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EXPERIMENTAL RESEARCH FACILITY FOR PRELIMINARY RESEARCH OF MEASUREMENT METHOD WITH 3D TOUCH PROBE BY TOUCH SIGNAL[9]

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Abstract: *For coordinate measurements with the 3D touch probe, the measuring tip of the stylus must touch the measured surface. As a result, a signal is generated that is used to determine the coordinates at the control point. With mass-triggered constructions, this signal is generated when the nib base is disrupted and a normally closed loop is interrupted. Because of the peculiarities of the structure, the signal is delayed after the touch. The delay is the cause of the so-called zone of insensitivity. The magnitude and unevenness of this area in the space, and especially in the XY plane, negatively affects measurement accuracy. In order to compensate for the zone of insensitivity, calibration is usually performed, which has shortcomings and limited capabilities in measurements on machining centers. Different manufacturers of 3D touch probe, offer their designs with a smaller and more uniform zone of insensitivity. These models, however, have a higher cost and have additional requirements for the work environment. The publication explores the possibility of using a signal from the closing of a normally open loop in contact of the measuring stylus with the measured surface. In order for such a scheme to work is requires the stylus and the measured object to be electrically conductive.*

Keywords: *Accuracy, 3D Touch probe, Efficiency, Zone of insensitivity*

INTRODUCTION

As known for making coordinate changes on machining machines and in particular machining centers, 3D touch trigger probe (TTP) are used. They are basically the type using a kinematic resistance system. In them a characteristic feature is the presence of a large and uneven zone of insensitivity (Dimitrov 2007 - 2017). This is an obstacle to accuracy and makes it difficult to carry out such measurements. Reducing the impact of the non-sensitivity zone is possible by applying calibration or set-up (Dimitrov, Karachorova, V., Szecsi, T 2012, 2014, 2015). This is an approach having at establishing the magnitude of the zone of insensitivity in the respective direction of measurement to be corrected for the result. This is done in the same way as the planned calibration. The control surface of the caliper is most often in the form of an inner cylindrical surface. Another approach is to incorporate an additional sensing element in the measuring head that reduces the zone of insensitivity. The first approach is impractical with a supposedly large number of different directions of measurement. The second approach leads to an increase in the cost of the TTP used and imposes additional restrictions on the working medium.

EXPOSITION

This paper considers the possibility of using the TIG coordinate measurements not to use the signal from its kinematic resistance system, but a signal that would arise when a circuit was closed between the measuring tip and the object being measured. To make such an approach feasible, it is necessary that the measuring tip of the TTP and the object to be measured be electrically conductive.

Further investigation of the applicability of this approach requires preliminary experimental checks. For this purpose it is necessary to develop a suitable experimental setting. In Fig. 1 is a schematic diagram of the main components of the device.

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It is shown in the diagram that TTP 3 is located in a three-pinch machines collet 2 to the rotating table "C" 2 of the 5-coordinate machining center MC032, which is has by the Laboratory of MECHANICAL AND MANUFACTURING ENGINEERING at the department of TMME of the University of Rousse. In the figure, the table "A" of the machine is in position 0 °. By means of the

