete's actions with the game plan will give multiple levels of analysis of achievements. This analysis will be effectively prompted to the users to allow for judgment and future improvements. After an athlete uses the system over a period of time, a history can be built up to analyze the athlete's ability to recover from training situations. The system can also be used to measure accelerations for impact data to help physicians diagnose potential injuries.

The main justification of these functionalities is to have a system that aids athletes in their development. This system will help players in all levels to be coached to their full potential. This increase in knowledge will revolutionize modern day sports.

Figure 2 below shows a component version of the functional diagram. There are three main components in the PosiTrack system; these components are the Access Points (AP), the Diagnostic Tool (DT), and the Graphical User Interface (GUI). The APs will provide the ability for the DT to find its location as well as provide a communication link. The DT will measure the athlete's actions using the AP. The DT will also communicate to the

GUI to provide the measurements in real time. The GUI will function as the interface between the system and the user. This software will provide the desired display and in depth analysis.

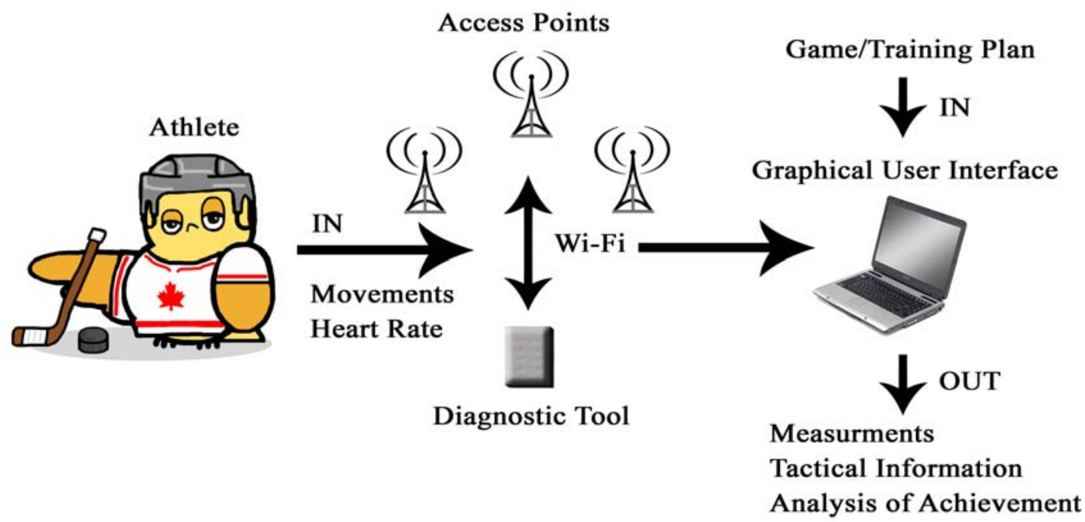

Figure 2: In-depth functional view of the PosiTrack system [3]

The following sections will provide the general and component specific functionalities. The functional specifications will be summarized and justified at the beginning of each section.

2.2. General Requirements

[R01 – 1] The proof of concept system costs less than $650

[R02 – 2] The range of the system is large enough to function in various sports arenas such as hockey rinks and football fields

[R03 – 2] The system's interface is simple and user friendly

[R04 – 3] The system is scalable and can realistically be produced in large volumes

[R05 – 3] The number of user actions to have the system fully operational from startup will be under 5 actions

[R06 – 3] The system is able to track up to 30 players simultaneously

2.3. Physical Requirements

[R07 – 3] The system is unobtrusive once installed into a sports arena
[R08 – 3] All system components are well enclosed in durable casings
[R09 – 3] All system components are compact and aesthetically pleasing

2.4. Environmental Requirements

[R10 – 3] The device must have silent operation and not affect player performance
[R11 – 3] The system is water proof and weather resistant
[R12 – 3] The system can operate in temperatures from -20ºC to 60ºC
[R13 – 3] The system is RoHS, WEEE and HazMat compliant
[R14 – 3] The system's packaging will minimize waste and use recyclable materials

2.5. Reliability and Durability

[R15 – 2] The product is able to withstand day-to-day usage
[R16 – 3] All system components have shatter resistant casings to prevent injury
[R17 – 3] The system can remain on continuously for a minimum of 3hours

2.6. Safety Requirements

[R18 – 2] No system components shall spontaneously combust
[R19 – 2] No system components can burn users
[R20 – 2] All electronic and mechanical components are securely enclosed
[R21 – 3] The system does not emit any harmful radiation or interfere with other devices
[R22 – 3] The product shall be able to detect mechanical and electrical failure. Should any such failure be recorded, the system will enter a safe mode and notify the user

