September 7. - 9.9.2009
Cheb, Czech Republic

TELEMETRIC EXPERT SYSTEM BASED ON INTERENT

ING. JÁN MOLNÁR, ING. TIBOR VINCE

Abstract: *The paper deals with the proposal of the measuring chain assigned for remote measuring in the automobile industry. The designed solution should be able to do automatic measurement of all required parameters and to send obtained data to the remote centre, where they could be analyzed by telemetric expert system.*

Key words: *measuring, automobile, expert system*

1 PROBLEM DESCRIPTION

Due to big progress of automotive industry the remote measuring system could help to solve many problems. Various automobile failures could be eliminated by prevention, early malfunction detection or failure detection. The detection and prevention would be based on selected data measuring, data collecting and transporting to the remote center for its further analyzing and evaluation.

Requirements for such a measure chain depend on the data type, which have to be measured. For instance, it is a big difference between a battery voltage and engine revolution measuring. In first case, it is sufficient to collect data few times per hour. In the other case, there is necessary to take a data few times per second. The sampling time is then some tens of miliseconds. In the case of automobile measuring, there exist various data of various types to be measured.

Another problem is created by the information transport to the remote center, where the data are analyzed, evaluated and also the decision about the failure state is made. Today's situation is based on preventive service inspections at regular intervals, where the car is connected to the PC and all diagnostic methods are done. It would be more suitable, if it would be possible to do at the moment of optimal value deviation or in any failure detection. All required data would be transferred to the center and evaluated by the expert system. Expert system should decide, if the failure state exists or not. In the case of failure state appearance, the driver should receive the information about failure from center. Measurement should be running during the automobile performance. Such a way discovering of incidental and a periodic failures will be easier, because such failures are the most difficult to identify. By designed method should be possible to transport measured data at the moment, when the failure appears.

2 SOLUTION DESING

Two types of net seem to be the most appropriate for data transport. The first is GSM (Global System of Mobile communication) and the second one is WiFi connection (Wireless Fidelity). Both nets have own advantages and disadvantages. The most important advantage of WiFi (compared with GSM) is bandwidth. It means that the bigger data amount in shorter time period can be transferred by WiFi using. The most important advantage of GSM (compared with WiFi) is that the great area is covered by GSM signal. Except that, it is possible to use various tools of GSM communication such a SMS etc. For remote measurement problem solving it is possible to use both types of the net. The nets could complement each other, depending on situation.

2.1 GSM (Global System of Mobile communication)

The Global System for Mobile Communications (GSM) is the most popular standard for mobile phones in the world. Most GSM networks operate in the 900 MHz or 1800 MHz bands. The channel data rate is 270.833 kbit/s, and the frame duration is 4.615 ms. The longest distance between mobile modem and the component of GSM network is 35 km or 22 miles in practical use. There are also several implementations of the concept of an extended cell, where the cell radius could be double or even more, depending on the antenna system, the type of terrain and the timing advance. Structure of GSM network is shown in Fig.1.

