TOOL MSUREMENT SYSTEM BASED ON REFLEXIVE INFRARED OPTICAL SENSOR

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ABSTRACT: The paper presents the design and implementation of an automatic tool measurement system using a infrared reflective optical sensor.The system in used on the TMA 5 axis machining centre for tool measuring purposes, having the capability of autonomous operation, the measuring process is done automatically by the CNC equipment.
KEYWORDS: tool measurement, flexibility, optical sensors.

1. INTRODUCTION

The system developed at the University of Oradea for tool measurement is an autonomous system for tool verification. The flexible manufacturing system is equipped with an ATR function.

Based on an algorithm several tools can be loaded or unloaded from the TMA 5 axis machine, depending on the existing tool list in the machine storage unite and based on the tool list of the work pieces to be manufactured in the system.

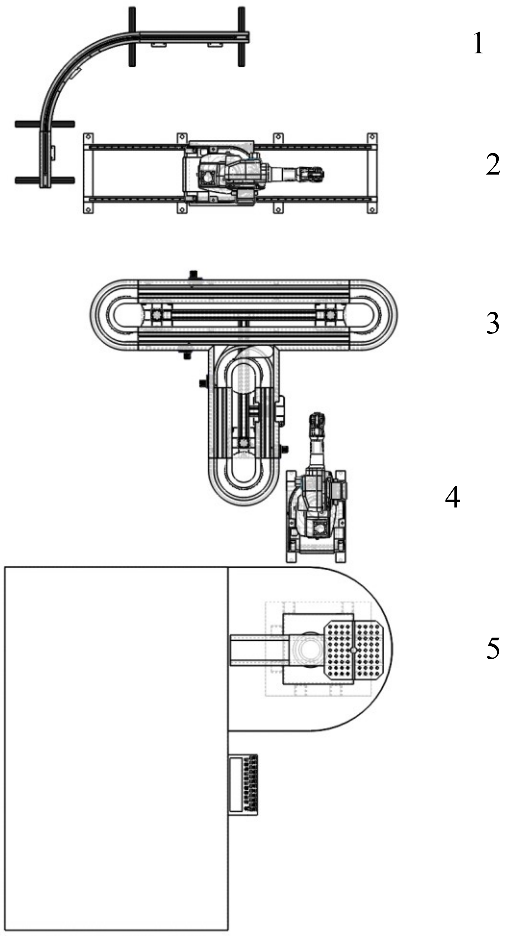

Figure 1. Structure of the flexible manufacturing cell[4]

The main components of the FMS are: TMA 5-axismachine-tool controlled by Fanuc CNC (position 5), two ABB IRB 1600 robots with SCHUNKPNG 100 grippers[5], (position 2 and 4), an ASRS for the storage of the pallet with work-piece, finite product and tools[5], (position 1) and a conveyor system (position 3).

The ATR function is designed to exchange tools between the storage system (position 1) and the tool storage of the machining centre (position 5). The tools are transferred using the same path and components as the raw materials and finished razing the error probability.

Although the flexible manufacturing system has an RFID based solution for monitoring the flow of materials through the system an additions system for tool measurements has been developed.

The tool measurement system is developed to run automatically and can determine if the tool being measured has the same parameters an existing in the database.

The geometric error of tools used in machine tools is a constant research subject, being approached using on machine calibration system [1]

The real time determination of tool errors system and angular straightness and machining performance is presented in [2].

The data acquisition of machine tools is presented [3]

2. STRUCTURE OF THE MESURING SYSTEM

The first challenge in designing the system was the necessity of holding the tool which in solved by having the measured tool in the main spindle of the

CNC machine. Thus the measuring system is located in the work area of the machine, namely on the tombstone device of the machine.

The data regarding the machine is obtained through the CNC equipment. Top realise this a wireless system was realised. The structure of the measuring system is presented in figure 2.

The structure of the system needs the use of a wireless data transmitter and a rechargeable battery to power the mobile part of the system.