2.7. Usability Requirements

[R23 – 2] The system is not be cumbersome to wear
[R24 – 2] The system's firmware is upgradeable by a service person
[R25 – 2] The system has a GUI interface that will display the measured data

3. Access Points

The access point's main function is to provide an appropriate number of anchors for localization [7]. The APs will need to send detectable signals to the diagnostic tool to allow for this functionality. The secondary function of the APs is to supply a wireless communication link between the DT and the GUI. The wireless communication protocol has been chosen to be Wi-Fi because of its current popularity. The Wi-Fi signal can also double as the triangulation signal [5] which increases the justification of this choice. *Figure 3* below shows the inputs and outputs of the APs and the following sections outline the functional requirements of the APs.

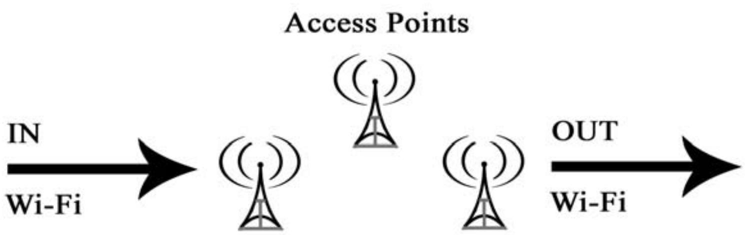

Figure 3: Inputs and outputs schematic of the access points

3.1. Functional Requirements

[R26 – 2] The APs emit signals that can be measured by the DT

[R27 – 1] The APs locations are known and fixed

[R28 – 3] The APs have a calibration mode to determine the relative locations

3.2. Physical Requirements

[R29 – 3] Each AP shall has dimensions no greater that 30cm x 30cm x 30cm

[R30 – 3] There are at least 3 APs in the system

[R31 – 3] The APs are installed in locations that give direct line of sight to the DT

[R32 – 3] The APs have a remote and local on/off switch

3.3. Electrical Requirements

[R33 – 3] Each AP has internet connectivity

[R34 – 3] Each AP works from a standard power source of 110V/120V at 60Hz

[R35 – 3] Each AP performs as a Wi-Fi router, bridge, and repeater

4. Diagnostic Tool

The primary function of the diagnostic tool is to measure the Wi-Fi signal strength, acceleration, angular rotation, and heart rate. The DT will process this measured data in order to determine the player's location, speed, distance traveled, and impacts. This information will then be sent back over a Wi-Fi connection to a central computer running the GUI software. The DT will be a wearable module which can be worn around the waist or on the upper back. *Figure 4* below outlines the inputs and outputs of the DT.

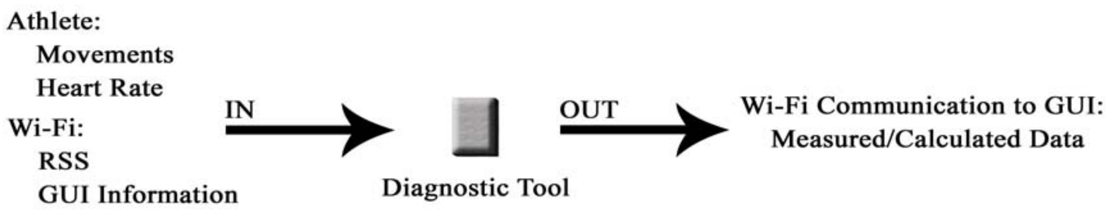

Figure 4: Inputs and outputs schematic of the diagnostic tool

4.1. Functional Requirements

[R36 – 2] The module can measure acceleration, location, and speed

[R37 – 2] The module can determine location using the RSSI from multiple APs

[R38 – 3] The module can monitor heart rate using a commercially available BlueTooth device

[R39 – 2] The module can use an accelerometer and gyroscope to dead reckon its location

[R40 – 2] The module sends processed data back to a central computer at 100ms intervals

[R41 – 2] The module will work within the range of a standard hockey rink

[R42 – 2] The module will work autonomously once turned on

4.2. Physical Requirements

[R43 – 2] The dimensions of the module will be no more than 10cm x 5cm x 3cm

[R44 – 2] The weight of the module is no more than 150g or 5.3ounces

[R45 – 3] The shape of the module is ergonomic and fits comfortably on the upper back

