DESIGN OF A MONITORING DEVICE TO IDENTIFY A HUMAN FACTOR INFLUENCING ON FUEL CONSUMPTION OF A LORRY

Szabó M., Majdan R., Angelovič M., Polonec T., Hujo Ľ, Čápora R.

Department of Transport and Handling, Faculty of Engineering, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic

E-mail: szabo@dtx.sk

ABSTRACT

The study is focused on design of device monitoring the human factor influencing fuel consumption in lorries. The study summarizes individual factors affecting fuel consumption with emphasis on human factor. Detection of excessive consumption effects caused by driving style was realized by specialized device designed and verified to record individual trips, actual positions, dates, times and speed vehicle as well as frequency of brake pedal pressings. Voltage from cigarette lighter supplies the monitoring device. Primary function of device is an autonomic data logging obtained from GPS system by the time of device operation at maximal possible detail level. All data including recordings of brake pedal pressing is recorded into designed electronic memory. All logged data are saved to SD card. Data analysis is realized by specially designed programme. Designed and verified device is currently installed in Renault Premium 450 DXi vehicle. Based on logged data together with videorecording was possible to detect a level of excessive fuel consumption caused by driver and to optimize drivers driving style.

Key words: human factor, GPS, brake pressings, fuel consumption

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INTRODUCTION

According to Vitázek (2006), the exploitation of primary energy sources negatively affects the environment in case of extraction and fuel treatment, but primarily in the transformation of one type of energy into the other. The reducing of fuel consumption has ecological as well as economic reasons.

In addition to fuel consumption, which is necessary for towing vehicles to run, also excessive fuel consumption is likely to occur in practice. The amount of excessive consumption is influenced by many factors. As the fuel price is increasing dramatically, it is important to recognise these factors and to minimise the fuel consumption (Janoško, 1996).

Apart from the engine type, there are also other factors that influence the fuel consumption. There are many factors dependent on the technical condition of vehicles. However, in the following part, we mention only those factors we are able to influence (Žikla,2009).

Aerodynamic resistance has a great impact on the overall fuel consumption. This resistance can be reduced considerably by a correct use of spoilers and aerodynamic stabilisers. However, the spoilers used unprofessionally, can increase the fuel consumption (Lenďák, 2006).

Based on the research carried out by the Renault and Michelin companies, the rolling resistance of tyres represents approximately one third of the overall power of resistance to motion. The tyre warms up during the drive, which is caused by bend stress (bend of the tyre side, bend of the tyre tread). Tyre bend causes friction that releases heat. That heat is the energy that the engine has to overcome. It is one of the fuel consumption factors (Liščák, 2004).

Apart from these factors, there is one more factor, which might significantly affect a vehicle excessive fuel consumption level – human factor.Economical driving style might result in fuel saving between 5% and 12% - better fuel saving as obtained by any technical solutions (Lenďák, 2013)

MATERIAL AND METHODS

To detect an effect of driver on excessive consumption, we designed a device according to Figure 1. Basic technical properties of device:supply voltage 5 V, operating frequency from 8 000 to 16 000 Hz, internal FLASH memory 128 kB, internal SRAM memory 4 kB.

Block diagram of individual functional parts of device is presented in Figure 1.
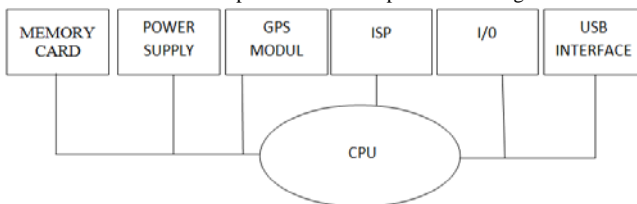
Fig. 1Block diagram of individual functional parts of device

Memory card type MMC/SD (Multi Media / Secure Digital Card) was selected as memory medium in device conception, because of its fast communication and unlimited capacity of memory space (capacity over 1 GB are currently available for price within reason).Card readers of such type are typically integrated in notebooks, PDA devices and are available as external USB card readers.

Selection of such type of card with logging, which is compatible with file system FAT/FAT32, is optimal solution for user, because all available GPS loggers utilize special FLASH memories, which requires special readers of software from device producer.

