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THE CONCEPTION OF MODULAR MONITOR OF CAR EXPLOITATION PARAMETERS

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Abstract

Current tendencies in electronics and informatics development going towards Internet of Things (IoT), Big Data or Data Cloud technologies create new possibilities in acquiring and utilizing data. The article presents the concept of modular monitoring of vehicles operating parameters. Presented device registers data from the OBD system and a set of independent, configurable sensor modules. Data from the OBD system is acquired via protocol. CAN Bus with a DLC connector. The signal from sensor modules is transferred via a Bluetooth wireless network. The registered data can be storage on board as CD card memory or alternatively on a typical user interface such as laptop, tablet, cell phone etc. The communication with the user interface is realised with USB. Moving vehicles modular monitoring system presented in the article can be used to attain a fuller representation of the vehicles state in relation to its environment. The base assumption of the device is maximal flexibility in term of sensors versality as well as possibilities of assembly on board. In connection with the concept, a prototype of the device was made and tested with an inertial measurement unit (IMU) module and a pressure sensor. Appliances modules are based on Cortex M4 and M0 processing units. A users interface in LabVIEW and examples of registered signals are showed at the end of the article.

Keywords: *automotive, communication networks, car parameter monitoring, CAN, modular system*

1. Introduction

Development of monitoring systems and acquiring data on a moving vehicle's condition was started with the implementation of the OBD [3, 4]. Originally, the idea of such set of regulations was to monitor the state of the vehicle to control its influence on the environment. Further works on the OBD systems gradually expanded the range of measured parameters. Currently (both professionally and commonly used) devices that communicate with the OBD systems through CAN data buses [1, 2, 7-11] enable a wide array of observing and monitoring both the vehicle's malfunctions and its operating parameters. While the quantity of such parameters is growing, due to necessity of standardization, the amount of information is restricted: both in the frequency of taking measurements and their precision.

Measurement systems designed to register specific data for the purpose of scientific research are a separate group. Such structures require large amounts of time and work. Despite their high metrological properties, they are difficult to implement on a large scale due to high costs and difficulties with modifying the range of acquired signals. Test preparations of these systems often require involvement of trained electronic specialists and programmers. Another separate, independent from the OBD, group of vehicle's data registration systems are mass produced devices that acquire strictly defined data. Appliances based on GNSS localization that give the possibility to review the route travelled and monitor speed and acceleration, are a typical example of such systems. Their usefulness is confirmed by their increasing amount of utilizations in companies using fleet vehicles. The operating of presented systems can often be redundant due to referencing the same data as in the case of vehicle's speed measurements. Acquiring data about the vehicle's speed from different sources is, for example, recommended in the applied regulations on digital tachograph systems. Aside from obvious data authenticating, such solution can also uncover undesirable attempts to interfere with the motion sensor's readings.

Current tendencies in electronics and informatics development going towards Internet of Things (IoT), Big Data or Data Cloud technologies create new possibilities in acquiring and utilizing data. An example of a highly complex IT network responsible for safety and fluidity of traffic are the systems related to navigation. Databases of such structures are constantly modified according to changing conditions on a particular section of a region or roads. Overground temperature and wind measurement points or information provided by drivers is the sources of the processed data. These statistics could be complemented by automatic reports on the vehicle's state and changes in relation to outside conditions, sudden braking, skids, gusts of wind or surface damage. In this context improving the vehicle's effectiveness as a source of information could be achieved by supplementing the data with diagnostics gathered by the OBD or equipping the vehicle with external sensors.

2. Concept of the device

Developing a concept of a moving vehicle's monitoring system was conducted based on:
- access to OBD information through an DLC diagnostic connector,
- real time data registration,
- building a system that is easy to expand and reconfigurate, due to a wide spectrum of sensors,
- device's durability and simple installation of the system's physical components,
- possibility of using on-line visualization using a HMI equipped with typical communication interface.

