

Remote stress monitoring package for the management of soldiers' physical load

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ABSTRACT

MILitUP is a remote stress monitoring package for the management of soldiers' physical load. Monitoring stress provides an opportunity for optimal performance improvement through identifying when soldiers are at an increased risk of failing military physical testing standards, becoming unwell or sustaining injury. We have designed the concept for managing numbers at company level (150+ individuals). All the data collection is automated and data storing is done in real time (GPRS, server, computer). MILitUP uses real time heart rate (HR) and global positioning location data for automated analysis. The technology used for MILitUP also enables the transfer of data by other methods.

Categories and Subject Descriptors

C.3 [Special-Purpose and Application Based Systems]: Real time and embedded systems

General Terms

Design, Experimentation, Standardization

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Keywords

Military, Wireless sensor networks, Remote control.

1. INTRODUCTION

The physical fitness of young men has decreased during the latest decades [4, 8, 11, 14]. It has been discussed that sedentary lifestyle is increasing and, thus, it has many unwanted consequences [4, 10, 11]. Among soldiers the decreased fitness has displayed e.g. increases in illness causing additional costs for the military forces [10]. The most recently observed news about U.K. soldiers' fitness [1] is another familiar example of this challenge that western armies are facing.

In the sport and coaching sciences, it is well known that individual responses to physiological stress are varied [2, 6, 7, 9]. In some cases, despite continuous exercise training, individual decrements in fitness have been observed which could be related to overreaching or overtraining [6]. The optimised improvement is based on alternating periods of progressive training with rest [3, 12, 13]. Although these basic things are well known in sport and coaching sciences, it is very challenging to control many individuals' stress levels – e.g. 150+ soldiers at the company/squadron level.

As a solution to this challenge, NewWell (Ltd) has created a concept named as MILitUP. It is a remote stress monitoring package for the management of soldiers' physical load. Monitoring stress provides an opportunity for optimal performance improvement through identifying when soldiers are at an increased risk of falling below military physical assessment standards, becoming unwell or sustaining injury. We have

designed the concept for managing numbers at company level (150+ individuals). All the data collection is automatically transferred, stored and can be observed in real time (GPRS, server, computer). MILitUP uses real time heart rate (HR) and global positioning location data for automated analysis which is displayed in a simple traffic light output signal. The technology used for MILitUP also enables the transfer of data by various other methods but primarily through Global Positioning Systems (GPS) and Global Packet Radio Service (GPRS). The solution and the software (SW) are an emerging science based technology, but the data transfer technology is based on existing technology currently on the market.

There are numerous physiological monitoring providers in the market; however none of them have combined current science and technology to provide a new, unique, simple and reusable concept for managing individual physical load levels and controlling optimization for performance improvement.

2. DATA TRANSFER ARCHITECTURE AND GLOBAL POSITIONING LOCATION

Tracker Security's GTS tracking devices provide unlimited tracking range in GSM cellular coverage (Tracker Security, Espoo, Finland). Using GPS/GSM/GPRS technology. Tracker Security's GTS-200HR is a small and lightweight GPS/GSM tracking device. The device features an on-board speaker allowing for two-way communication between the wearer and those monitoring their movement. The GTS tracking uses GPS, in which the transmitter identifies its latitude and longitude coordinates using satellites. In the MILitUP concept, these coordinates are passed to a centralized receptor (a computer) and are mapped on a topographical map (Fig. 1).

ANT+ facilitates the collection, automatic transfer and tracking of sensor data for monitoring information (Dynastream Innovations Inc. Alberta, Canada). The key advantage of this network is device specific interoperability which enables wireless communication with other ANT+ products. This interoperability function (added to the base ANT protocol) facilitates the reliable transfer of data between sensors and display devices. ANT+ provides off-the-shelf interoperability to digital wireless communication in the 2.4 GHz license-free band.

In MILitUP we used a HR transmitter, which was migrated to an ANT+ interface. By integrating ANT+ interface to GTS-200HR, we were able to send HR data to server IP address (Fig. 1). The HR data was then transferred from server to computer. In MILitUP SW it is used for different physiological stress calculations, which are displayed in a simple traffic light output signal.

