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FUTURE TRENDS IN DESIGN OF CONSTRUCTION AND AGRICULTURAL MACHINES

New trends in design of construction and agricultural machines are apparent mainly in aims that they should achieve e.g. economic transport, more efficient work technologies, environmental protection etc. The controlling process of building or agricultural technologies is often very similar. This operational control includes e.g. laser methods that operate construction and agricultural machines by means of total station; Global Position System (GPS) with a mobile map utilization that controls construction and agricultural machines etc. The mutual combination of these systems can be seen as well. Stability analysis of the system implementation is to be done in Czech Republic. The main reason for the analyses is eventual wearing out of firm's machinery. The paper describes the mathematical model of laser control and dozer's work technology with the utilization of GPS and laser.

***Keywords**: construction machines, agricultural machines, GPS, laser, work technology*

1. Introduction

The design and utilization of modern construction and agricultural machines represent an area with the dynamic economy and technical development. Mainly in agriculture these machines play a key role and they are the main driving force of work efficiency increase and the increase of total production volume. They decrease simultaneously labour costs as well.

The base of the machines is usually designed as a wheel or caterpillar undercarriage. Every machine can be equipped with different additional working tools. These facilities change the machine's use from a single-purpose into a general-purpose – e.g. dozers, loaders, excavators, scrapers, graders and tractors.

Through the last fifteen years the amount and quality of provided services significantly and rapidly increased in the Czech Republic. The services are offered with a significant emphasis on the individual approach to customers with the aim to satisfy completely customers' requirements. Services with adequate quality can be only provided with a support of implemented modern technologies – mainly in agriculture. The implementation of technology represents not only direct investment but relatively heavy investment in software and hardware or indirect investment associated with a company's structural changes, employee training etc. Every company will be, sooner or later, face to the problem of modern technology implementation. The utilization of modern technologies is the only way to increase quality of offered services and to decrease company's operational costs.

One part of these modern technologies is automatic control or automatic operational methods. These methods consist of procedures (set of methods) and technical facilities ensuring the most effective control (based on utilization of economy - mathematical theory of control including the means for information collection, data transfer, storage and processing used in a decision-making processes).

The design of construction and agricultural machines' control will be lead not only in a direction of a modern structural element design but in a direction of machines' economical utilization, new work technologies and complete environmental protection. It is very probable that it includes modern methods of work control of agricultural machines as well – especially laser methods operating by means of a total station; global position system with a mobile map utilization etc.

Some of companies use the outworn machinery in the Czech Republic from time to time. That is why the stability analyses must be carried out before the laser equipment's implementation. The paper describes and proposes solution of this problem on the example of dozer's utilization.

2. Mathematical model of laser machine control

The main requirement for the dozer's equipment function is the earthmoving work with leveled (plane) terrain by a ploughshare blade. The level should be parallel with the laser plane at a distance of H_0. During the machine's operation the blade of working tool follows the terrain unevenness ΔH_t and it deviates from the required plane.

A system utilizes the negative feedback principle; it means that the system is reacting against changes moving itself out of its balanced condition. Considering a speed when the process runs, it is necessary to deal with a stability of the proposed circuit by utilizing of frequency transfers in order to ensure a harmonic curve of the given quantities.

System description – (see Fig. 1): Receiver **P** will forward a signal to amplifier **Z** and, after that, to evaluation unit **VJ**, which will produce a signal for opening servo valve **SV**, which controls the tool hydraulic engine **HM**. The hydraulic engine corrects a deviation $\mathbf{\Delta H_n}$ by shifting the blade by $\mathbf{\Delta H}$, which will bring it back to its original required position. We use either direct or indirect working tool elevation control. The solution of direct control is described in a following text only. One of its features is the incorporated servo-valve into a high-pressure circuit. The primary advantage of this solution is a direct and quick control of HM hydraulic engines. The disadvantage of the solution is the disruption of the high-pressure circuit and the increased through-flow and pressure load of the control circuit. The circuit can become unstable and it has to be checked. The **1/p** term is a pure integration element used for formal mathematical transfer from the motion speed to the position. This system is the positioning system.

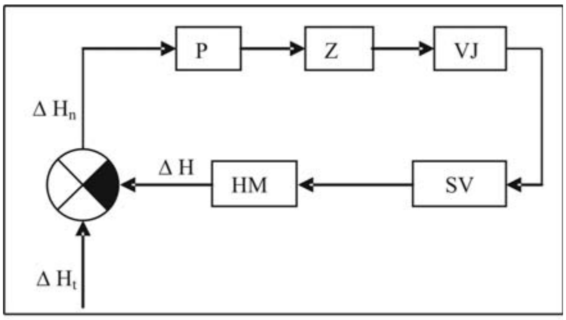

Fig. 1. Classic mechanized technology

3. Stability of solution

The stability of the proposed circuits was solved by means of the Michailov – Leonhard criterion. In this case it necessary to take into account the right side of the equation only – as a function of a complex variable. The left side of the equation has no impact on the circuit stability.

The notation of equation $M(\omega)$ of the n^{th} order is a parametric notation of the stability limit of the Michailov curve, which describes a stable circuit only when:

a) $M(0)>0$ – curve $M(\omega)$ starts on the positive half of the real axis;

b) $\lim_{\omega \to \infty} arg\, M(\omega) = n \cdot \frac{\pi}{2}$

The equation describes the direct control of a tool position and it is an equation of the 5[th] order. If the solution is to be stable, the Michailov curve has to start on the positive half of the real axis and it also has to run through 5 complex plane quadrants.

$$\lim_{\omega \to \infty} arg\, M(\omega) = 5 \cdot \frac{\pi}{2} \qquad (1)$$

The equation describes the indirect control of tool position and it is an equation of the 6[th] order. If the solution is to be stable, the Michailov curve has to start on the positive half of the real axis and it also has to run through 5 complex plane quadrants.

$$\lim_{\omega \to \infty} arg\, M(\omega) = 6 \cdot \frac{\pi}{2} \qquad (2)$$

4. Conclusion

The level of automation of industrial processes has become the growth measure and the growth factor in recent years. As in other branches electronic systems are widely applied into construction and agricultural machines especially at earthmoving machines of tractor type as well. This automation is used as in single structure elements as in machines' control. During the 90' the development achieved a goal from the simple and independent (functionally insulated) systems that indicate limited situations to warn machine's operator to the complex systems monitoring and controlling operational quantities. These systems are currently interconnected and the mutual systems' communication is created.

The most modern systems that control technological processes are based on data transfers between the main computer containing a construction site plans and the individual machines operating on that construction site. Machine's operators can get on-line information (display) presenting a relationship between their work results in comparison with the complete construction plan. They provided by machine's location information that includes the real and required surface condition. This situation allows operate more efficiently with the every machine, increase a work productivity and to decrease costs. For example, work efficiency of a dozer with a modern control system increased about 25% in comparison with a dozer using the usual work control system.

These supreme modern control systems represent a beginning of revolutionary changes in the field of earthmoving and agricultural works. Any later implementation of these modern methods can cause large economic losses. The success of companies on the market is, and it will be, dependent on the new technology utilization. This statement is valid quite generally and not only in civil and agricultural engineering.

5. References

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