THE MANIPULATOR CONTROL SYSTEM ON THE STEP MOTORS AND SERVO DRIVES

Maxim Trofimov

Saint Petersburg State University of Aerospace Instrumentation
Saint-Petersburg, Russia

maxtrof2@gmail.com

Abstract

This article describes the manipulators control system on the step motors manipulators and/or servodrives. The system consists from the software with the graphical interface that can run on different platforms, and the control board. These development bases on three principles: simplicity, functionality and expandability. The task – to create an automation system, which at a minimum costs for the implementation and staff training would be consistent with the specified requirements.

I. INTRODUCTION

Currently, all the leading manufacturing facilities have the automated conveyors. However, the costs of automation for small business are too high, and existing solutions in their majority are too specific. For this reason, it often used the individual developments. The universal solution would reduce the costs for the implementation and would widen the range of such systems implementation.

II. COMPONENTS

Motors control board is based on the microcontroller Atmel ATMega16. The location of the contacts is shown on Figure 1.

A microcontroller selection was determined due to its flexibility and affordability. The program has been implemented on C language in the CodeVisionAVR medium. microcontroller operates from a built-in generator, which have the enough accuracy.

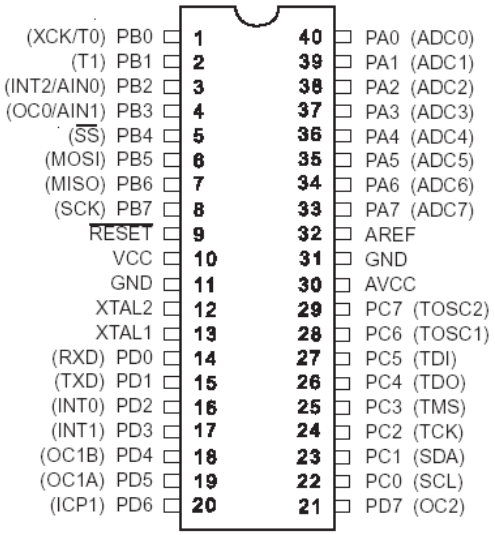

Fig. 1. The location of the contacts ATMega16

The implementation of the firmware was carried out by means of PonyProg2000 through the in-circuit programmer of the COM port (Figure 2).

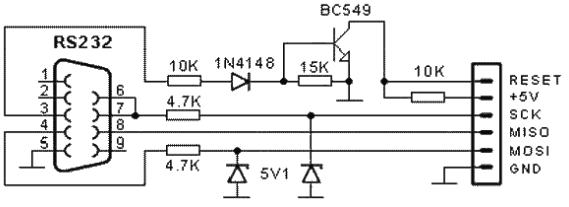

Fig. 2. In-circuit programmer of the COM port

Communication with PC was realized via USB port by means of FT232RL microcircuit. The system easily connects to a desktop PC as well as to the laptop. The scheme is shown on Figure 3.

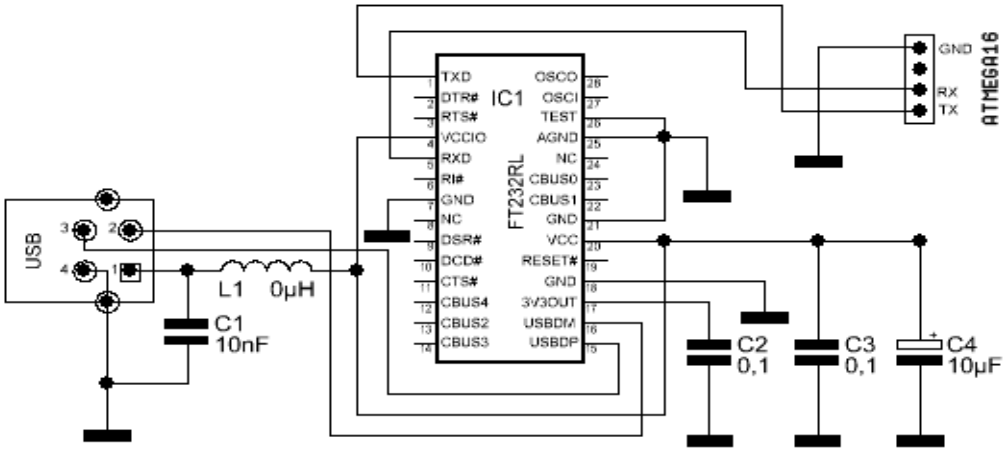

Fig. 3. Connection of the microcontroller to the PC USB port

For the system testing it was assembled the arm-manipulator with 6 degrees of freedom.