[R46 – 3] The module comes with a lightweight sports vest to hold on the player

[R47 – 3] The module can withstand up to 50G's

[R48 – 2] The module's SD card is accessible to user and can be easily removed
[R49 – 2] The module has external ports for charging and USB access
[R50 – 2] The module has an external button for on and off control

4.3. Electrical Requirements

[R51 – 3] The module has a typical battery life of at least 4hours
[R52 – 3] The recharge time of the module is under 30minutes
[R53 – 3] The battery has a functional lifetime of at least three years under typical use
[R54 – 2] Sufficient overcharge protection to prevent overheating and fires
[R55 – 2] The module uses a maximum voltage of 5V to prevent electrocution
[R56 – 2] The module is not affected by other Wi-Fi traffic / noise
[R57 – 3] The module will charge with a standard wall socket of 110V/120V at 60Hz

4.4. Software Requirements

[R58 – 1] The module runs the Linux kernel and OS
[R59 – 1] The code for the module is written primarily in C and C++
[R60 – 1] Preexisting device drivers are used for Wi-Fi, BlueTooth, RAM, and SD
[R61 – 2] The code runs automatically when the module is turned on
[R62 – 2] The module communicates data back to a central computer over a Wi-Fi link
[R63 – 2] All software is documented and follows commonly accepted development practices
[R64 – 1] Device driver for A/D inputs is contained within a single module within the kernel

4.5. Hardware Requirements

[R65 – 1] The module has Wi-Fi capabilities following the IEEE 802.11 standard
[R66 – 1] The Wi-Fi has channels 1 through 13 and can measure RSSI
[R67 – 1] The module has BlueTooth capabilities following the IEEE 802.15 standard
[R68 – 1] The CPU is intended for embedded low power applications
[R69 – 1] The module has a 3-axis accelerometer and gyroscope
[R70 – 1] The antennas in the module are low profile and oriented for performance
[R71 – 1] The hardware has adequate connections for debugging and software development
[R72 – 3] The module has GPS capabilities

5. Graphical User Interface

Figure 5 below shows the inputs and outputs to the GUI. The purpose of the GUI is to provide a graphical interface between the coaches and the raw data gathered from each player's individual DT. The GUI will be user friendly and allow the coaches and athletes to visually monitor/analyze one or more players at one time. The GUI will also allow coaches to gauge present performance against past performance using historical data and also allow various statistical analyses.

Figure 5: Inputs and outputs schematic of the GUI [3]

5.1. Functional Requirements

[R73 – 2] The GUI can be run on any standard Linux machine

[R74 – 3] The GUI can run on any standard Linux, Windows, or Mac machine

[R75 – 2] The GUI can monitor a single player in real time

[R76 – 3] The GUI can monitor 30 players simultaneously

[R77 – 2] The GUI will allow for a single player's data to be graphed

[R78 – 3] The GUI will allow for the whole team's data to be graphed

[R79 – 2] The GUI will store historical data

[R80 – 3] The GUI will store the historical data in multiple formats

[R81 – 3] The typical user has a learning curve of 2 hours for 90% of the functionality

6. User Documentation

[R82 – 3] The user documentation consists of a manual with general and technical information about the system, written in English, French, Spanish, German, Japanese and Simplified and Traditional Chinese, in order to satisfy language requirements for international markets

[R83 – 3] The user manual is written for a non-technical audience

[R84 – 3] A detailed installation guide for technicians is included with the system

8. Conclusion

The present document outlines the functional requirements of the PosiTracker Athlete Performance System. Our system currently comprises several elements, the access points, the worn module, and the GUI, and each module requires different specifications. Moreover, we have identified the different requirements for our proof-of-concept model, and additional requirements that would be needed for the marketable version of our product. We are expecting that all functional requirements needed for the proof-of-concept model (the prototype) will be implemented by April 16th, 2010.

9. References

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www.gpsports.com

[2] Vancouver Canucks Player Salaries, Jan 18th 2010
http://www.nhlnumbers.com/overview.php?team=VAN&season=0910

[3] Laptop image source, Jan 18th 2010
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[5] V. Olivera, J. Cañas Plaza and O. Serrano, "WiFi localization methods for autonomous robots" in Robotica, vol. 24. UK: Cambridge University Press, 2006, pp. 455-461

[6] C.-H. Lim et al., "A Real-Time Indoor WiFi Localization System Utilizing Smart Antennas", *IEEE Transactions on Consumer Electronics*, vol. 53, No. 2, May 1997.

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