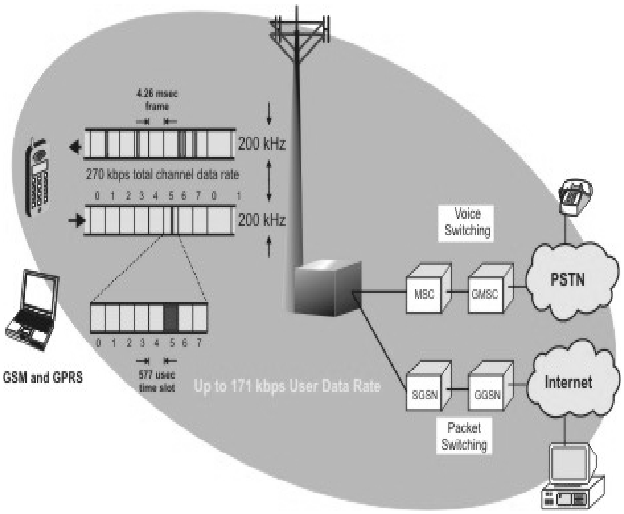

Fig. 1. Structure of GSM network

2.2 WiFi connection (Wireless Fidelity)

Wi-Fi networks use radio technologies called IEEE802.11b, 802.11a or 802.11g to provide wireless connectivity in local area networks. A Wi-Fi network can be used to connect computers to each other, to the Internet, and to wired networks using IEEE 802.3 or Ethernet. Wi-Fi networks operate in the unlicensed 2.4 and 5 GHz radio bands, with an 11 Mbps (802.11b) or 54 Mbps (802.11a or 802.11g) data rate or with products that contain both bands (dual band), so they can provide real-world performance similar to the basic 10BaseT wired Ethernet networks used in many offices. Unfortunately, 802.11a is not compatible with 802.11b/g. Wi-Fi is a standard developed by the Wi-Fi alliance that certifies vendor products to ensure 802.11 products on the market follow the various 802.11 specifications. Example of such WiFi network shows Fig 2.

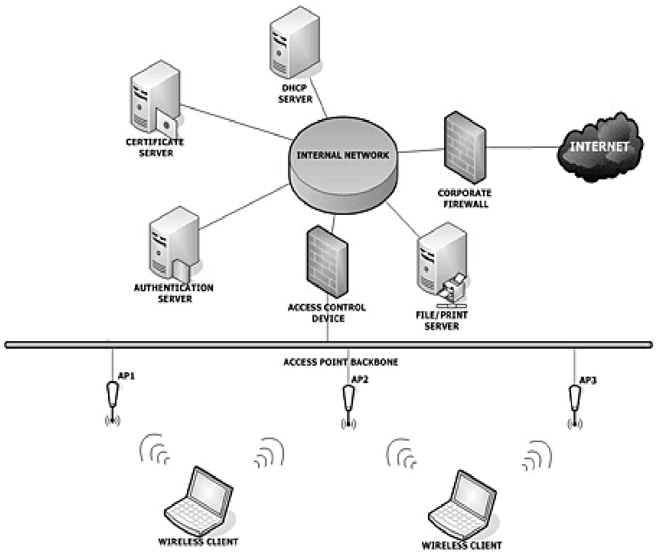

Fig.2. WiFi network.

In praxis, if every automobile would be connected to the net and every one car would continuously sending a data, it would be inefficient and the net would be very soon overloaded. The net should be used only for diagnostic and optimization case.

During diagnostic, there would be monitoring of all automobile processes and values. Measured date would be compared with optimal values. Evaluation could be done by some local expert system or using artificial neural network etc. In case of deviation from standard state, automobile should connect the expert system and measured data would be transferred to the remote expert system. Remote expert system should be more sophisticated and frequently updated, so the evaluation by remote center should be more exact. For such communication a GSM network would be sufficient. Similar local expert system is nowadays implemented in advanced automobiles of higher class. But connection with central expert system will enable much complex and reliable diagnostic. It is much effective to update the central expert system than individual local systems in each automobile.

If the car will be inside the area covered by WiFi signal and transfer capacity is sufficient, then the optimizing of engine setup, the automobile software update and various modifications would be enabled which were done only in car service yet. The basic condition of such modification is given by sufficiently fast connection existence, which would be able to transfer the fast changed parameters (such engine revolution, gas consumption etc).

3 ARCHITECTURE PROPOSAL

Architecture proposal of such connection is displayed in figure Fig.3. Architecture doesn't deal directly with measuring. Measuring problems are mostly solved nowadays. Architecture deals with problem of data transport. The "bus" of the measure chain is responsible for data transport to the evaluation system.

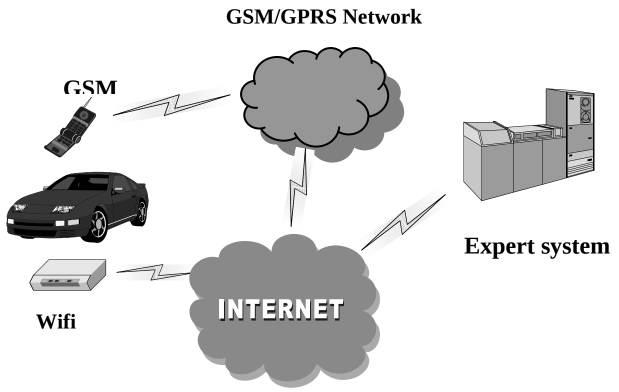

Fig.3: Architecture proposal

As the figure shows, the automobile should have integrated GSM modem and also device for WiFi net connection. Using the GSM or WiFi net, the automobile would have access to the Internet. Via Internet the car would be connected with remote expert system.

