CONTROL OF EFFECTIVENESS OF USE OF TILLAGE AGGREGATES

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Abstract: The efficiency of soil tillage units depends on many parameters, and stability of movement plays a big role among them. Control of this important indicator can be carried out with the help of acceleration sensors.
Keywords: tillage unit, acceleration, sensor, accelerometer.

In the practice of research to assess the operational parameters of mobile machines, it is of great importance to determine their traction and dynamic performance, as well as controllability and stability in various modes of movement. To determine these characteristics of mobile machines during operation at the present stage, it is necessary to use modern control and measuring instruments and complexes. In such measuring equipment, modern element base is used as sensitive elements, sometimes micromechanical inertial sensors are installed – three-component accelerometers Freescale Semiconductor model MMA7260QT.

The use of accelerometers in dynamic testing of mobile machines has become widespread in recent years [1, 2]. Research using accelerometers in testing mobile machines is currently legalized by international and national standards in a number of countries [3]. Accelerometers, which are widely used in the electronic systems of various mobile machines, can be used to study the dynamics of mobile agricultural units. In the process of obtaining reliable (complete) information about a moving object, it is necessary that each degree of freedom of the said object corresponds to a certain measuring axis. When using multi-component accelerometers with several measuring axes, the number of sensors is determined as follows

$$K_D = \frac{H}{n}, \quad (1)$$

where H – number of degrees of mobility (defined as the number of degrees of freedom relative to the fixed link;

n – number of sensitivity axes in one sensor.

It is known that the main operational indicator of an arable machine is its productivity W_h, which depends on Br and Vr, as well as on the coefficient of shift time utilization τ

$$W_h = 0{,}1 B_r \cdot V_r \cdot \tau, \quad (2)$$

where B_r – plow working width, m;

V_r – working speed of the plowing unit, km/h;

τ – shift time utilization factor.

Based on formula (2), we conclude that the highest productivity of the machine is ensured in straight and uniform movement. Consequently, it is necessary to ensure control in two axes, lateral deviation of the machine (axisУ) and uniformity of longitudinal movement (axisX). A material point has three degrees of freedom in three-dimensional space. To measure the parameters of its motion, it is enough to place one three-component accelerometer (with three inter-perpendicular sensing axes) at point *A*. The unit in three-dimensional space has six degrees of freedom, when installing three-component accelerometers, their number will be,

$$K_D = \frac{H}{n} = \frac{6}{3} = 2. \quad (3)$$

To improve the accuracy of movement and the reliability of the results of the plowing unit as a dynamic system, at least two sensors are required and the correct determination of the installation and orientation points of the acceleration sensors and their measuring axes. From the existing set of indicators that allow to assess the efficiency of a machine-tractor unit, the two most significant ones in the functioning of plowing units are operational and technological. These indicators cover a wide range of issues and are in a complex functional relationship. We propose one way to control the efficiency of the units. The required number of measuring axes for these tests is determined depending on the number of degrees of mobility of the mobile machine, and the influence of their positioning accuracy on the measurement error in operation. Each direction of independent movement of the object must correspond to one measuring axis of the acceleration sensor. If this does not happen, then if the required total number of measuring axes is met, some of the independent movements of the object will not be observed, and some will be duplicated [4]. This issue requires additional research. To do this, it is necessary to increase the accuracy and reliability of the results of dynamic tests by ensuring the observability of mobile machines as dynamic systems by correctly determining the installation points and orientation of the measuring axes of acceleration sensors.

To achieve this goal, it is necessary to solve the following tasks: to build possible physical models of mobile machines; to determine the rational installation points of linear acceleration sensors and the directions of orientation of their measuring axes. The construction of a physical model of a mobile machine is possible for the simplest, often used in modeling, is a single-mass model of a mobile machine.

References

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