Biblid: 0350-2953 (2013) 39(1): 33-40 Originalni naučni rad
UDK: 631.372:631.312 Original scientific paper

TESTING THE SYSTEMTOSENSING A SELECTED PARAMETERS OF TRACTOR

Chrastina J, Janoško I, Polonec T
Technickáfakulta, SPU v Nitre, Tr. A. Hlinku 2, 949 76 Nitra, e-mail:
jozino.ch@gmail.com

SUMMARY

This paper focuses onoperational tests of newly developed system for monitoring of technical exploitative characteristics of the tractors and vehicles. System enables monitoring the current and the cumulative fuel consumption, speed, position etc. and by using mathematical relationships identified gear and informs the operator of optimizing driving. The system calculated values by according the current mode as air pollutants, emissionsin the exhaust, areal performance and areal fuel consumption. Part of the materials and methods describes the functions and characteristics of the sensing elements as well as the irinvolvement and basic mathematical relationships. The aim of this work is to verify the reliability of under real conditions work. The results are presented in part graphical outputs of the selected measurement along with its description.

Keywords: monitoring system, GPS, tractor, fuel consumption

1. INTRODUCTION

Monitoring the technical parameters of motor vehicles is not only important for the indirect diagnosis of vehicles, but also affects the actual operating cost ratio. Economy of vehicle operation depends on many factors. It is a vehicle's parameters such as a power and efficiency of the combustion of fuel, gear and at higher speeds the aerodynamics of the vehicle. Not insignificant influence on the fuel consumption and the construction of the road itself as the ascent, descent, resistance, curves etc. These parameters we can consider as a constants.

The biggest impact of the increased fuel consumption has driver during vehicle's unfailure operation. Inappropriate shifting of gears and associated with higher engine speeds, resulting an increase of engine wear as well as transportation cost.

The aim of this work is verified of our designed automated system to monitoring the selected parameters such as the vehicle's engine speed, vehicle speed, fuel consumption, routing etc. This system indicates an actual driving mode by using software and informs the driver about possible reduction of fuel consumption.

2. MATERIALS AND METHODS

Verified measuring system is designed to inform the operator about the current and cumulative fuel consumption, engine speed, speed and position, angle of climb, descent, and acceleration, current and recommended by the gear etc.

During the test measurements, we tested the suitability of the measuring apparatus, the functionality and reliability of the system under operational conditions.

Block diagram of the various elements is shown in Figure 1. Measurement system consists of GPS device type Holux M 1000C and two measuring cards LabJack U12. Measuring cards senses the fuel consumption, operating temperature of the fuel, engine speed and operation of hydraulic pump. Each captured value is then converted by transmission constants, mathematical processed, graphically displayed and archived.

