SaxShoe

Integration and implementation of an Inertial Navigation System in firefighters' boots

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Subject: Developing concept designs of an integrated sensor system in firefighters' boots.

Background information: Within the SaxShoe project, Saxion, Hva, NHL, University of Twente and the business community are looking at a way to develop a shoe-sole system for monitoring the location and measuring the walking behavior of the user, in situations where there is a lack of standard infrastructure such as GPS or WiFi networking.

Relevance: On the 9th of May 2008 at the shipyard of De Punt, a fatal accident occurred among three firefighters [1]. During a fire in one of the buildings, three firefighters got disoriented after a big explosion. This situation has been examined extensively, which has led to a change in the way of thinking in regard to safety and fire suppression in the future.
The SaxShoe project [2] aims to improve the safety of firefighters by making it possible to localize the position of firefighters in a building.

Main research question: How can a sensor-system be integrated in a firefighters boot?

Approach: To get an impression of the relevant product properties, desk research is performed. The product properties are identified by gathering information from the website of the manufacturer and Online retrieval of documents about EN ISO standards. The movement of the boots has an influence on the working of the sensor system. The usage and movement of the boots are identified by observation of a firefighter performing different activities (representative of a deployment) on a PPME track and an interview with firefighters Hengelo.
To give context and direction to the research, the state-of-the-art of the project and technology is identified by gathering information about the project in the SaxShoe project plan and briefing. Information about technical specifications of the sensor is gathered from the manufacturer's website to identify geometry, working principles and performance specifications.
System requirements are determined. The goal of the SaxShoe project is to make it possible to locate a firefighter by integrating a sensor system in the firefighter's boots. The user demands are identified by conducting an interview with firefighter Hengelo. The boot demands are identified by online retrieval of documents about EN ISO standards
The technology demands are determined by gathering information from the manufacturer's websites.
When SaxShoe is implemented, there is risk of failure. This is addressed through making a qualitative fault tree analysis.
With implementing a sensor system there is the chance of failure. Requirement for maintenance is described.
Charging options are determined by gathering information different charging methods to provide appropriate solutions.
Battery options are determined by gathering information about batteries with the demanded capacity, to identify geometry and volume
Design and visualization of multiple concepts is done by Sketching, Drawing and 3D Designing of different concepts, taking in regard the demands and wishes and physical components, to show the feasibility of integration and implementation.
Concepts are evaluated on impact on manufacturing, usage and safety demands, exposure to environmental factors and expected sensor performance.

Results: Multiple concepts are developed with different modes of integration.

Figure 1 - Concept Sole

Figure 2 - Concept Shaft

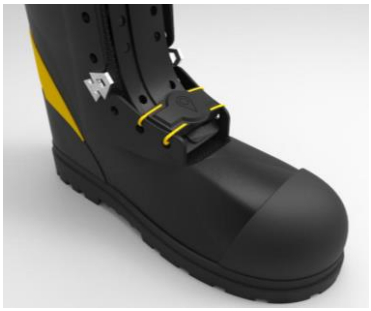

Figure 3 - Concept Instep

Figure 4 - Concept Toe Cap

Conclusion

In this research, different concepts have been developed to determine how an Inertial Sensor System can be integrated in a firefighter's boot. The concept designs have been evaluated qualitatively, so that a decision can be made based on the impact on the manufacturing process, usage and safety demands, exposure to environmental factors and expected sensor performance. Four different positions are provided for further development in the SaxShoe project.

Recommendations

A user test regarding movement is recommended. The concept of the Toe Cap can possibly be designed to improve the esthetics of this concept. Usage of materials needs more exploration as well as the design of a sealed system that is protected against dirt and moisture. The moment of calibration and the way of activation / turning on or off the system needs to be described. Power consumption of the sensor will need future testing. Possible wireless charging options in the sole can be tested to determine if such a solution is feasible. Cost calculations will need to be made on the adjustments that are needed in manufacturing to make budget decisions. This is also needed, when the boot needs re- certification after adjustments. When developing a sensor system with obstruction to maintenance, a Cost-Benefits analysis will need to be made weighing the risk of failure to discarding or damaging the boot.

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