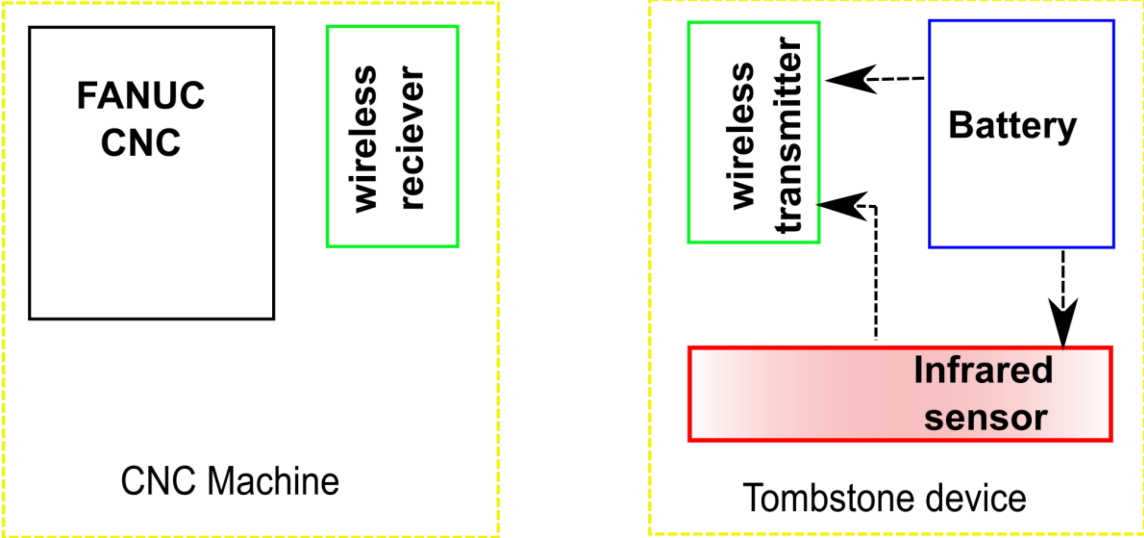

Figure 2. Structure of the measuring system

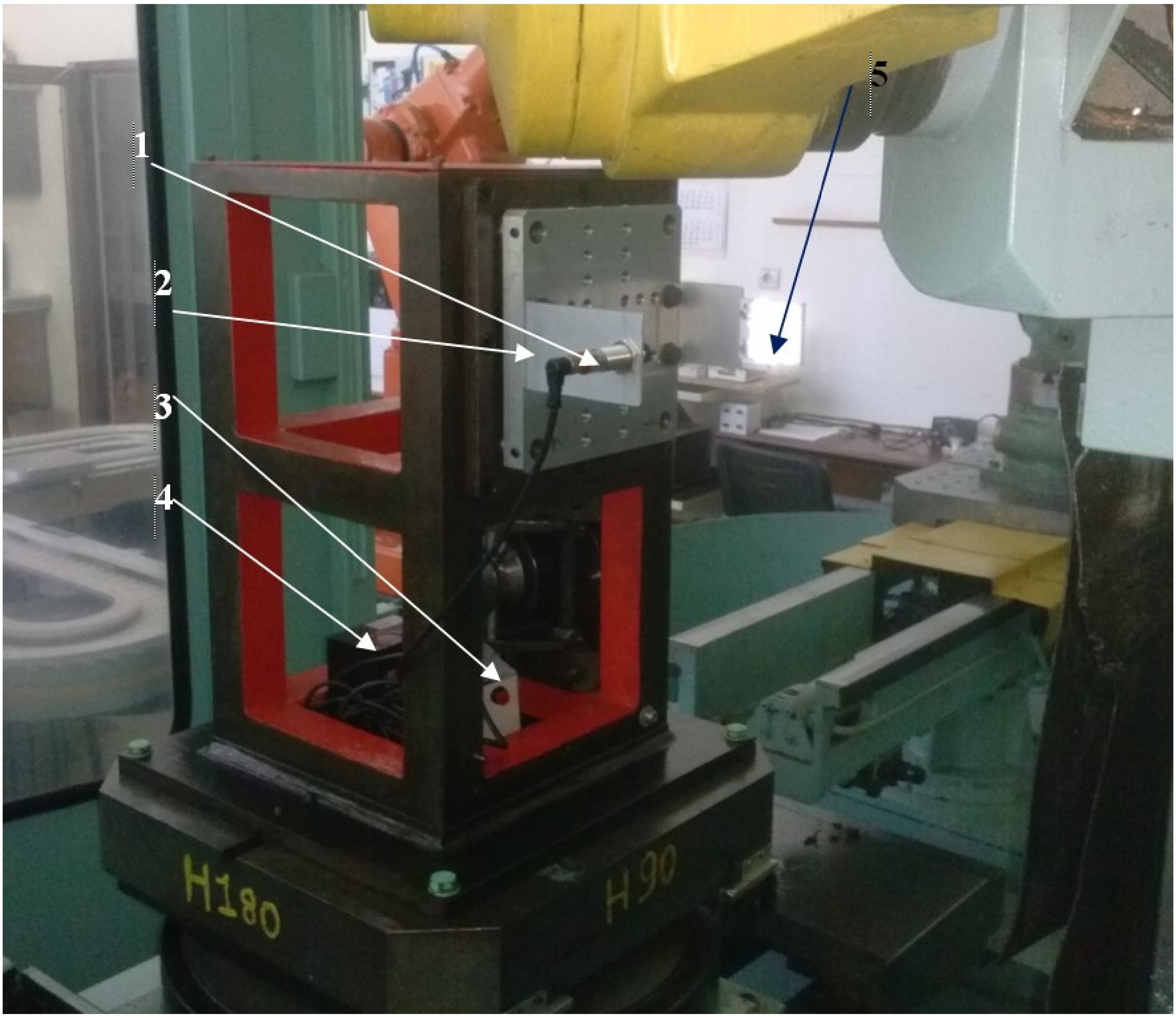

Figure 3. Overview of the system mounted on the 5 axis CNC machine.
1-IMO sensor, 2- jig, 3- wireless transmitter, 4- battery, 5- mirror.

The structure of the measuring system contains the reflective optical sensor mounted on a specially designed jig. The jig is mounted on the tombstone device existing in the workspace of the system.

In figure 3 the system if presented, mounted on the tombstone device of the 5 axis CNC machine.

The system uses an IMO sensor type DM2/0-1H, which is an M 12 miniature photoelectric switch. The main characteristics of the sensor are presented in table 1.

Table 1. Characteristics of the IMO sensor used for the application [6]

Characteristic	Value
Nominal sensing distance	100 mm
Emission	Infrared (880nm)
Tolerance	+15%/-5%
Repeat accuracy	5%
Operating voltage	10-30VDC
Load current	100mA
Output type	NPN/PNP – Light On/Dark On selectable
Switching frequency	400Hz