We recommend installing car video camera into vehicle for back analysis of traffic situation. Car video cameras are available on domestic market for price within reason of 50 EUR. We recommend a camera with wide-angle objective lens of minimal 140 DEG with SD card trip recording. To enhance detection of traffic situation, we recommend car camera indicating date, time and GPS coordinates. Car video camera EvolveoCarCam F140 FullHD meets all selected criteria.

RESULT AND DISCUSSION

Device (Figure 2a) is designed and programmed to save following data on SD card within time period of 0.2 s:number of logging, date, time, speed, driving distance since last logging, GPS coordinates and brake pedal position.

a)   *b)*

Fig. 2Device detecting an effect of driver on fuel consumption: a) connection of individual parts, b) software for loggings assessment

Position of brake pedal was monitored by contactless scanner installed on brake pedal. If brake pedal is pressed in the moment of logging, device will record value of 1 on memory card, value of 0 is record in opposite case. Position of brake pedal is monitored every 0.2 second, i.e. 5 times per second.

By means of such device, it is possible to detect, if driver drives like "racer", drives by brake-throttle style or drives economically. It is possible to detect driver's acceleration and braking, contravention of traffic rules as well as mistakes in driving behaviour and driving style. Device is connected by means of USB bus from power box including 4 monocells with voltage of 1.5 V, placed in holder or by means of vehicle lighter socket.

Data analysis was realized by data downloading from SD card by means of special designed program shown in Figure 2b. All loggings from SD card are displayed, when program is started. All logging might be filtered by date, i.e. it is possible to display and analyse only selected loggings. This function is useful in case of two or more drivers drive the same car. We are able to compare driving style of drivers, in case, when drivers drive the same trips.

Individual loggings can be exported after their downloading. Programme software enables data export in following formats:

- .TXT –suitable for various *driving book* programmes, for exampleAutoplan

- .KML –file suitable for Google Earth

- .MRP-databases

- .CSV –suitable for Microsoft Excel import.

All trips are displayable in Google Maps, which also indicates possible down-times. Diagram image of CPU programme operational procedure is presented in Figure 3.
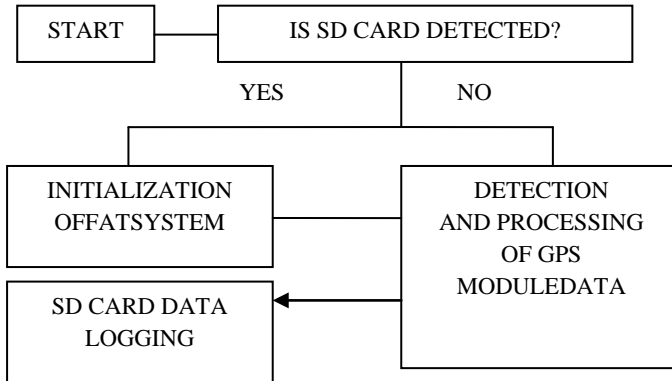
```
┌─────────────┐     ┌──────────────────────────┐
│   START     │─────│   IS SD CARD DETECTED?    │
└─────────────┘     └──────────────────────────┘
            YES                      NO

┌───────────────────┐     ┌──────────────────┐
│   INITIALIZATION   │     │    DETECTION      │
│   OFFATSYSTEM      │─────│ AND PROCESSING    │
└───────────────────┘     │    OF GPS         │
┌───────────────────┐     │   MODULEDATA      │
│  SD CARD DATA     │◄────│                   │
│   LOGGING         │     └──────────────────┘
└───────────────────┘
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Fig. 3Diagram image of CPU programme operational procedure

Device can be used to create driving books, to monitor speeding on roads, to control drivers (possible stops on suspicious places), to measure travelled distances per day, to display travelled trips on maps. GPS modul installed in our device will enable on-line vehicle monitoring, but it was not an object of our study.

CONCLUSIONS

Our study describes a device design used to monitor driving properties of driver. Based on device output results is possible to analyse driving behaviour of driver as well as to compare individual drivers. Described system enables to detect weak properties of drivers requiring training courses. Economical effectivy might be evaluated in the end of training courses. Device might be used to create vehicle log book, which are obligatory for transport companies. In case of speeding over maximal speed limit, the programme will display violation of such traffic law. The trip is displayable in Google Maps, which also indicates possible down-times and length of downtown.

Device is suitable alternative to currently used informative systems in vehicle. Produced informative systems provide similar information, but their monthly charge is higher than price of such device.

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