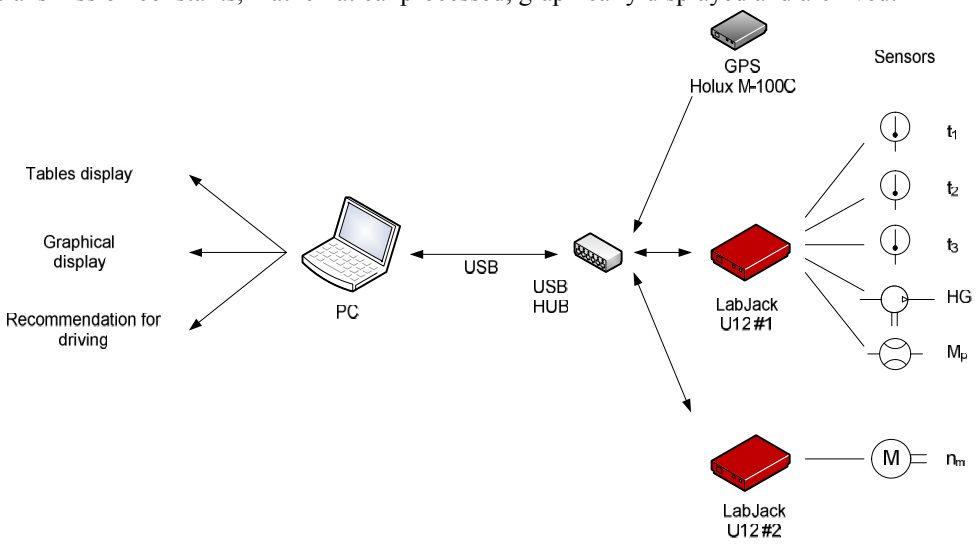


Fig. 1. Schematic diagram of measuring circuit

PC - recording computer; **USB HUB** - USB bus coupler of the single output; $\mathbf{t_1}$ - temperature of diesel in the suction branch; $\mathbf{t_2}$ – temperature of injected diesel; $\mathbf{t_3}$ - temperature of oil in the overflow pipe; **HG** - state variable running of hydraulic pump; $\mathbf{M_p}$ - unit diesel consumption; $\mathbf{n_m}$ - engine speed.

GPS device Holux M100C

This device (Figure 2A) is used to measure time, position and velocity, i.e. longitude, latitude and altitude. The measured values followed by equation (1) we calculate the acceleration of the vehicle, climb angle or descent (2), the cumulative (3) of the section traveled track, areal performance (4), areal consumption of fuel (5) and others. Measuring device communicates with PC through USB bus with 1 Hz location data refresh rate.

Recorded precision of the receiver
- Location: under regular conditions in the range of <3m without SA,
- Speed: from 0.1 ms^{-1},
- Time: 0.1 ms synchronized with GPS time.

$$a = \frac{v_n - v_{n-1}}{3.6\,T}, \quad m.s^{-1} \qquad (1)$$

where: a - acceleration of the vehicle, $m.s^{-1}$;v_n – actual speed, $km.h^{-1}$; v_{n-1} - previous speed, $km.h^{-1}$; T - time period of GPS data refresh, s.

$$s_v = tg\frac{h_n - h_{n-1}}{s_n}, \quad ° \qquad (2)$$

where: s_v - road elevation, °; h_n - actual altitude, m; h_{n-1} – previous altitude, m; s_n - track during one period, m.

$$s_{KUMn} = \frac{v_n.T}{3.6} + s_{KUMn-1}, \quad \text{m} \qquad (3)$$

where: s_{KUMn} - cumulative track, m; v_n – actual speed km.h^{-1}; T - time period of GPS data recovery, s.

$$W = 0.36.B_n.v, \qquad \text{ha.h}^{-1} \qquad (4)$$

where: W - areal performance ha.h^{-1}; B_n - working width, m; v - drive speed, m.s^{-1}.

$$M_{pS} = \frac{1}{3.6}.\frac{M_p}{W}, \qquad \text{g.m}^{-2} \qquad (5)$$

where: M_{pS} - areal fuel consumption, g.m^{-2};M_p - hour fuel consumption, g.h^{-1};W - areal performance, ha.h^{-1}.

Measuring card LabJack U12

LabJack is external peripheral device using the USB bus (Figure 2B).Provide a digitization of analog values and receiving digital signals such as theoperation of hydraulic pump. As mentioned earlier, measuring cards are used to capture the fuel consumption and speed, where it is used a 32 bit digital counter. Temperature sensors are sensing the temperature of fuel in differential analog input connections.

Basic technical specification of the measuring cards:
- Analog Inputs: 8x to the ground or 4x in differential connection with 12-bit resolution
- 20 digital inputs or outputs,
- 1x 1 MHz digital counter with 32-bit resolution,
- Powered through USB.

Fuel consumption meter Adast Js6 8500.06

Adast Js6 is four-piston fuel flow meter, which is used for the direct measurement of real fuel consumption. The flow meter was mounted before the low-pressure fuel pump. The output of the overflow pipe from the injectors was not fed back into the tank, but it was connected through a three-way one-way valve back into the low-pressure circuit for flow meter (see Figure 3A). This connection mechanical avoids double loading the fuel and requires using only one flow meter. Temperature effect on fuel is monitored by temperature sensors Pt1000. Pulses derived volume passed through the fuel are module in flip-flop circuit. Designed software process these signals and calculates the total cumulative and through time periods immediate fuel consumption (6).

