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THE DEVELOPMENT OF VISUAL POSITIONING SYSTEM

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ABSTRACT
This paper is oriented on application of artificial intelligence in robot control systems with emphasis on image processing. Positioning system using algorithms, methods and vision analyze was designed to non-collision manipulation. The main part of positioning system is positioning table with turning movement. Object recognition and its non-collision positioning are realized by developed visual positioning system.
Keywords: Computer Vision, positioning system, robot, manipulator, control system

1. INTRODUCTION

Robotics is one of famous application areas of artificial intelligence. Intelligent robots always use sensors. The sensors collect and analyse every kind of information. After analysis robot can correct its attitude and choose the next step (adaptive control). Adaptive control can be applied in cognitive robots.
The basic process in cognitive systems is: reading, processing and decisions making.
The systems working like adaptive control systems can do: way detection, direction detection, distance planning, object recognition, etc.
Main task digital images analyse for robot AC is pattern recognition, which is used for processing of robot interaction in surrounding, shape and orientation identification. Mathematics methods are used for image analyse in continuous plane, transfer from Euclid plane to raster plane, they contain Fourier – transformation, filtration, light correction, segmentation, contour, morphological transformation, sceletation and identification of edges.

2. DESIGN OF POSITIONING SYSTEM

Visual Positioning Software (VPS) provides object identification an object positioning towards robot grip without collision on two workplaces at the Department of Machining and Automation, Faculty of Mechanical Engineering, University of Žilina.
The first workstation is on training robot SLR 1500 with 6 DOF. Second workplace is on portal manipulator based on pneumatic parts by company SMC. Manipulator will realize simple assembly and sorting of parts. These two workstations are used for teaching of robotic and manipulating systems and for solving problems of design and control these systems.
Both workplaces are used to solution non-collision manipulation, shape recognition, sorting and recognition each part, also to detect bad parts. Positioning system using algorithms, methods and vision analyzers was designed to non-collision manipulation.

2.1. Positioning table design

The main part of positioning system is positioning table with turning movement which main job is to turn element into non-collision position. In this position, effector can take the element. Table is made from stand and round board (Fig. 1).

The stepping motor SMR 300-300 in stand realize turning of the round table. Round table is attached to shaft of stepping motor. Colour of the positioning table is opaque white. It is because of the contrast between part and background. Shape analyzing needs good contrast. Advantage of stepping motor is its precision.

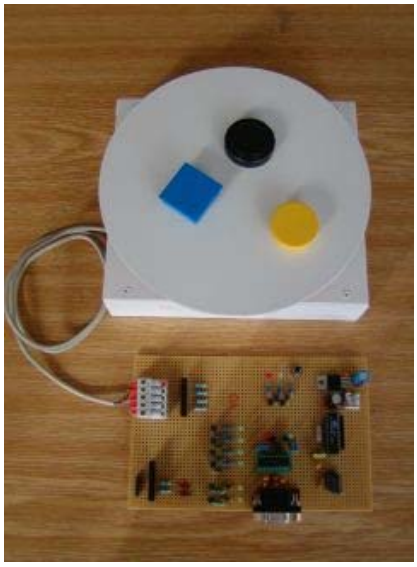

Figure 1. Positioning table

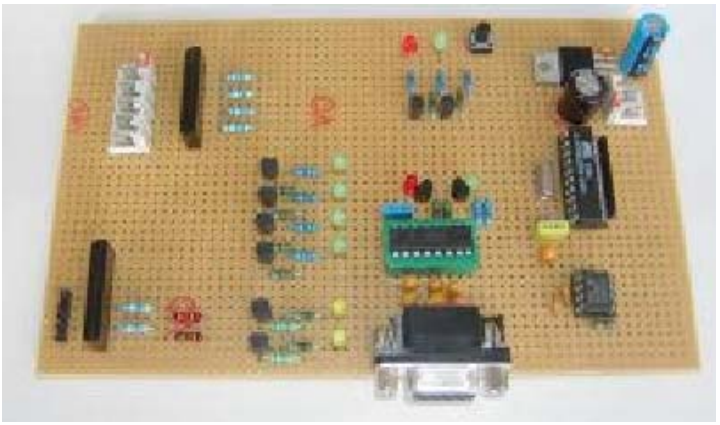

Figure 2. Control unit A51 KM

2.2. Control unit design

Control unit (CU) based on microcontroller ATMEL AT 89C205 labelled A51KM controls stepping motor. Schema of CU is in Figure 2. Motor is connected by cable through connector CUM/CUF 5/5 to the CU. Cu generate control impulses for stepping motor in wanted directions and number of steps.
Supplying circuits and voltage stabilizer make 5V for microcontroller and other circuits of CU with integrated stabilizer LM 7805. The main part of the CU is 8-bit microcontroller AT 89c2051 which cover with 20 outlets is put in socket. Microcontroller contains 128B of internal RAM memory and 2kB internal FLASH EPROM memory of program. Microcontroller is clocked by external crystal on 11.0592MHz. Serial port of CU is made by integrated circuit MAX323 providing conversion of 5V TTL to 12 V. There is 9-pin connector to connect serial conductor. Serial link signal is made from RXD, TXD and GND serial ground. Transistors C546B and LED diodes provide triggering circuits KM and indication of regulation status KM. External control is realized by button. Main job of triggering circuits is amplification of control signals from microcontroller from TTL 5V level to 12V/0.5A. This function is provided by monolithic integrated circuit STA401A.
CU is connected by RS232 through CANON connector to control computer. It enables control round board from computer. CU A51KM communicates with control computer through designed and implemented communication serial protocol.
Communication protocol is made from two basic commands:

- command ID – identification,
- command RUN – movement of stepping motor.

