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RAILROAD TRACK INSPECTOR WEARABLE TECHNOLOGY INTERFACE

SUMMARY

Conducting railroad track safety inspections requires constant vigilance to detect defects that could have dangerous consequences. It also requires information to be received and sent during the execution of the inspection task. A Wearable Technology Interface (WTI) could prove helpful in supporting hands-free, eyes-on-task communications for railroad track inspection work.

In Phase 1 of this research effort which started in December 2014, Syntek Technologies, Inc., (STI) successfully demonstrated a WTI for a railroad track inspection task in a laboratory environment. In Phase 2 that started in April 2016, STI selected an appropriate WTI technology, conducted a Task Analysis for track inspection work, developed the necessary software and testing scenarios, and conducted a Field Validation Experiment with the WTI in a realistic work environment. The WTI tested was a breadboard version of the Syntek Wearable Technology System (SWTS). Figure 1 shows the hardware parts of the system as worn.

The Buckingham Branch Railroad (BBRR) conducted a 3-day experiment near Charlottesville, VA. Two BBRR track inspectors participated in the experiment. The first day was for training. The subsequent two days were for testing in a hi-rail vehicle and while walking along the tracks. Tests were conducted on tangents, curves and turnouts, on both Class 2 and 3 Tracks. Altogether 15 track inspection scenarios and functions were tested in 48 trials using the breadboard version of the WTI.

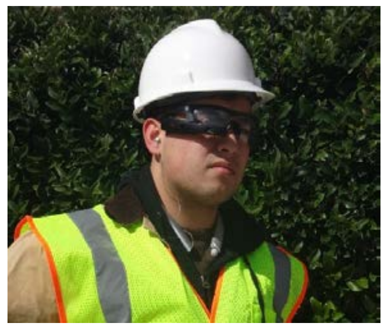

Figure 1 System hardware as worn

The WTI performed well in the Field Validation Experiment. It successfully supported the data exchange needs of actual track inspectors working on an operational railroad. The WTI was positively regarded by the track inspectors, with the general belief that it would add value to their work. Especially beneficial were the hands-free, eyes-on-task communications capability, the automatic generation of track inspection reports, and the use of a relational database. The main problem was insufficient time allotted to train the WTI speech engine to recognize a new voice. The next stage of development will correct this problem.

This next prototype version will have custom applications running on the cellphone and smart glasses. These applications will significantly reduce the number and length of track inspector voice interactions with the WTI, dramatically increasing the reliability and efficiency of the user interface.

BACKGROUND

The central technology of the WTI tested in the Field Validation Experiment was assisted reality smart glasses. The global market for smart glasses technology of all types is expected to grow from annual sales of about 150,000 units (about $138.6 million in revenue) in 2016 to about 22.8 M units (about $19.7 billion in revenue) in 2022 (Kaul, 2017). This market comprises several application areas: consumer, sports, enterprise, healthcare, public safety, industrial, etc. The North American industrial applications segment of this market includes manufacturing, warehousing, logistics, energy, transportation, etc.

Although major railroads may automate many aspects of track inspection, manual track inspection will still always play an important role, especially for smaller railroads. It is estimated that about 14 million American workers will be wearing smart glasses by 2025 (Gownder, Voce, Ask, & Hewitt, 2016). The present research helped to answer the question: can this technology enhance railroad safety by increasing the accuracy and efficiency of manual track inspection?

OBJECTIVES

The objectives for phase 2 of the research were: 1) to assess the utility of wearable technology for track inspection work; 2) to develop training for the WTI and 3) to validate the use of the WTI in the field with realistic track inspection scenarios. The results of this research will be used to evaluate the usability and utility of WTI in completing track safety inspection tasks. These goals support the FRA mission to increase safety of railroad employees and passengers by reducing accidents.

METHODS

The research participants were two track inspectors from the BBRR. The WTI tested had both hardware and software components. The hardware consisted of Recon Jet smart glasses, an LG audio neckband, and an iPhone 6s cellphone, with a built-in Siri speech engine. Third-party software consisted of Recon Engage and Atheer AiR Suite. The majority of the software was the Syntek Maintenance and Inspection Software (SMIS). The SMIS consisted of two major parts: 1) business logic using PHP, and 2) a relational database using MySQL.