Characteristics of flow meter
- Measuring range 1-100 dm^3.h^{-1},
- The maximum flow 130 dm^3.h^{-1},
- Medium time between failure 1000 operating hours,
- The minimum deductible value 0.001 dm^3,
- Accuracy 2% of the flow range 2-130 dm^3.h^{-1},

and 3% in range Q = 1-3 dm^3.h^{-1}.

$$Q_{os2s} = V_{2s}.k, \qquad \text{dm}^3.\text{hod}^{-1} \qquad (6)$$

where: Q_{os2s} - immediate fuel consumption calculated for 2s, $dm^3.h^{-1}$,

V_{2S} - the volume of fuel passed through flow meter indicated in 2s, dm^3;

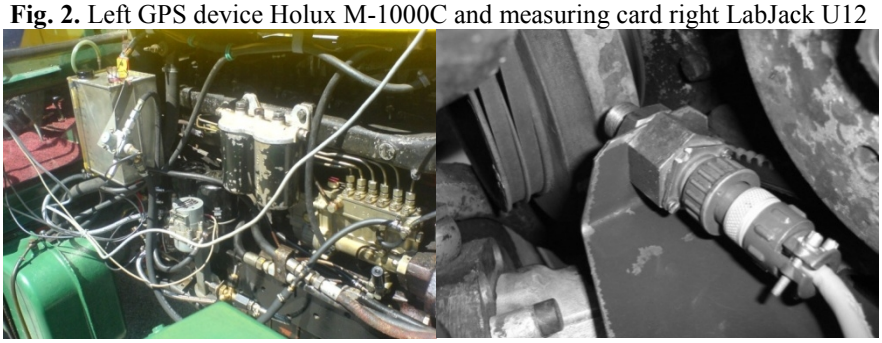
k – conversion constant k = 1.8.

We performed calibration of flow meter on a test bench for injection pumps and injection unit, so we compared the indicated fuel consumption by flow meter overflow with real diesel fuel in a graduated cylinder at specified flow rates.

Engine speed sensor

It is an electro-magnetic sensing element change the magnetic field induction. This change indicates a proportional voltage. Change caused by magnetic induction elements mounted on the crankshaft pulley or flywheel teeth motor. The number of magnets or teeth unfolds shooting accuracy (Figure 3B).

Fig. 2. Left GPS device Holux M-1000C and measuring card right LabJack U12



a) b)

Fig. 3. Left flow meter Adast js6 8500.06 with calibrate reservoir and the right engine speed sensor

Fig. 4. Measured tractor Zetor 122 45

3. RESULTS AND DISCUSSION

Test measurements of the experimental system were implemented in the area of the Slovak Agricultural University in Nitra. We performed the journey by road paved with measured tractor has been loaded byanother tractor. During the measurement, we have focused on the overall reliability of the system, and we verified accurate capture using a calibrated fuel tank, as well as to indicate the gear. In order to prevent data loss, the computer recording the measured values stored in the RAM first, and always after 10^{th} minute of recording, system performs the automatic data backup to USB flash drive.

Graph of one of the test measurements are shown in Figures 5,6, and 8. During this measurement, we recorded the transmission ratio, i.e. the ratio between the vehicle speed and engine speed at which we then assigned a serial number falling transfer.