Engines – servodrives Power HD High-Torque Servo 1501MG (shoulder, elbow, wrist bends) and Springrc SM-S4306 (hand turn and grip) (diagram on Figure 4).

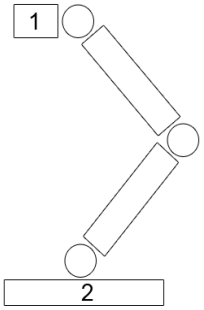

Fig. 4. Scheme of the manipulator
(1 – Grip, 2 – Base)

III. THE ALGORITHM OF WORK

Both drives are controlled by pulse duration. For 1501MG – sets its rotation, for the SM-4306 – the speed of rotation.

The signal from the PC (the number and angle of rotation/speed), which passes through the FT232RL enters the USART interface of the microcontroller, which processes the signal and sends the acknowledgment to a PC for the failures tracking (RX and TX microcontroller pins).

The format of commands arriving at the control board is identical to the format of the commands from the most of the servo controllers manufacturers (Pontech, New Micros, Pololu, Net Media, Lynxmotion, Picobytes, Parallax), so that in conjunction with the program, we can use almost any control board.

All mathematical calculations are due on the software. Thus, the delays between the arrived command and its implementation are minimized.

For the video control it was implemented two cameras (for the obtaining of the coordinates in three-dimensional space). It is possible the tracking of the particular shade or object (the objects are detected by means of Speeded Up Robust Features «SURF» algorithm). The location of the cameras for the hand tracking is shown on Figure 5.

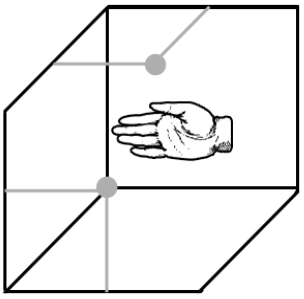

Fig. 5. Obtaining of the hand coordinates of the hand in three-dimensional space

During the process of the software development, the considerable part of work was aimed at the implementation of the maximum number of options for the control of the manipulator. This approach greatly extends the applicability and usability of the program during its implementation.

As the control commands can be used:

– the angles of engines rotation;

– the coordinates of the point. Software calculates the angles of the drives rotation, during the possibility a few variants - find the most effective;

– movement path;

– video control (for example, the repeating of the user movements). In case of following after the tone – detects the largest by the area region, and

calculates the coordinates of its center. During the movement used smoothing in order to prevent the excessive vibration;

– the sequence of commands (for example, movement from one object to another object). By means of video camera obtains the coordinates of the object (s) that are used as the waypoints.

IV. EXAMPLES OF USE

The main examples of use are:

– "dangerous" works, work with chemical/radioactive materials. Operation is performed by repeating of the operator's arm movements, control - through the vision cameras;

– working with the conveyor, for example, finding of the defective products and removal of such products from the assembly line (using of the defective products images array in the role of reference points);

– student's research;

– CCTV systems.

The universality of this system lies in the fact that all the control scripts are specified by the user and does not require any special knowledge. It is enough to select a way of operation and set the reference points, or "show" the movements.

p

V. CONCLUSION

The developed system can be used both for training purposes and for small industries, as the cost of the final unit will be much less than the factory counterparts.

The assembling process of the manipulator housing takes no more than 3-4 hours. Parts are made from sheet of steel in 2 mm of thickness by means of laser cut.

The stand can be used as laboratory works for students, for algorithms testing.

Currently, the algorithm of the full human hand movements repeating is under the development process (for the present moment the manipulator moves only after the hand, wrist flexion/extension t is not implemented).

It is planned to add the ability to set a new laws and algorithms of the drives movement directly into the program without changing the source code. Thus, the software can be used for a wide range of the scientific developments.

REFERENCES

[1] Houde,S., and Hill, C. (1997) What do prototypes prototype?, in Handbook of Human Computer

[2] Jef Raskin, The Humane Interface: New Directions for Designing Interactive Systems

[3] Herbert Bay, Tinne Tuytelaars, Luc Van Gool "SURF: Speeded Up Robust Features" Available from:http://www.vision.ee.ethz.ch/~surf/eccv06.pdf

[4] ATmega16 Datasheet