Demo Proposal for MobiSys 2006

Health and Safety compliance in the field

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INTRODUCTION

We propose to demonstrate a system that can illustrate the use of intelligent mobile sensor networks to improve health and safety compliance in the field.

Over recent years there has been a significant increase in the health and safety rules and regulations that govern work practices in hazardous environments such as construction sites, factories or chemical plants. The advantages of compliance with these regulations are significant and range from the obvious benefits to workers health and well being through to improvements in productivity and reductions in compensation claims and reputation damage.

Currently most health and safety rules rely on human information gathering and recording in the field with decisions being taken by workers, supervisors or back office staff processing the data off-line. Within the context of the NEMO project we are investigating the use of intelligent mobile sensor networks to improve health and safety compliance in hazardous workplaces [1,2]. In particular, we envisage a world in which physical work artefacts such as tools are augmented with cooperating mobile nodes featuring both sensors and actuators and communicating over ad-hoc wireless networks. These mobile systems would be able to observe the working activities taking place, evaluate compliance with health and safety regulations and assist or actively enforce compliance with these regulations.

In order to realise this vision we have been working closely with domain experts from two major international companies. Through this collaboration we have identified a number of health and safety application scenarios. This demo proposal involves one of these scenarios, namely the prevention of injuries associated with extended use of heavy vibrating machinery such as pneumatic breakers and drills. In the context of this scenario we are using the NEMO technology in order to provide an environment where operators of vibrating machinery will be assisted in terms of health and safety.

MONITORING HAV EXPOSURE

Increased hand-arm vibration (HAV) exposure can lead to long term health risks including general whiteness of fingers and pain and loss of sensation in fingers (Figure 1). These symptoms are generally known as white knuckle syndrome or vibration white finger (VWF). Health and safety regulation dictate exposure levels for operatives of vibrating machinery [3]. As part of the NEMO project we developed a prototype system for monitoring vibration exposure to drill operators (Figure 2). Our approach builds on the concept of networked intelligent sensor nodes capable of monitoring compliance with health and safety regulations in the field.

We developed a system consisting of two components: (1) an industrial petrol-operated drill and (2) a personal wearable device, both equipped with wireless sensor and processing components for accurate measuring and recording of vibration exposure. Specifically, we use Smart-It wireless sensor nodes [4] that communicate using a short-range wireless ad hoc network.

When brought together, the drill and wearable tag co-operate to perform several functions: (1) measuring vibration on both drill and user (2) correlating vibration data to identify which operator is using the drill (as there might be several workers in the vicinity of the drill it is important to distinguish between operator and bystanders) (3) recording duration of tool usage and calculating the exposure levels of the (4) long-term storage of personal exposure data. In effect, by displaying cumulative exposure data the personal wearable tag functions much like a radiation dosimeter, through with the tool it is measuring.

Figure 1: Left: A pneumatic drill in operation. Right: An operative's hand with white knuckle syndrome as a result of extended exposure to hand-arm vibrations.

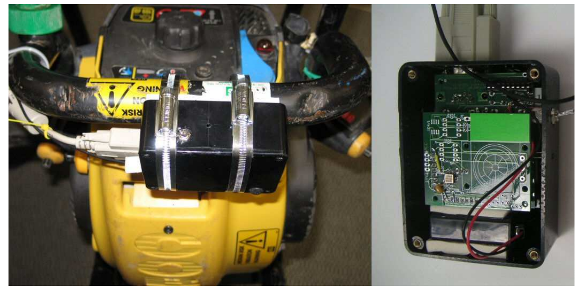

Figure 2: A drill instrumented with wireless vibration measuring unit.

HARDWARE

Due to the restricted environment where the demonstration is going to take place (indoors) it is not possible for us to include a fully operating hammer drill. Instead, the effects of an operating drill will be simulated through other means (electric operating vibrating tools).

All mobile devices that will be used (drill controller, user controller) are Smart-its Particles wireless sensor nodes [3], a motes-like wireless sensing nodes based on a PIC 18F6720 microcontroller. Each node is equipped with dual axis high-g iMEMS Accelerometers (ADXL278). The RF communication between the particles is through RFM TR1001 transmitter, 125kbit bandwidth, operating at 865.35 MHz Band.

In addition to the two mobile devices, a laptop will act as a link to a back-end database. The back-end will be able collect logging information about the worker's exposure to vibrations.

DEMONSTRATION

In this demonstration, conference delegates will be able to observe the monitoring of vibrations for a drill operator. This demonstration will cover the scenario of a drill operator using a vibrating tool. The mobile devices attached to both the vibrating tool and the operator will collaborate in order to monitor the activities performed. Specifically, the devices will use their accelerometers to monitor the vibration patterns of their corresponding physical entities (tool, user). According to these patterns they will determine the different activities taking place, such as when the drill is turned on, when it is used, etc. The user's device will display messages regarding the use of the tool, (e.g. "Drill is breaking"). The user device will also present logging information about the total exposure of the user to vibrations. When the maximum exposure limit is reached, the user will be notified to terminate the use of the vibrating tool. Moreover, a wireless link to a back-end laptop will offer real-time monitoring of the data collected by the two devices.

REQUIREMENTS

In addition to a standard demo table/booth we require:

(i) At least 3 power outlets for charging the mobile controllers the laptop and powering a projector.

(ii) A screen or suitable surface (e.g. a wall) on which to project a computer display. If a projector is available to be borrowed (for minimal cost) we would be willing to do this – alternatively, please let use know so as to bring one ourselves. In the case that a suitable projection surface is unavailable we would require a large monitor as an alternative solution.

ACKNOWLEDGEMENTS

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http://www.comp.lancs.ac.uk/nemo/

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