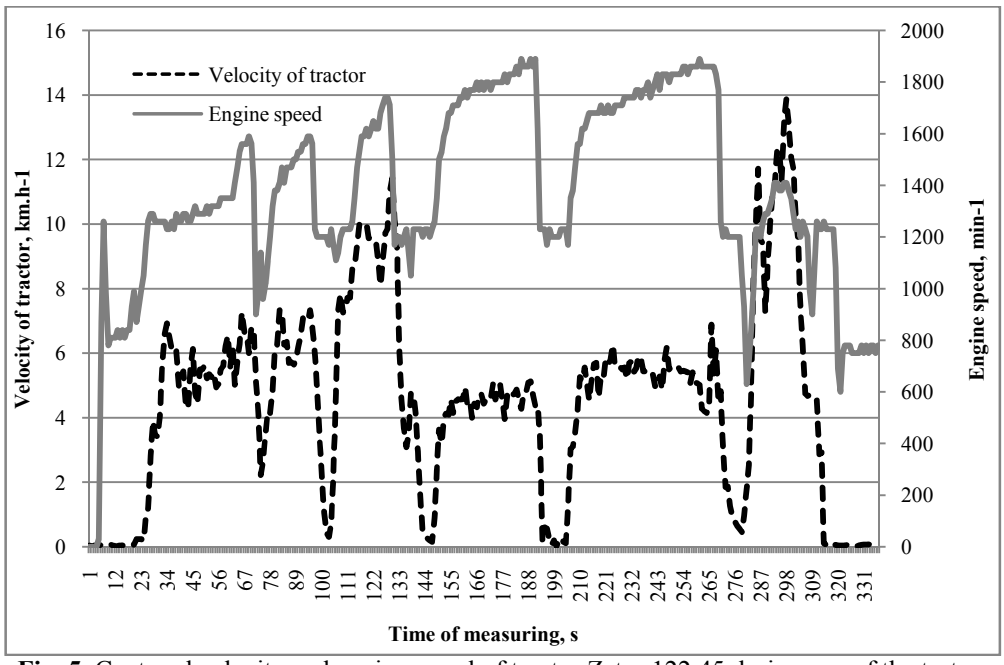


Fig. 5. Captured velocity and engine speed of tractor Zetor 122 45 during one of the tests measuring