Local expert system would not just watch the automobile parameters, but it could also control the communication. It would decides, which data and how often would be send to the remote system in the case of failure state. It would also decide which data would be sending via GSM and which via WiFi. It would be also responsible for optimizing data transfer.

Expert system would offer suitable solution for driver. In case of failure, it would recommends the driver to stop the car immediately, drive the car to the next service or ignore the problem (problem is temporary). It would be possible also give attention to the driver, in the case when he often uses the high engine revolution etc. Connection to the Internet would have much more advantages like as an on-line help (how to change electrical fuse – and which one, change a wheel, weather forecast). But the most important is possibility of emergency call. Using GSM net it would be possible to find out the car location etc.

Such a way created system, the part of which is remote measurement chain utilizing the Internet and connection to the expert system, would be great benefit for automobile reliability and safety.

4 MEASURING AND COMMUNICATION SYSTEM

The root of the whole communication and measurement system is FOX Board. It ensures communication between GSM modem and Wifi. Individual equipments are directly connected to FOX Board using USB interface. Communication itself controls the program which surveys accessible networks. According to the network the program decides the device will be used to connect the Internet and data transfer. 12bit converter handles with the analogue signals and changing them to the digitals. The converter is directly connected to a one of the I/O interfaces of FOX Board. A/D converter and FOX Board communication ensure the program, which control a sampling rate and save measured data to a text file on memory medium. The memory medium has also a backup function in case of no accessible network.

All saved data are transferred to a server via Internet. Measured data are saved and analyzed on the server. Block diagram of the measure chain is on the following figure Fig. 4.

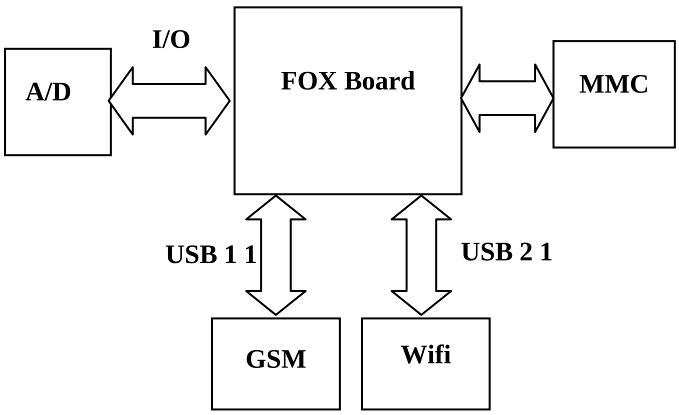

Fig.4 Block diagram

5 FOX BOARD

FOX Board runs a real Linux operating system (not a uC Linux) on an ETRAX 100LX microprocessor, a 100MIPS RISC CPU made by Axis Communications. FOX Board has two main field applications:

- As a stand alone device to build a micro web server or other network devices as proxy, router, firewall, etc.
- As a core engine to plug onto the PCB of a user application board instead of a simple microcontroller.

Two USB 1.1 host interfaces can be connected to USB memory stick, hard disk, webcam, modem, Wi-Fi or Bluetooth dongle, ADSL adapter, Serial converter, etc. Through the 10/100 Ethernet interface it is possible to have access to the internal Web server, FTP server, SSH, Telnet and the complete TCP/IP stack.

Compilation of simple program can be done by web-compiler from the manufacturer web site. For more complicated programs is possible to download whole system core. It is possible to install also in desktop computer as a virtual application. Using this application it is possible to compile whole Linux core and upload it to the FOX Board.

Individual programs handling whole measurement chain are located in memory of FOX Board. In case of more memory requirement, it is possible to use on of more memory media connectable to the FOX Board.