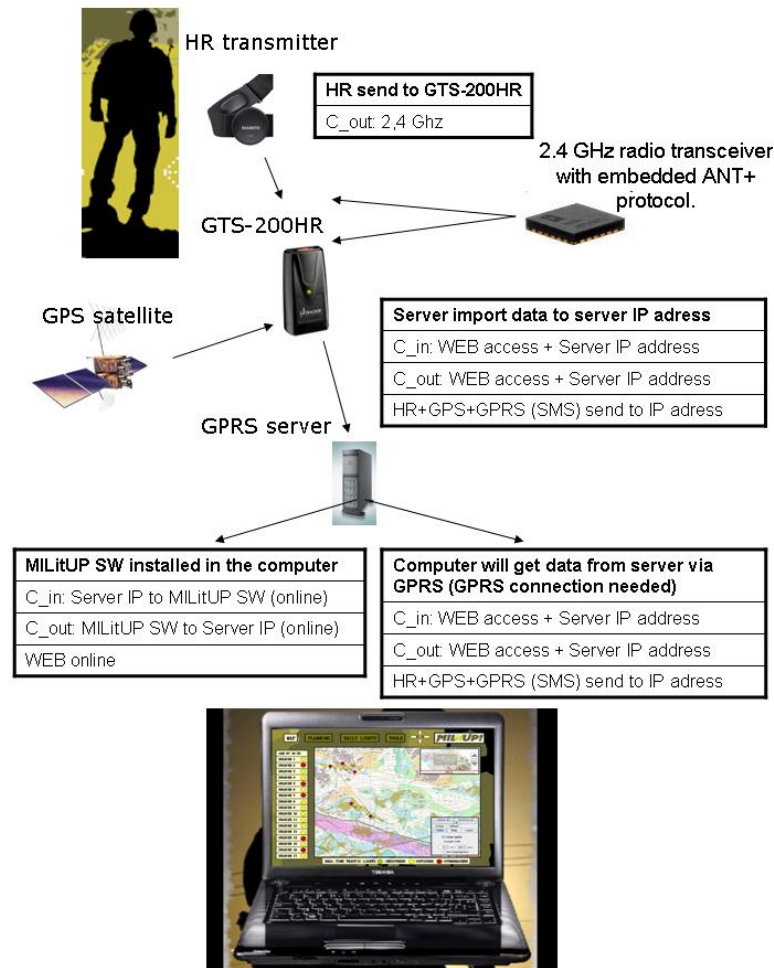


Figure 1. Concept architecture

3. SOFTWARE ARCHITECTURE AND PLATFORM

3.1 Software architecture

SQL server serves as a structured data management system, to easily and reliably retrieve and store the collected data. Database design is focused to separate the collected data (HR, GPS) and user library. Each of the sides is linked only at the client software views by connecting the user selectable GTS-200HR to an individual at specified time. This separation enables the use of data in different anonymous statistical management. With use of SQL database the customer can decide which server platform is appropriate for utilization (Fig.2).