Interference by sunlight	10000 lux
Protection degree	IEC IP67

The used sensor in presented in figure 4

Figure 4. INO DM2/0-1H sensor [4]

The measurement system is powered by a 12V battery, 4500mAh. Data transmission from the sensor is done by means of a wireless data transmission system. System operates at 433 MHz frequency. The system has an 6 channel transmitter module, and a receiver module with 6 relay outputs

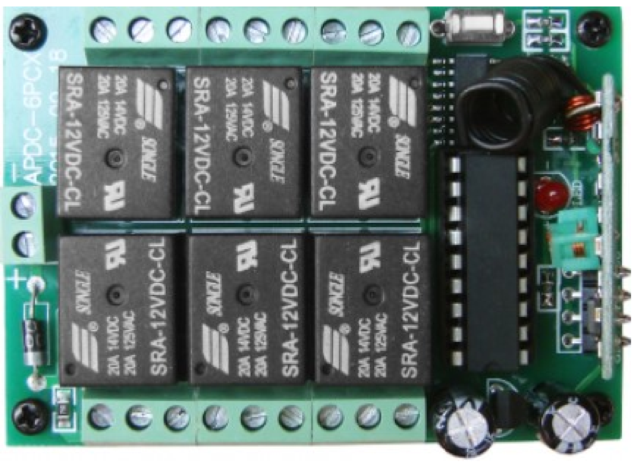

Figure 5. Receiver module used for the measuring system [5]

The transmitter module has its own power source. The sensor output is connected to a relay which. The relay contact replaces one of the contacts of the transmitter module. When the sensor detects an object, the relay is activated ant the transmitter module is activated. The diagram in presented in figure 5.

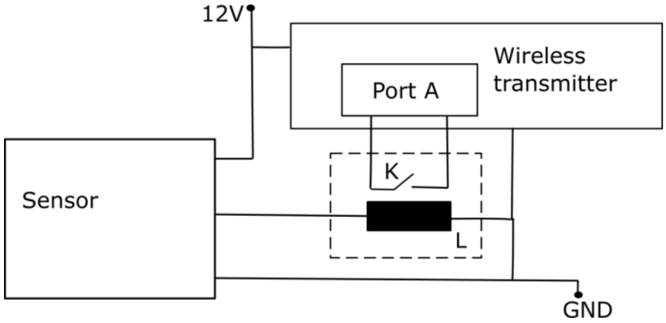

Figure 6. Connexion diagram for the transmitter part of the system.

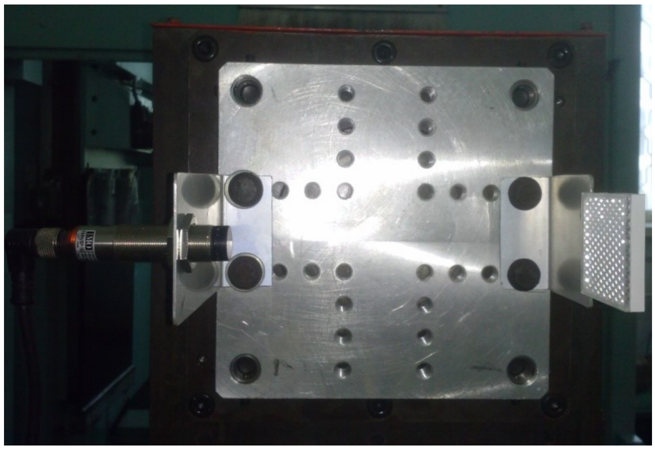

Figure 7. Front view of the system [1].

