WIRELESS COMMUNICATION
As an Innovation Technology for SMEs

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Abstract: This short paper briefly describes results of our research and a new application creation as a part of our project work. One of the goals specified in the project is to develop simplified support tools for SMEs, which facilitate processes both within the SME and externally with its partners, suppliers or customers. An application for a mobile phone was developed, which is able to send data regarding the status of a monitored object into an operator's centre. The cell phone either uses its own sensor, such as a GPS unit, etc., from which data are sent directly to a central operator station or the ability to connect other wireless stations to a mobile phone and send data from extra sensors such as motion, pressure, humidity, temperature sensors, etc. The connection to a mobile phone is provided by Bluetooth wireless technology. Furthermore, the paper suggests an example of how this application may improve a small company operation and service-production processes.

1 INTRODUCTION

Wireless technologies represent a large area, which is a desirable subject for a wide range of scientific disciplines and application possibilities. Wireless technologies also have become an integral part of everyday life. In general, we find them in industrial, commercial and home automation, as well as in security technology, healthcare, and the automotive industry, etc. We are talking about sectors, where various types of wireless technologies were successfully applied or are being applied. We would like to focus on the use of these technologies to support small and medium-sized companies.

The initial specifications for the design of a tool were written based on the requirements to remotely monitor employees who perform physically demanding occupations, or are exposed to the risk of injury. They could be professional drivers, delivery service personnel, etc. These people are often at risk of, for example, a traffic accident in the environment in which they work. It can be the dangerous collision of vehicles, persons and vehicles, fallings down with subsequent injuries, in most cases they are unpredictable and therefore they can not be avoided. By monitoring and evaluating deviations from the normal state these situations can be quickly responded to and provide immediate assistance. A special group of end users for such tool are companies directly dealing with and helping the elderly, handicapped or otherwise disadvantaged people. The designed and developed system is intended for use by small and medium-sized companies partnering in our project, however, it provides a relatively large potential for practical use regarding service providing area. With further extension of the design specifications for an implementation to support small and medium-sized enterprises, mobile phones can be used in cases for monitoring and measuring variables in industrial equipment, followed by the sending of data to the remote central unit for processing. In this case a functional unit for data collection and wireless transmission was created. The above mentioned system is using wireless Bluetooth and GSM (Global System for Mobile Communications) technologies.

2 AN APPLICATION DESIGN

The easiest way to monitor the status of an employee and generate an event in the case of occurred danger is to use a mobile phone. Almost everyone has it. To be able to monitor unexpected events, an

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acceleration sensor is needed. For testing the sensor in a mobile phone, Nokia E72 was selected, which is also equipped with a GPS (Global Positioning System) receiver used in a mobile phone to identify your location and measure distances. The device also supports A-GPS (Assisted GPS), i.e. the possibility of obtaining additional data over a packet data connection. This helps in calculating the coordinates of an actual device location. When service is activated, the device receives information about satellites from an assistance data server over a cellular network and using these data it can get a real GPS position much faster. The data from the server with A-GPS are loaded only when needed. To use the packet data connection the device must have defined an internet access point to the Internet.

2.1 Using an Acceleration Sensor in Mobile Phones

The mobile phone we selected has a Symbian operating system, version 9.3, and our software was developed in the programming Java environment (J2ME). We named our newly developed application F-SME-GPS (FutureSME GPS)

After switching an application on in the mobile phone, the GPS receiver is activated and will find the current location of your mobile phone, see Figure 1. For our application we reprogrammed the acceleration sensor's dead band for the value to ± 1.5 g.

Up to this default value any event occurring with the mobile phone makes no change, which can be perceived as the normal state of the mobile phone.

After exceeding this set value any event is evaluated as the limit (for example a fall or hit of a person carrying the mobile phone or a crash) and

Figure 1: F-SME-GPS application finds the current location.

data from the accelerometer, the current GPS location and time of the event are sent or saved.

This is made possible by options under the application's settings, so a user selects where the data is going to be sent, see Figure 2. The Address option is the choice of an address, the IP address of the server where the data can be forwarded via Wi-Fi or GPRS (General Packet Radio Service) connection. A File option is used to define the file that will save all the data generated by the event. The SMS (Short Message Service) option is to set the recipient's phone number on which the data is sent via SMS.