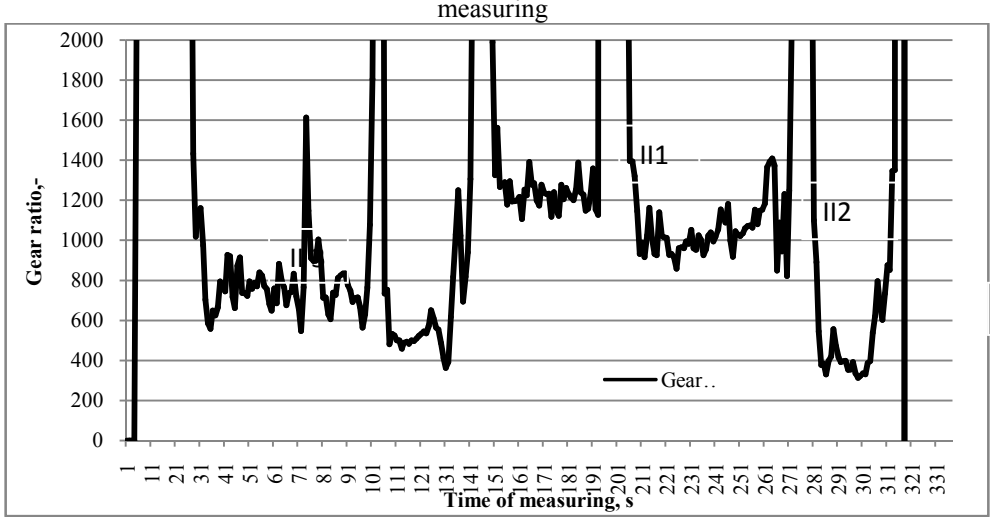


Fig. 6. Gear ratios of tractor Zetor 122 45

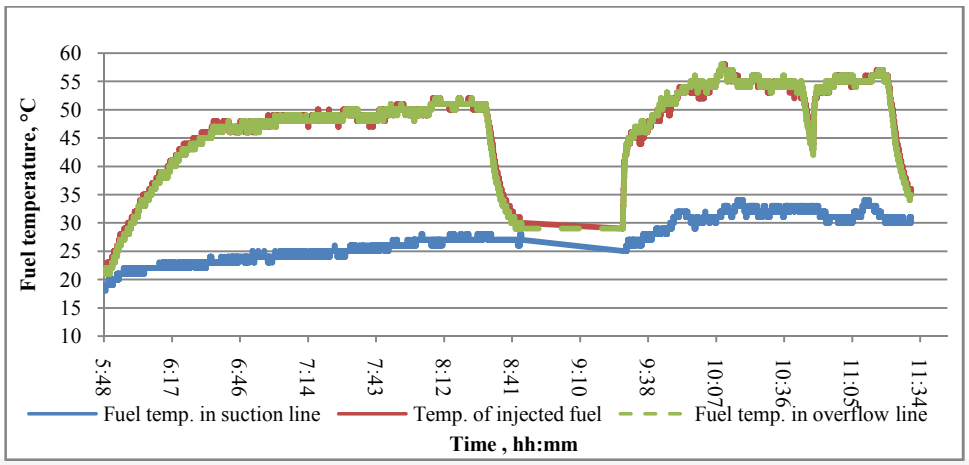


Fig. 7. Sample temperature of gasoil in the suction branch, branch discharge and overflow pipes

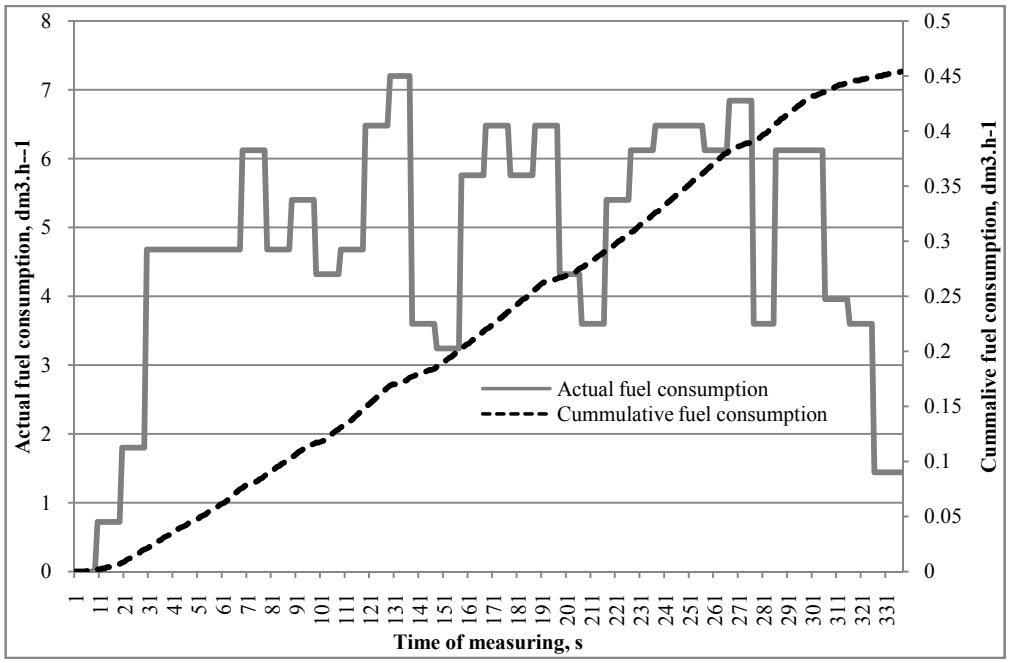


Fig. 8. Captured fuel consumption of tractor Zetor 122 45

Comparing the amount of fuel consumed indicated by flow meter refill the fuel tank in a calibrated we observed a maximum deviation of 1.98% which corresponds to the tolerance of this type of flow meter.

The measuring system reliably record all sensed values. Despite frequent vibration avoid loss record of the measurements. In spite of low range of gear ratios and an indirect method of measuring vehicle speed to avoid inaccuracies detection gear.