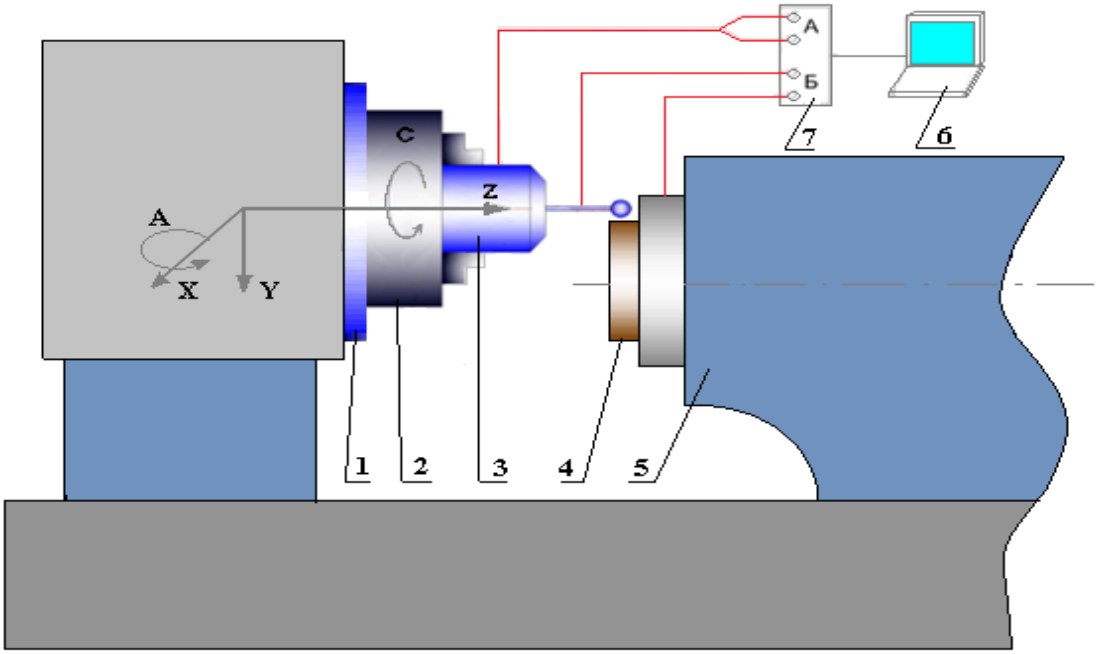

Fig.1. Principal scheme of the experimental setup

TTP measuring tip, contact coordinate measurements are made at the same point of the spindle 4 of the node 5 with vertical measurement movements performed with displacements along the linear axis Y of the machine. With the set table position "A" with the rotating table "C", it is possible to test the operation of TTP at different angular operating positions and directions of measurement in the XY plane. In other positions of table A, TTP behavior can be investigated in space.

The experimental setup also includes an analog-to-digital converter 7 (ADC) and a PC 6 with incoming signal processing software.

The operating principle of the experimental setting and the possibilities to manage the conditions for carrying out the experiments are the following:

1. The measurement system is ready.

2. Using the measuring program introduced into the machine's CNC system, a Y-axis measurement cycle is performed with iterations, the number of which can be changed as desired.

3. The speed of the displacement measurement can be set infinitely within the scope of the feeder yield on the Y axis of the machine, which in this case is 1 ÷ 2000 mm / min.

4. The angular position of the TTP can also be varied with discretion, corresponding to the discretion of the table positions" C" of the machine, which in this case is not less than 0.001 °.

5. Measurements generate two signals. One is by closing the electrical loop "B" through the TIG measuring spindle and the spindle 4. The other is the standard signal from the existing kinematic resistance system in TTP.

6. he two signals arrive at the ADC, and from there, after appropriate processing can be removed and compared different features using specialized software.

7. For the specific studies related to the determination of the zone of insensitivity, it is necessary to establish the difference in time between input of the two signals.

8. At a certain velocity of displacement in the Y axis measurement and a time difference between the two signals, the magnitude of the TTP sensitivity zone at a selected angular position corresponding to a selected measuring direction in the XY plane can be calculated.

A preliminary research to determine the factors influencing the process of generating a touch signal is planned. Among them, the main ones are:

- the type and characteristics of the electrical signal used to record the touch of the contact pairs. The condition is the signal should ensure reliable touch recording at minimal energy cost.

- the material and quality of the contact pairs. As a result, the limit of the method application of the electrical conductivity which depends on homogeneous and heterogeneous contact pairs materials can be determined.

- the magnitude of the measurement effort. It is necessary to determine the minimum value of the measuring unit, which is sufficient for a reliable measurement.

Research to determine the effects that interfere:

- contamination of contact surfaces. In many cases, different types of cooling liquid are used in cutting operations. Part of it remains on the surface of the workpiece after finishing the machining. It is necessary to investigate the extent to which the presence of such a liquid will influence the formation of the measurement signal in the contact pairs.

- accompanying vibrations. Coordinate measurements on a machine centers are performed under conditions associated with interfering processes. One of them is the vibrations. The vibration source may be the machining center itself or the machines that are nearby.

The expected outcome of the theoretical and experimental studies is to clarify the significance of each of the above factors on the touch signal generation process, to determine the limits of applicability, and possible approaches to limit all the interferences.

Experimental studies require special measuring equipment - voltage generator, oscilloscope and program environment for receiving and processing signals and outputting results.

In Fig. 2 shows an oscillogram obtained in a TEN RENISHAW test vertically (A = 0) and a probe length of 50 mm. When the touch probe touches the signal, the R signal drops sharply. The opening of the contact system in 3D touch probe (signal Q) occurs after further displacement, with a significant area with a smooth change. In this case the distance between the switching of the Q and R signals is 8 μm.

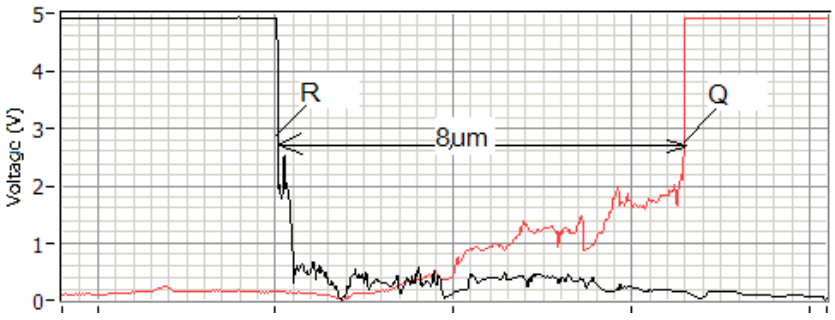

Fig.2 Pathway for 3D touch trigger probe RENISHAW

CONCLUSIONS

An experimental setup has been developed to provide an experimental test to determine the TTP insensitivity zone under different conditions.

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