User interface was created to control and check hardware.
Communication protocol enables to turn positioning table 65 536 steps what is 294 912°. Use of RS 485 could enable communication with more equipment.

3. VISUALIZING POSITIONING SYSTEM DEVELOPMENT

Object recognition and its non-collision positioning are realized by visualizing positioning system.
Designed program recognizes changes in given part of scene and find out presence of an object. It is provided by the row image function.
Then the function of automatic recognition and parameterization (position, colour, shape, and angle) triggers.

If there is known object, the number of steps is calculated and the direction is chosen in non-collision way. Then effector can snap part.

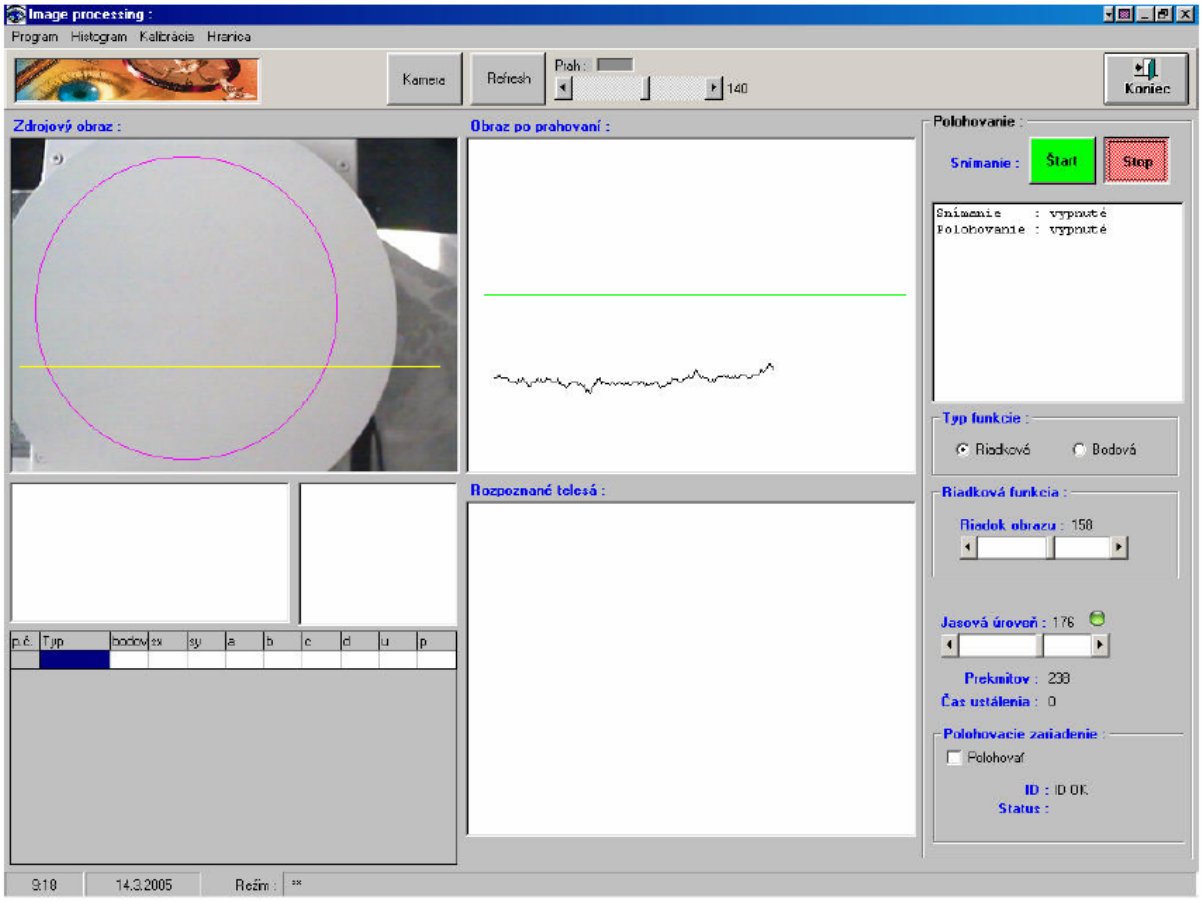

Figure 3. User interface of software – positioning table without part

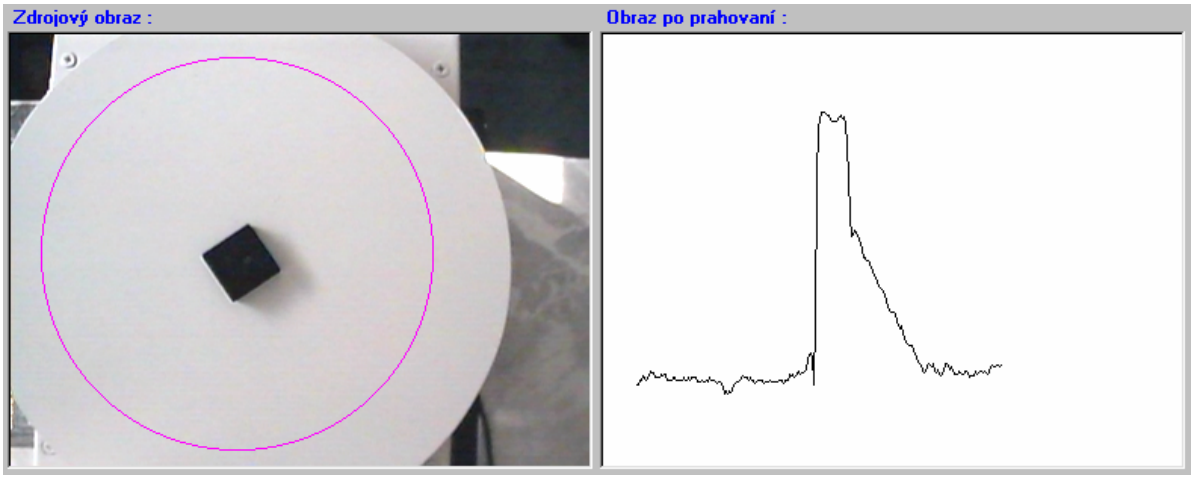

Figure 4. Object position detection

If the positioning function is enabled, it sends command to the CU of stepping motor A51KM to rotate round board. After finishing of rotation, it reports it and waits for removing the object. After removing object, it starts from beginning.

Start button switch on positioning process and *Stop* button switch it off.