Communications with FOX Board itself, user can establish with any software which communicates with telnet server build in FOX Board for example PuTTY, HyperTerminal etc.

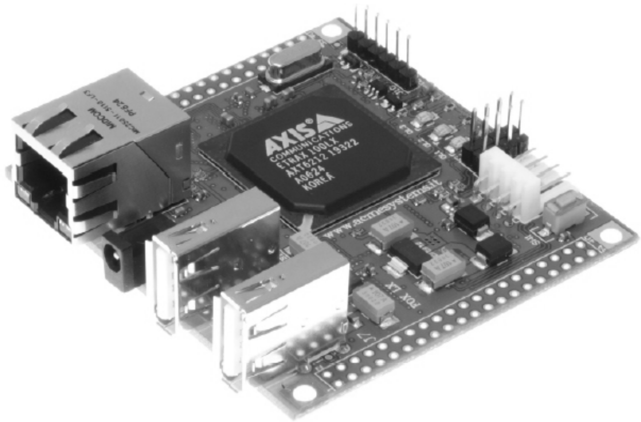

Fig.5: FOX Board

6 CONCLUSION

Using of worldwide network – Internet seems to be optimal for remote data measurement inside the car. The GSM and WIFI connection is suitable for Internet connection. The biggest advantage of WiFi is bandwidth. It is able to transfer data faster than GSM. The biggest advantage of GSM net is that the GSM signal covers majority of area. Realization of such a remote measure chain will serve for future exploration of remote measure chain using Internet as a bus, also in real-time applications. That way would increase possibilities to integrate various measurement systems in the whole complex system.

7 ACKNOWLEDGEMENT

The paper has been prepared by the support of Slovak grant projects VEGA No. 1/4174/07, VEGA No. 1/0660/08, KEGA 3/5227/07, KEGA 3/6386/08 and KEGA 3/6388/08

8 REFERENCES

[1] Kováč, D., Kováčová, I., Molnár, J.: Electromagnetic Compatibility - measurement, TU Košice publisher, 72 pages, ISBN 978-80-553-0151-8.

[2] Kováč, D., Kováčová, I., Vince, T.: Electromagnetic Compatibility, TU Košice publisher, 138 pages, ISBN 978-80-553-0150-1.

[3] Tomčík, J., Tomčíková, I.: IT Security of automation and SCADA systems (Part 1). In: AT&P Journal, Vol. 13, No. 4 (2006), pp. 50 – 54, ISSN 1336-5010.

[4] Molnár, J., Kováčová, I.: Distance remote measurement of magnetic field. In: Acta Electrotechnica et Informatica, Vol. 7, No. 4 (2007), pp. 52-55, ISSN 1335-8243

[5] Kováčová, I., Kováč, D.: Modelling and Measuring of Electronic Circuits, textbook FEI TU Košice, ELFA s.r.o. Publisher, 1996, 92 pages, ISBN 80-88786-44-4.

[6] Kováčová, I., Kováč, D.: EMC Compatibility of Power Semiconductor Converters and Inverters, Acta Electrotechnica et Informatica, 2003, Vol.3, No.2, pp.12-14, ISSN 1335-8243.

[7] Molnár, J.: Remote measurement system in automobile scheme. In: Proceeding of 8th International PhD Workshop OWD 2006, Warszawa, pp. 400-403, ISBN 83-922242-1-3.

[8] Molnár, J.: Automatic measurement of magnetic field via internet. 7th PhD Student Conference and Scientific and Technical Competition of Students of Faculty of Electrical Engineering and Informatics Technical University of Košice s. 57-58. ISBN 978-80-8073-803-7.

[9] Vince, T., Molnár, J., Tomčíková, I.: Remote DC motor speed regulation via Internet. In: OWD 2008 : 10. international PhD workshop : Wisla, 18-21 October 2008. [s.l.] : [s.n.], 2008. p. 293-296. ISBN 83-922242-4-8

Ing. Ján Molnár[1], Ing. Tibor Vince[2]
KTEEM FEI TU
Park Komenskeho 3
042 00 Košice
tel: +421 55 602 2592
email[1]: jan.molnar@tuke.sk
email[2]: tibor.vince@tuke.sk