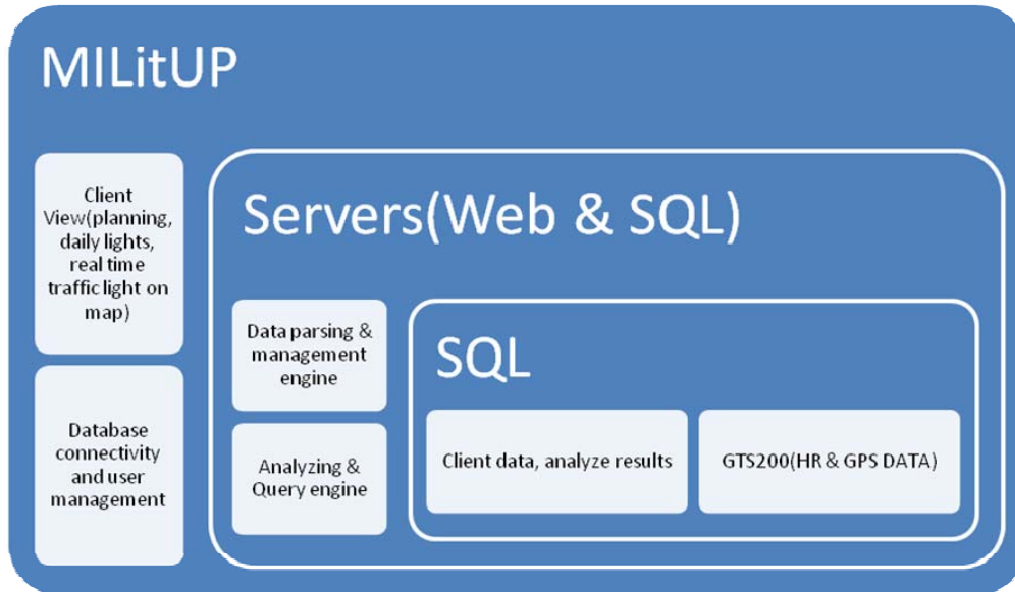


Figure 2. Software architecture

Platform independent client software serves as front end for the stored data. Client is based on platform independent Java technology, and as so is easily modified to varying end user terminals. Java is an object oriented language for the manipulation of data and is only possible through tested pre-defined methods, as the safety and integrity of data is one of the main principles. A great deal of time was used to minimize the need of refactoring in the future iterations of the client software, by assigning design patterns to solve potent issues beforehand [5].

Security was gained through encryption of data from the GTS-200HR to database (GPRS), which itself uses predefined permissions to control the use of data in the clients. Each client must be predefined in the server before gaining access to data and no data is stored in client at any stage.

3.2 Software platform and functions

MILitUP SW uses SQL server, for data management and storing. Platform is based on independent Java client software.

The concept includes three main functions:

Planning tool:

Weekly program tool that shows planned daily and weekly programs as traffic lights for three different fitness levels (Fig. 3a).

Daily traffic lights:

Enable to follow individual training load (TL) levels (Fig. 3b).

Real time traffic lights:

The individual momentary training load (TL) and location in map (Fig. 3c).

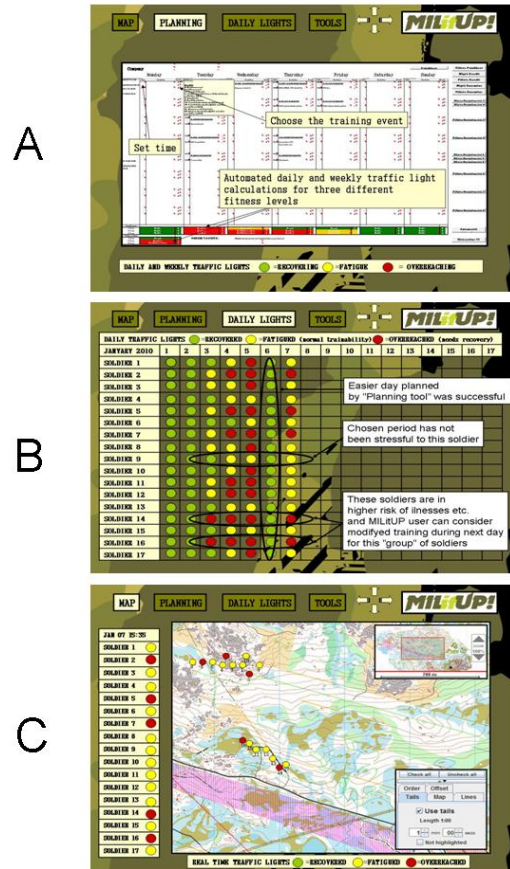


Figure 3. Software functions; Planning tool (A), daily traffic lights based on training load (B) and real time location (C)

4. CONCLUSIONS AND FUTURE WORK

The unique points of the MILitUP concept are its ability for remote operation on large groups (E.g. Company/Squadron level, 150 individuals) along with automated location and heart rate data transfer via GPRS. Automated calculation tool for absolute stress from all possibilities such as physical stress. This has not been achieved anywhere else in the world on this scale with such a simple traffic light feedback system for military managers' use.

Ensuring the well-being of soldiers throughout physical training is paramount, however without the ability to monitor stress objectively may subsequently lead to those who are overreached being at a higher risk of avoidable illness or injury. We believe that it is ethically viable to monitor stress when preparing soldiers for military service and operations in large groups. We equally recognize that informed consent and the right to withdraw from monitoring or an opportunity to observe own data should always be offered.

Although the MILitUP concept product is designed as an easy to use off the shelf item, we understand the need for rapid product deployment and use throughout all army training units and therefore the possibilities of other data transfer networks, e.g. such as ad-hoc mobile networks, should be studied.

By using the ANT+ interface our concept enables the real time transfer of various physiological data, e.g. such as function of the heart by electrocardiogram (ECG), action potentials in muscle fibers by electromyography (EMG) or waves of brain activity by electroencephalography (EEG). These future possibilities may be very useful both in military and civilian human sciences.

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