Figure 5 and 6 illustrate activity of positioning system using vision recognition in application of robot SLR 1500 and portal manipulating system. Precision is enough in both cases. Maximum divergence is 4,5° what is one-step of used motor SMR 300-300. To increase the precision it is possible to use other motor or use gearbox.

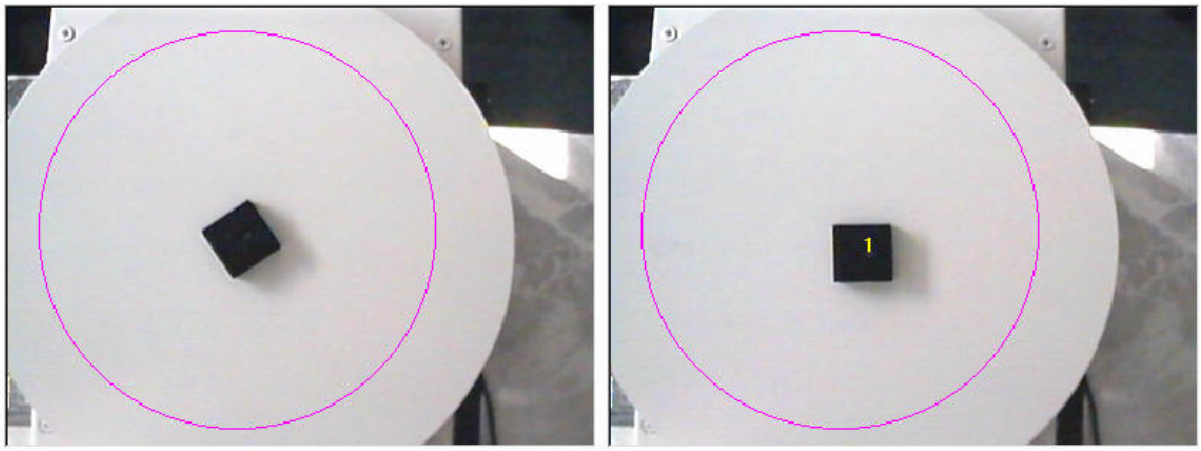

Figure 5. The table before and after positioning

Figure 6. Example of part non-collision positioning for manipulator gripping with pneumatic effector

4. CONCLUSION

The algorithms for image processing and object recognition in picture were designed at our department on basis of theoretical knowledge. Functions can be supplemented, modified and utilised with creating of control software and system.

Positioning system using algorithms, methods and vision analyzers was designed to non-collision manipulation. The main part of positioning system is positioning table with turning movement. Control unit is based on microcontroller ATMEL AT 89C205 labelled A51KM, it controls stepping motor. Object recognition and its non-collision positioning are realized by developed visualizing positioning system.

5. ACKNOWLEDGEMENT

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