As an alternative to this last option we designed the possibility of using services such as GPRS for data transmission to the central operator unit that will evaluate the data.

The acceleration sensor is generally used in mobile phones to rotate the image; to go through viewed images forward or backward, etc. Our application is using this sensor together with a GPS unit for entirely different purposes, which allows SME companies partnering in our project very easily and effectively to extend their services using commonly available wireless technologies.

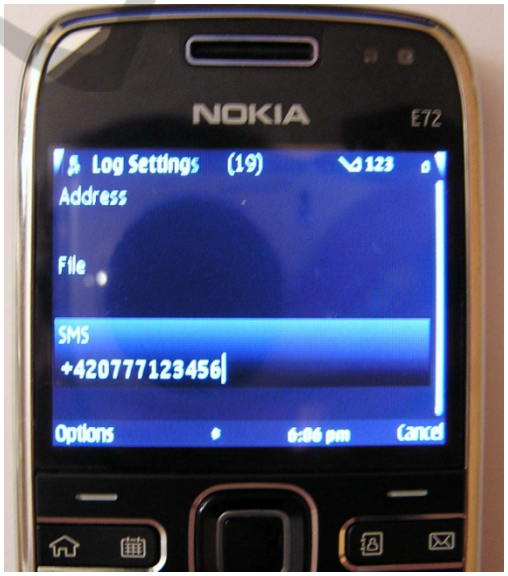

Figure 2: F-SME-GPS application sends SMS with data from an event triggered by the set limit for a in-built accelerometer.

2.2 Transferring Data via Bluetooth

The use of commonly available mobile phones for measuring variables from any technological or industrial production process is not possible yet, because we do not have available sensors that would

allow us such data acquisition - input/output (I/O) units available for direct connection to a mobile phone. However, we can use hardware devices with a Bluetooth (BT) communication standard to measure the required variables and with this technology we can connect wirelessly to a mobile phone, which in this case, serves as a gateway between the wireless BT and GSM networks, see Figure 3. This enables our mobile phone to transmit data from the short range BT network into the long range GSM network.

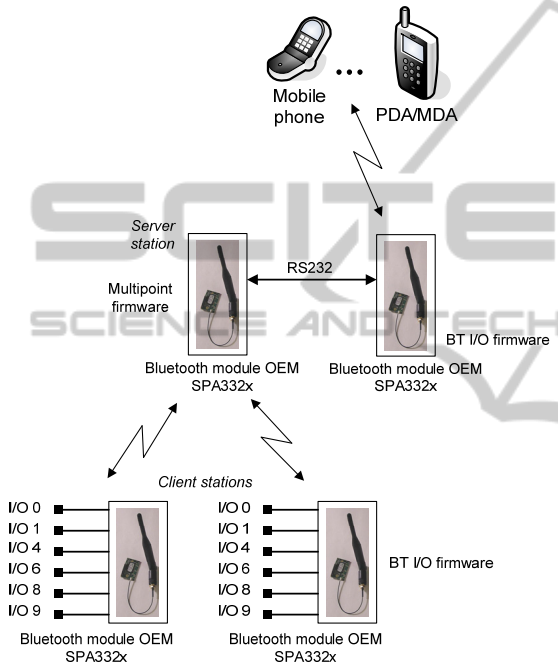

Figure 3: Bluetooth network topology (point-to-multipoint) and connection to a mobile phone.

The module containing multipoint firmware allows us to simultaneously communicate with up to 7 client stations. Only one station containing the BT I/O firmware is visible for the mobile phone, which will be receiving all data from all client stations. Communication between a server and a module with BT I/O firmware is provided by the serial interface RS232. This bridge had to be applied because the server cannot receive data and send them to a mobile phone, which is in the position of another client, at the same time.

As suitable for testing we selected BT modules OEM 332i SPA-02 from *connectBlue*™. Their big advantage is in controlling them by AT Commands (commands starting with the two letter sequence AT) and having a serial interface (UART, RS232). These modules use the EDR (Enhanced Data Rate) technology, which significantly increases the data rate of BT, which can approximate the value of 650 kilobytes per second. The modules operate in BT Class 1 with a maximum output of +20 dBm and the consumption of a wireless module ranges from 10 mA to 170 mA.

