

# WEARIT@WORK

## Retain in view: Indoor localisation of persons in danger



### Indoor Localisation for First Responders

Modern buildings are complicated structures full of reinforced concrete and synthetic materials. In the event of fire or disaster thick smoke can propagate quickly. For first responders navigating can be very difficult. The well-known GPS is an ideal solution on roads. But in deep urban canyons GPS satellite signals are reflected and attenuated. Position fixes are unreliable.

It might be assumed that dead reckoning approaches to pedestrian navigation could address the needs of first responders, including fire fighters. However, conventional pedestrian dead reckoning approaches with body-mounted motion sensors can fail when used with the irregular walking patterns typical of urban search and rescue missions. The technique was therefore extended by using shoe-mounted sensors. This technique is very accurate in terms of distance travelled and can handle many arbitrary manoeuvres, such as tight turns, side/back stepping and stair climbing.

In our approach, a motion measurement unit (MMU) (containing tri-axial accelerometers, rate gyros and magnetometers) is solidly attached to, or mounted in, footwear. Standard strap-down mechanization equations, threshold-based stance detection and zero-velocity updates allow for the direct calculation of foot displacements between footfalls. These latter are determined simply by double integrating the accelerations rotated to the world frame. Xsens' MTi IMU was the main instrument for our experiments. The sensor was attached to the shoe using the laces and the data cable run up the pant leg.

When checking the ground truth data for experiments performed outdoors a uBlox GPS receiver is used.

Based on this research of the TZI of University Bremen and in the context of the EU funded project wearIT@work an infrastructure less solution for indoor positioning was developed as an effective solution for the demanding positioning problem of first responders.

At the heart of the solution is a compact inertial sensor cluster that is mounted in the boot.

Other positioning systems exist such as those based on radio frequencies waves. However these have significant disadvantages and may not be reliable in emergencies.

wearIT@work was set up by the European Commission as an Integrated Project to investigate "Wearable Computing" as a technology dealing with computer systems integrated in clothing.

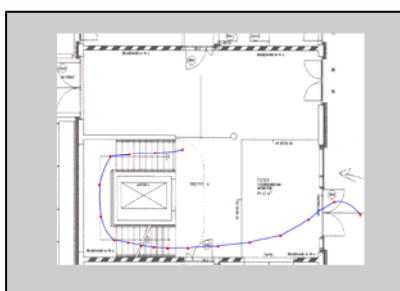
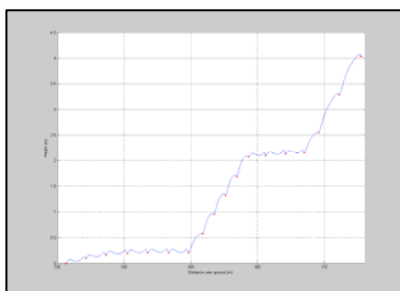
The project has 42 partners with a project volume of about 23.7 million € and a funding of about 14.6 million €

It is the largest project world-wide in wearable computing.

<http://www.wearitatwork.com>



In a typical mission everything happens very quickly. In our solution the first responders have the boot sensors as a part of their standard equipment. The location of the first step of the mission can be established by an absolute position fix such as from the vehicle GPS. From then on the boot mounted system operates autonomously. Every step length and direction is calculated precisely. The sensor cluster used is composed of three different sensors: accelerometers, rate gyroscopes and magnetometers. With measurements of these sensors the trajectory of the foot can be estimated to high precision by following the single foot.



The sensor cluster signals of the feet are pre-processed and the sensor data packets are relayed via Bluetooth to the police radio and to the commander's console in the support vehicle where the incident commander can view the progress of his team members shown as red points on a computer display.

The steps of the first responders can be shown e.g. as an overlay to an aerial photograph of the building or an existing floor plan of the building. When a building plan is used to overlay the positioning data meter level accuracy is possible. In this way the commander knows precisely where his people are at all times. Taking two stairs at a time can be detected in this way in an altitude plot as well as crawling and shuffling motions on a floor plan.

This fine grain positioning can increase safety in critical situations. In this way the system becomes applicable to real emergency interventions.

In the current configuration of the system the sensor is securely attached to the boot behind the latch. The user hardly notices it. In the near future the sensor cluster will be further miniaturized. The goal is to embed the device into the boot heel to increase accuracy and reliability.

### ***The Emergency Response Showcase***

*The Emergency Response Scenario of wearIT@work builds on firemen equipped with several advanced devices. The equipment allows for full-duplex short distance communication with sufficiently high data rate and quality. It includes indoor localization and navigation support, the data acquisition system towards the intervention control including photo and video capabilities as well as the transfer of physiological parameters. Information visualization is done via a head mounted device. Input to the system can be done by the firemen by voice commands enabling hands free operations, by a textile keyboard, and by gestures.*

*A transparent multimodal communication connects the firemen to the command and control system with appropriate bandwidth allocation for transfer of videos or images as well as for sensor data. The command and control system supports remote assistance (by image annotation) monitoring of the physiological condition of all firemen and by consulting hazmat information. Two exemplary scenarios have been built for evaluation. One scenario deals with urban search and rescues the other scenario with hazmat interventions.*

*A second line of activity supports the intervention training. A virtual environment, deals with new forms of tactical training of firemen. The development strategy has started analyzing the currently used low-fi intervention simulation to find out about requirements for a more advanced solution. Based on these requirements a virtual environment has been built allowing for multi-user intervention simulation and has been validated against the intervention training site of the Paris Fire Brigade.*

*This virtual emergency simulation environment is capable to be connected to the hardware firemen use during their real interventions. This allows realistically simulating events during an intervention. Communication problems between the firemen taken as an example can be simulated based on the model of the environment contained in the simulator.*

*This environment currently being further developed will be implemented at more than 10 fire stations in France Italy, and Germany.*



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