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EDUCATIONAL ROBOT - “ROBCO” SCARA

N. Chivarov, N. Shivarov, P. Kopacek and S. Shivarov

Abstract: *ROBCO SCARA is a five degree of freedom educational minirobot consisting of base, three links and a gripper all driven by stepper motors. Graphical User Interface for easy control of ROBCO SCARA is developed to allow for both manual (by keyboard commands) as well as automated (by execution of automated control scripts) user control and configuration. Command Line Interface for Family of Educational Robots ROBCO is an interface allowing the user to control the robot using simple text input and output through RS-232 serial interface using common terminal programs (Hyper Terminal, PuTTY, etc.) or custom software that communicates through PC’s serial (COM) port (hardware or emulated through USB, etc.).*

Key words: Educational Robots, ROBKO SCARA, Graphical User Interface, Command Line Interface

1. Introduction

The **SCARA** acronym stands for **S**elective **C**ompliant **A**ssembly **R**obot **A**rm or **S**elective **C**ompliant **A**rticulated **R**obot **A**rm.

In 1981, Sankyo Seiki, Pentel and NEC presented a completely new concept for assembly robots. The robot was developed under the guidance of Hiroshi Makino, a professor at the University of Yamanashi. The robot was called Selective Compliance Assembly Robot Arm, SCARA. Its arm was rigid in the Z-axis and pliable in the XY-axes, which allowed it to adapt to holes in the XY-axes. By virtue of the SCARA's parallel-axis joint layout, the arm is slightly compliant in the X-Y direction but rigid in the ‘Z’ direction, hence the term: Selective Compliant. This is advantageous for many types of assembly operations, i.e., inserting a round pin in a round hole without binding.

The second attribute of the SCARA is the jointed two-link arm layout similar to our human arms, hence the often-used term, Articulated. This feature allows the arm to extend into confined areas and then retract or “fold up” out of the way. This is advantageous for transferring parts from one cell to another or for loading/ unloading process stations that are enclosed. SCARA's are generally faster and cleaner than comparable Cartesian systems. Their single pedestal mount requires a small footprint and provides an easy, unhindered form of mounting. On the other hand, SCARA's can be more expensive than comparable Cartesian systems and the controlling software requires inverse kinematics for linear interpolated moves. This software typically comes with the SCARA though and is usually transparent to the end-user.

2. ROBCO SCARA

ROBCO SCARA is a five degree of freedom educational minirobot, which is very good test bed for education of students, young specialist and researchers. It’s consisting of base, three links and a gripper all driven by stepper motors and is suitable for a variety of applications in service and industry. Having our Robot – ROBCO SCARA as a good example tool for learning about robotics, we have developed Educational stand for demonstration of one possible example of use of a ROBCO SCARA.

Let us realize a physical model of a stand with ROBCO SCARA for simulated manipulation of medical flask carrying modeled specimen’s of hospital laboratory items (imitating urine, blood or other liquids via colored water) see figure 1. Our SCARA robot is equipped with a specialized gripper of a scissor type for soft grasping of the "necks" of the glass flasks (having built in force sensor for avoiding breakage of the glass necks from applying greater closing force. The robot is installed on the middle of a wooden platform having some "nests" for a safe placing of the flasks by the robot and has a "Z" axe movement for lifting them. There is one neutral nest for placing the new incoming flask and other nests for replacing the "incoming" flask there for an eventual further "processing". The idea is to use this stand being installed on the back of a mobile robot platform, which is "circulating" between the hospital laboratory and some doctor's places where the specimen’s "will be taken" from the patients. This experimental model is used by the students for teaching the robot to get a new flask from certain outer "nest", to take it "on the board" of the mobile platform and than to replace it to the certain free nest for transportation to the hospital laboratory. On the way the robot can pick another specimen from different doctor's room and similarly place it in another free nest. This simple model is very informative for the students who are realizing a "real" task.