A system concept, with consideration of these assumptions, was adopted; the system composes of:
- a main module, responsible for controlling the system, communication with the external HMI, communication with the OBD through CAN, communication with peripheral sensor modules through a Bluetooth protocol [5, 6], cooperation with a mass storage device,
- peripheral sensor modules working as an integrated autonomous units, composed of a sensor-converter, Bluetooth interface and an independent power source,
- software for configuring, visualizing, data analysis and controlling the system through an external device, such as a PC. Schematics of the concept are showed in Fig. 1.

3. Prototype of the device

As part of working on the monitoring system, that is the focus of this article, initial tests of the prototype main module and the movement dynamics module were prepared and performed. The construction of the main module prototype was based on a Cortex M4 (Kinetis K60) controller, embedded on an evaluation set TWR-K60N512 [15]. The peripheral sensor modules were built with the evaluation set FRDM-KW41Z [10], based on a Cortex M0 microcontroller and a movement dynamics parameters measurement module composed of an accelerometer and a magnetometer – FXOS8700CQ [14] and a gyroscope – FXAS21002C [13].

Simplified schematics of the presented prototype are shown in Fig. 2. Fig. 3 depicts the device during road tests.

As part of completing the prototype system, LabVIEW based user interface software working on a laptop-type devices was prepared. The software was created to work in following modes:
- mode 1: Device configuration and choosing parameters to be monitored,

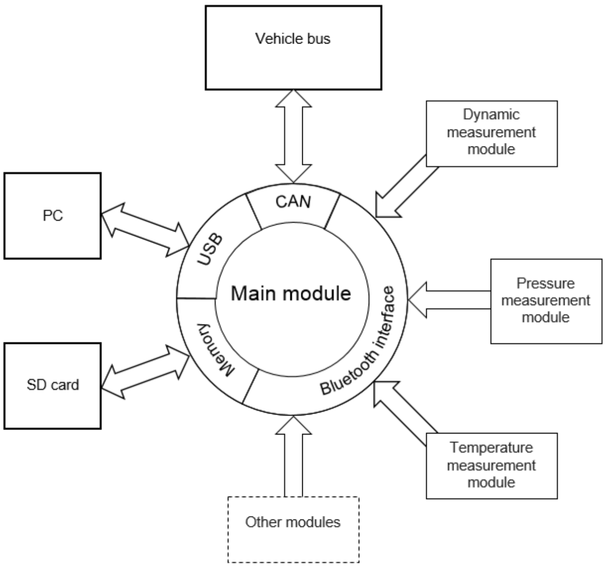

Fig. 1. The conception of modular monitor of car exploitation parameters in motion