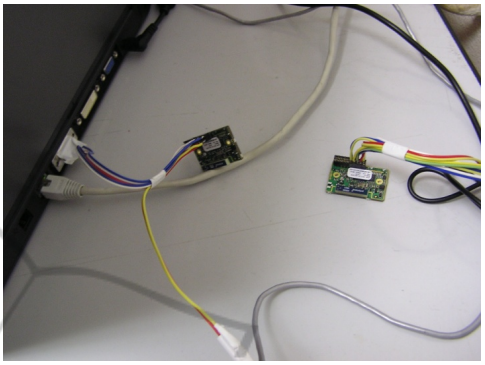

Figure 4: Bluetooth wireless connection modules SPA332i (with a ceramic antenna).

To use the wireless module for measuring values and status monitoring of equipment it was necessary to design a functional unit (electronic mobile unit) consisting of a charging circuit, increasing voltage converters, communication units and rechargeable Li-ION battery, see Figure 5. The battery is recharged through the charging circuit from an external source connected to the unit. This made our module independent from the power network.

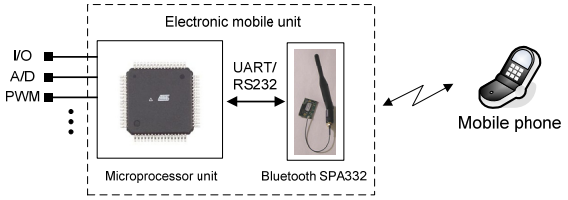

Figure 5: Connecting the microprocessor to SPA332 module.

A voltage converter adapts and stabilizes the voltage from a Li-ION battery of variable sizes ranging from 3 V, which is a low status, and 4.2 V corresponding to a fully charged battery, to the voltage of 5 V. This is needed to power the wireless module SPA332. The average consumption of a wireless module in the broadcasting state is about 55 mA, which is, using the battery capacity of 600 mAh, almost 11 hours of operation.

2.3 Using BT Technology in Mobile Phones

For the mobile phone we programmed an application

named F-SME-SPP (FutureSME-Serial Port Profile), again in Java, enabling the receiving of inputs from the wireless module. Received data are of 8 bytes size and each byte has a meaning, such as the starting byte, packet identification, identification of the wireless module, etc., the last byte has a check function. The wireless module connects directly to the mobile phone and is configured as a server with enabled visibility for other modules. For the communication the SPP (Serial Port Profile) is enabled. After start up the application will try to find the electronic unit or the wireless module as the server and will initiate a connection. Figure 6 shows an electronic mobile unit and a mobile phone application receiving data from the electronic unit's switches.

Figure 6: Connecting electronic mobile unit to the F-SME-SPP application.

The communication module can also be directly connected to a microprocessor, which extends the function of the wireless module with the possibility of increasing the number of inputs and outputs (analog, digital, PWM (Pulse Width Modulation), etc., see Figure 5). The 8-bit microprocessor uses a wireless module for sending data to a BT network. It communicates with the wireless module via UART interface or with a converter (MAX232) with RS232 interface. With this extension we are able to use wireless technology to measure variables and monitor conditions of equipment. The designed electronic unit is portable and can be deployed for less demanding applications, such as monitoring water level, temperature, relative moisture, but also to control light switching or switching on and off machines, air conditioning, etc.

3 CONCLUSIONS

The described system solutions focus on using a mobile phone as a device for measuring variables. In the first phase, we focused on the use of mobile phones and their available sensors for detecting unexpected events corresponding to such as a person falling to the ground. This system design enables us to send information about the GPS position, the exceeded value from accelerometer and the time of the event as data to another mobile phone or monitoring center (operator's site) for data processing. This way it is possible to react very quickly to unpredictable or even dangerous situations.

The second system solution uses Bluetooth technology and expands the use of mobile phone for the purpose of measuring variables and monitoring condition of equipment. An electronic unit was developed enabling communication with other units in the Bluetooth network allowing the unit to transmit data to a mobile phone. The mobile phone serves as an intermediate tool for sending and further processing data to the GSM network.

Both of these system solutions were designed, developed and tested along with SME companies partnering the FutureSME project, however, it provides a relatively large potential to help other small and medium-sized companies extend their services offered along with their products, which will primarily depend on the interest of the commercial sector.

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