4. CONCLUSION

Systems for monitoring operating parameters of vehicles have proven to be an effective and reliable tool to monitor the traffic. Due to the openness of the system proposed by us in terms of freedom of connectivity with different reading devices and defining different operating conditions can also be an effective tool for the solution to reduce the cost of operations vehicles.

5. REFERENCES

[1] Bajla J, Tóth, J. (2006): Predikcia pracovných odporov náradia na základe penetračných meraní. In: *Traktori i pogonske mašine*, roč. 11, 2006, č. 2, s. 11-19.

[2] Bajla J, Tóth J, (2007): Návrh nosiča snímačov s nožovým meracím zariadením. In: *Traktori i pogonske mašine*, roč. 12, 2007, č. 2, s. 37-41.

[3] Čupera J, Šmerda T, (2009): Fuelconsumptionmeasuringbased on CAN-BUS data in comparisonofcoriolismassflowmeterresults. In : Advances in automotiveengineering, Volume II, Proceedingsofscientificpápers. Nitra : Slovak UniversityofAgriculture in Nitra, 2009. ISBN 978-80-552-0256-3, s. 88-92.

[4] Kadleček B, Ružička M, Pejša L, (2009): GPS dataprocessingusedformeasuremntofvehicle´sdrivedynamics. In : Advances in automotiveengineering, Volume II, Proceedingsofscientificpápers. Nitra : Slovak UniversityofAgriculture in Nitra, 2009. ISBN 978-80-552-0256-3, s. 72-79.

[5] Kadleček B, Ružička M, Pejša L, (2009): The Dynamics ofdrive and fuelconsumtion. In : Advances in automotiveengineering, Volume II, Proceedingsofscientificpápers. Nitra : Slovak UniversityofAgriculture in Nitra, 2009. ISBN 978-80-552-0256-3, s. 80-87.

[6] Jablonický J, Tkáč Z, Sloboda A, Majdan R, (2009): Palivová sústava traktorových motorov a princípy regulácie vstrekovacích čerpadiel 1. Časť. Strojník mechanik : časopis pre stavebných a poľnohospodárskych odborníkov. 2009. Roč. 2, č. 4, s. 28--31. ISSN 1337-6888.

[7] Mullerova D, Jablonický J, Hujo Ľ, Kosiba J, (2011): Detectionofemision in combustionenginesexhaust. In Machines, Technologies, materials, vol.5,2011,no 4, p. 53-56.

[8] Semetko J, Janoško I, (2005):Zisťovanie parametrov traktorov. Nitra : SPU v Nitre, 2005. ISBN 80-8069-553-9, 140 s.

TESTIRANJE *SISTEMTOSENSING* A ODABRANIH PARAMETARA TRAKTORA

Chrastina J, Janoško I, Polonec T

Rezime

Ovaj rad se fokusira na operacione testove novo razvijenog sistema za praćenje tehničkih eksploatacionih karakteristika traktora i vozila. Sistem omogućava praćenje trenutnu i kumulativnu potrošnju goriva, brzinu, pozicija itd. i pomoću matematičkih odnosa stepena prenosa prepoznaje i obaveštava operatora o optimizaciji vožnje. Sistem izračunava vrednosti po osnovu trenutnog režima kao što su zagađivači vazduha, emisija izduvne grane, stvarne performanse i potrošnju goriva. Deo materijala i metoda opisuje funkcije i karakteristike senzorskih elemenata kao i učešće i osnovnih matematičkih odnosa. Cilj ovog rada je da se se proveri pouzdanost u realnim uslovima rada. Rezultati su predstavljeni u delu grafičkih prikaza izabranog merenja zajedno sa opisom.

Ključne reči: sistem praćenja, GPS, traktor, potrošnja goriva.

ACKNOWLEDGEMENTS

Article was supported by the Ministry of Education project VEGA 1/0857/12 Reducing adverse impacts of agricultural and transport technology on the environment.

Primljeno:05.02.2013 Prihvaćeno: 21.02.2013