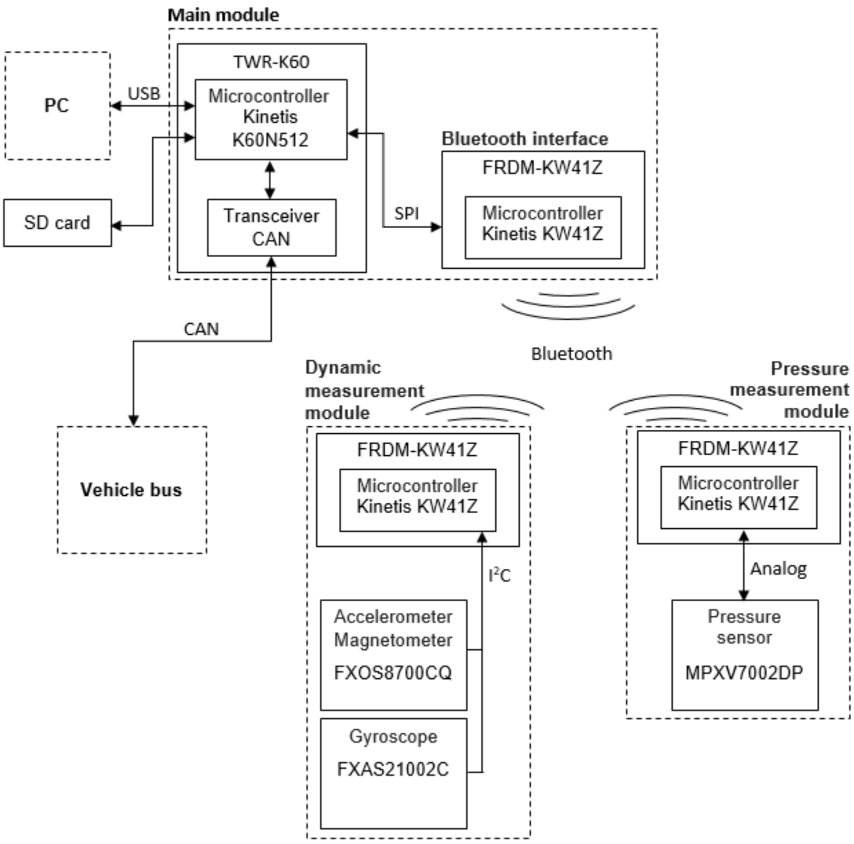

Fig. 2. The scheme of the prototype of modular monitor of car exploitation parameters in motion

– mode 2: Active reading of the registered parameters on-line,
– mode 3: Reading data from mode 2, stored in a mass storage.

The choice of monitored parameters screen is depicted in Fig. 5.

As part of the preliminary tests of the prototype, signal registration trials were conducted in road conditions. Examples of the registered signals are shown in Fig. 4. Since the system (based on previously presented assumptions) is supposed to be very flexible in terms of used sensors and registered signals, it is to be expected that the peripheral sensor modules may be installed in various locations, for example: inertial sensors on elements of the suspension, temperature or acoustic sensors in the engine compartment, airflow sensors on the external parts of the car body (to establish the influence of gusts of wind). Because of the possibility of transmission interference (engine compartment) or obstructions in the transmission area due to the metal parts of the car body, initial tests of communication between the modules (for localizations marked in Fig. 6) were conducted. During the test, no transmission interference was noted, regardless of the location of the peripheral sensor modules.