The assembled system is presented in figure 6. The system is mounted on the tombstone device, which mounted on the work table of the machine is controlled by the CNC equipment.

The receiver module is mounted on the CNC machine. the relay output of the module is connected to the CNC equipment output. Also the power for the module is provided by the CNC. Based on this characteristic, the CNC has been set up to control the system. Two functions have be declared and implemented to activate and deactivation the measurement system, namely M27 for activation and M28 for deactivation. This allows the user to start or stop the measuring system just as any function of the CNC machine.

There are two ways to realise the measurements using the system. The first method involves using TOOL MESUREMEN functions existing ready implemented in the CNC equipment, permitting sweeping of the tool in manual mode, or it is possible to carry out a program of measurement that can be called by a processing program to verify dimensional tooling located at the level the central the manufacturing centre.

Figure 8. Receiver module mounted on the CNC machine [4].

3. MEASUREMENT APPLICATION

Beside the existing and implemented application in the CNC equipment for automatic tool measurements, a separate application has been developed.

The application uses parametric variable to store and transfer data. Using the application and the system presented above information about the tool dimensions can be obtained.

The measuring system has a fixed location on the tombstone device (position 2) fixed with the mounting device (position 3, 5). The beam is reflected using a mirror for reflexive sensors. The tool (position 4) is mounted in the spindle of the machine tool (position 1).

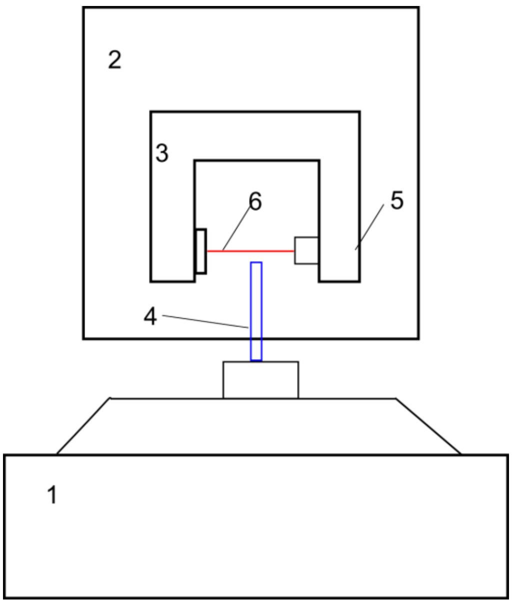

Figure 9. Measuring schematic for tool length

To determine the tool length of the tool mounted in the main spindle of the machine, the X and Y coordinated are loaded form predetermined variables. The system will move the table on the X axis at the centre point, meaning that the centre of the spindle will correspond with the centre of the measuring system. The same procedure is done on the Y axis. The Z axis is moved at maximum distance from the spindle as the machine setting allows it. All this movement are done with the maximum linear speed of the machine.

After all these setting have been automatically done by the machine, the measurement has is initiated. The X and Y axis are kept in position; the only movement is done by the Z axis. The movement of the axis is done at a low speed.

The movement on the axis is continued until the tip of the tool interrupts the beam of the sensor. When the beam is interrupted, the sensor will give an output triggering the relay (Figure 6). The relay will, activate the signal generator of the system and the receiver will give an HI signal to the corresponding port of the CNC equipment. The low speed in necessary at this stage to avoid overshoot of the travel on Z axis.

When the CNC equipment receives the signal from the measuring device, the data for the Z axis is read and the calculations are made for the tool length.

The procedure is similar for the tool diameter, with the difference that the procedure is done while keeping X and Z axis constant and also is done with an approach from Y+ and an approach form Y-.

The system has advantages regarding the flexibility and the capability of transmitting data to the machine whiteout the need of a cabled connection between the CNC and the work space.

The disadvantages of the system are caused by the influence of the tool position relative to the sensor. If for determining the tool length the tool is located closer to the sensor (tool being closet to the point where the beam is emitted) the precision is improved. Setting the parameter in this way could be problematic for tool with a large diameter. Also the speed of the approach is important, overshoot in this case being directly added as an error to the length of the tool.

This system does not have the precision required be used as an tool ware measurement system, but does give to the FMS the ability to determin if the tool mounted in the spindle has the same tool data (length and diameter) as those specified in the data follow of the system.

4. ACKNOWLEDGEMENTS

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