Both group and individual training were developed to familiarize the track inspectors with the system (see Figure 2). Fifteen realistic track inspection scenarios and associated data functions were created to evaluate the WTI in the field.

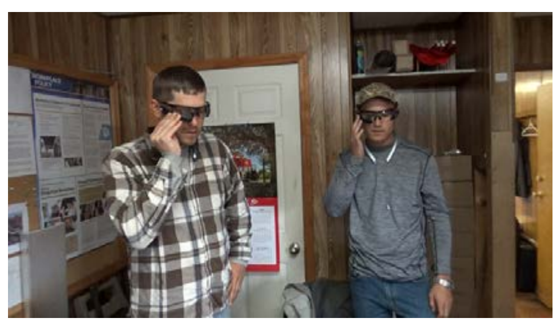

Figure 2 Track inspectors training on system

RESULTS

The outcome of the Field Validation Experiment was analyzed in terms of quantitative and qualitative results. The quantitative data consisted of three primary metrics: 1) Task Completion Rate, 2) Time on Task, and 3) Task Errors. The Task Completion Rate was about 90 percent. The overall average Time on Task was 3 minutes and 9 seconds. This relatively long average Time on Task does not have to distract from the work flow. Since the WTI is hands-free and eyes-on-task, the inspector can be simultaneously engaged in other track inspection activities.

Altogether, the two track Inspectors made 52 Task Errors during the experiment. Of these, only one error was due to a software bug, which was immediately corrected. The rest were user-generated errors. Most of these were speech engine errors caused by inadequate time allotted to voice recognition training on the WTI. There were 15 errorless trials, all of which had Times on Task in the 1 to 2 minute range.

In terms of quantitative results, the WTI performed well, given the breadboard level of product development, and the short time allotted for voice training. The next prototype version is expected to perform substantially better.

The qualitative results of the experiment came from three primary sources: 1) observations during training, 2) observations during testing, and 3) feedback from participant debriefings. These results were positive, and helped to substantiate the Conclusions described in the next Section.

CONCLUSIONS

Several conclusions were drawn from the Field Validation Experiment. Training on the system was intuitive, flexible and sustainable. This training assisted with track inspector acceptance of the technology. The overall system performed well in an operational environment. Performance metrics for Time on Task and Task Errors were reasonable given the breadboard-stage of product development. Hands-free, eyes-on-task communication was helpful in task execution. The system was comfortable to wear and easy to use. Automatic generation of track inspection reports was regarded as a major benefit. In addition, the relational database feature of the system created added value.

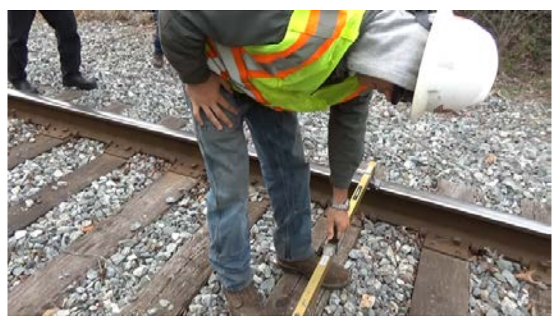

Figure 3 Track inspector participating in experiment

FUTURE ACTION

For this next prototype stage, several major product improvements are proposed. The prototype version will have applications running on the cellphone and on the smart glasses that will prompt and control all track inspector communication, both visual and auditory. The Data Transmission Service will be switched from a combination of email and text messaging to direct data communication between the cellphone and the server. These two improvements alone will dramatically increase the reliability and efficiency of the user interface.

In addition, the new version will have a You-See-What-I-See training/mentoring capability and an Automatic Alerting Function based on GPS to immediately supply critical information to the track inspector. These product improvements will undergo extensive local testing, and will be evaluated in field experiments at crucial stages of development. Ultimately, the goal is to commercialize the final version of the WTI as the Syntek Wearable Technology System (SWTS), to address the needs of the railroad industry and the broader market for industrial applications of assisted reality smart glasses technology in the areas of maintenance and inspection services.

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