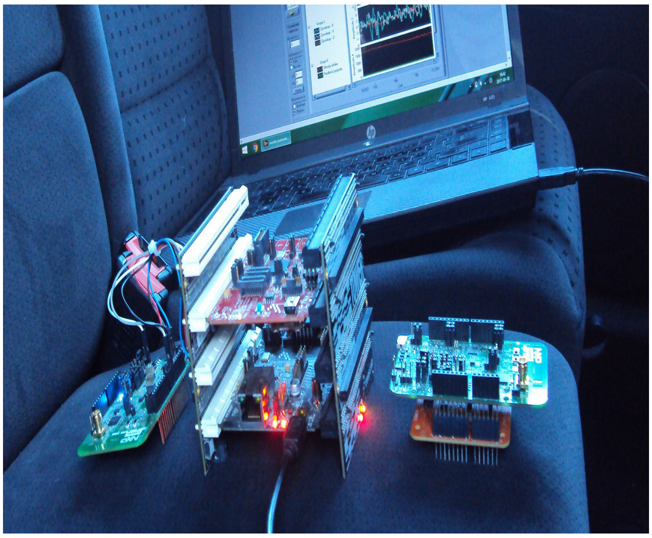

Fig. 3. The device during road tests

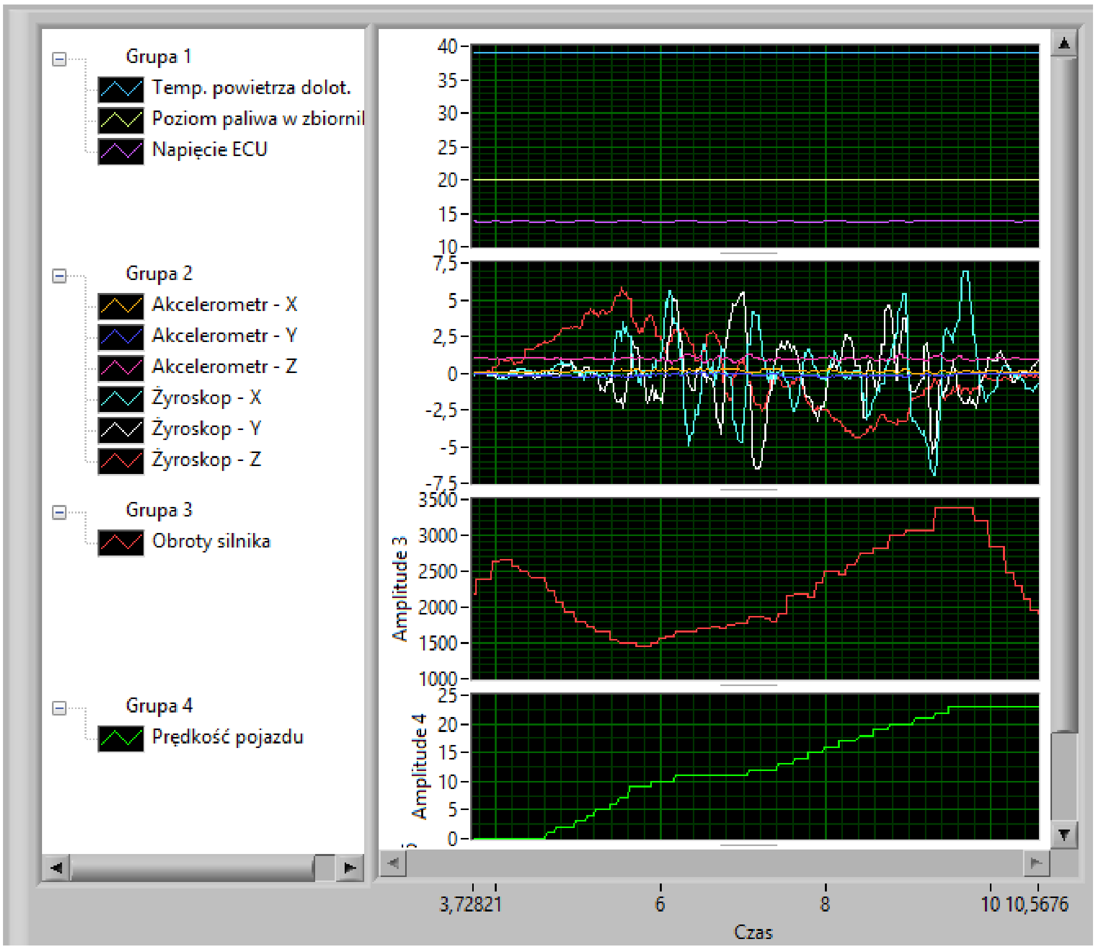

Fig. 4. The example of monitored parameters in road test

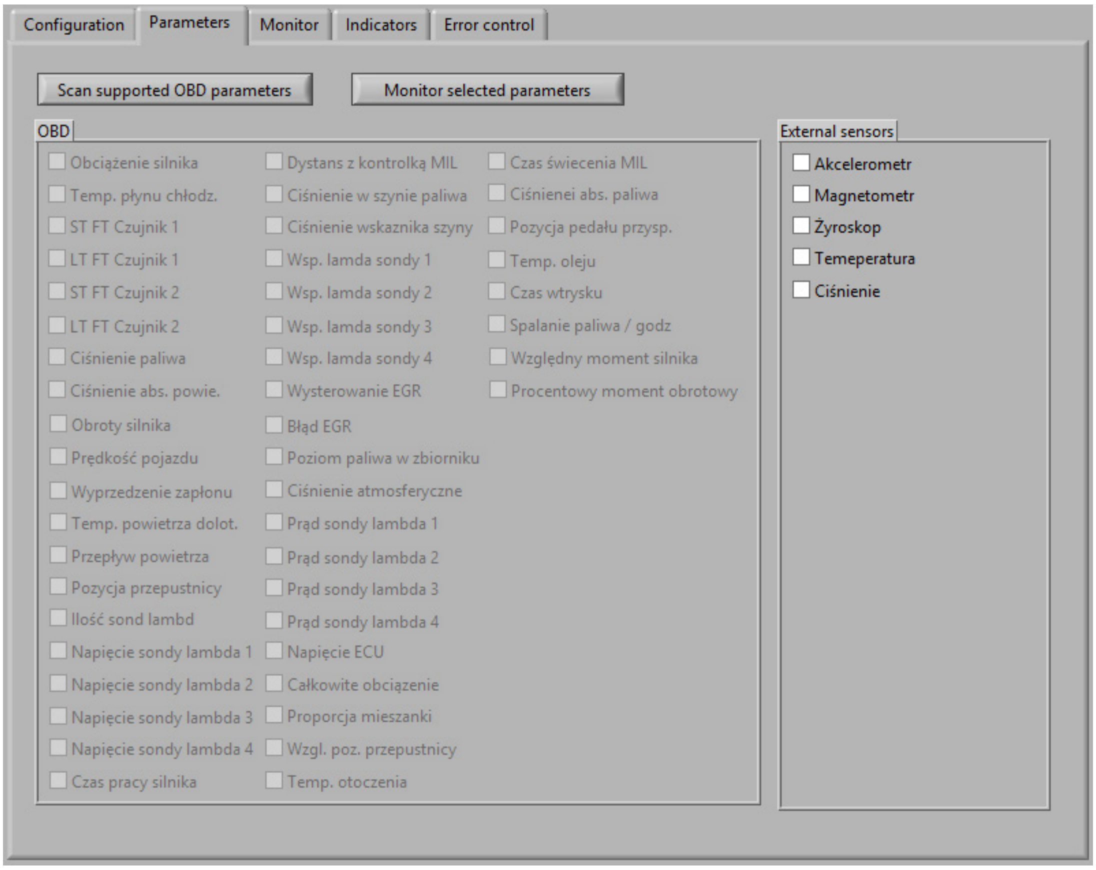

Fig. 5. The user interface programme – selecting monitored parameters

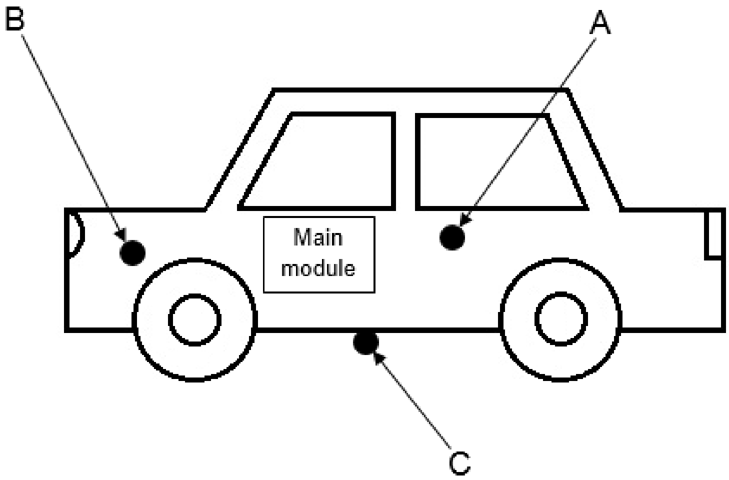

Fig. 6. The location sensor modules during the communication test (A – passenger compartment, B – engine compartment, C – under the chassis)

4. Summary

Moving vehicle's modular monitoring system presented in the article can be used to attain a fuller representation of the vehicle's state in relation to its environment. Further works on the system's concept are to focus on implementing it in car fleets, which would supplement data base systems responsible for traffic fluidity and safety in given areas of cities and sections of roads. For this purpose, subsequent prototypes are planned to be equipped with modern communication systems such as LoRa or Sigfox. Further works and experiments on advance processing algorithms, data acquisition and implementing modern sensors systems will also be required.

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