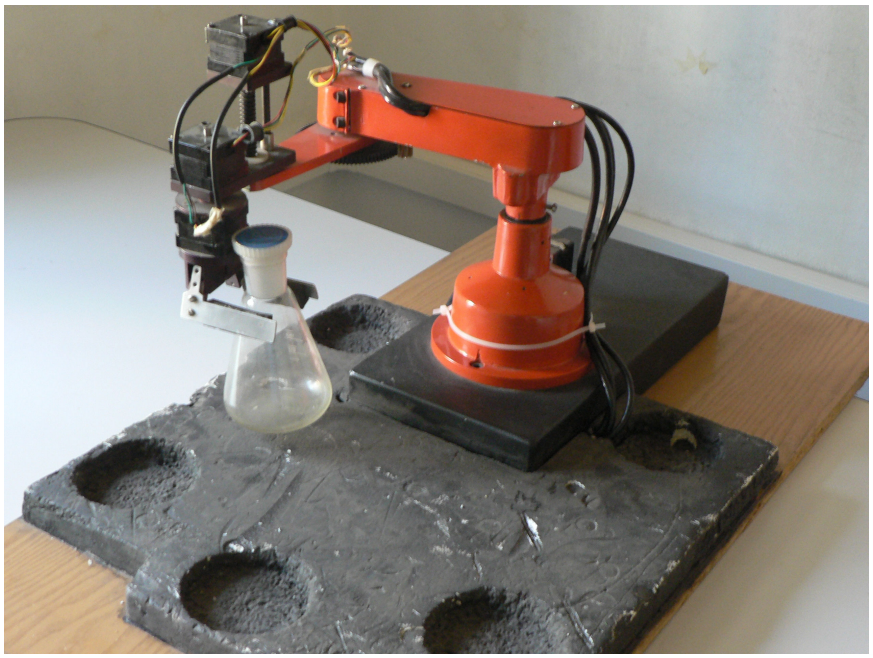

Fig1. ROBCO SCARA

3. Control System of the ROBCO SCARA

The common block diagram of the robot is shown on figure 2. All electronic control modules are interconnected by a system bus. That gives an extreme flexibility and scalability to the whole architecture for performing the largest possible range of tasks of the Robot.

All commands to the Robot are passed and processed by the control module Robot Controller. The distribution of different queries and commands to different modules, self-test and detection of system's configuration, as well as the whole robot intelligence at high level is performed by the embedded software of the controller using the system bus Robot System Bus. The immediate control of the stepper motors is implemented by separate intelligent electronic modules. Those modules care on one hand for communication with the Robot Controller using specially designed communications protocol and on the other hand for the immediate physical control of stepper motors. On Fig. 2 an example is shown for a few stepper motors controlled by intelligent modules.

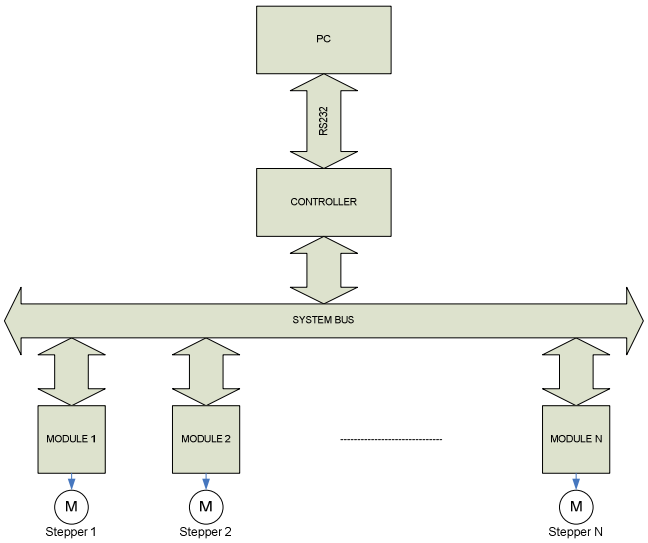

Fig. 2 Control System of Educational Robots – ROBCO SCARA

The position of actuator mechanism can be monitored by counting the steps from its starting point (the position in which the power is turned on), controlled by the motor and on query – transmitted to the Robot Controller. Modules also implement basic functions for electrical overload protection and other low-level functions.

For the purposes of easy user control over the Robot, a set of commands is defined and supported by its Robot Controller. We created an interface that provides the means for user access to the Controller and its command set – the Command Line Interface (CLI) which is a simple text console for inputting commands and displaying the results.

4. Graphical User Interface

The Graphical User Interface (GUI) is provided as a means of easy configuration and control of the Robot Arm through a PC serial port. It allows for manual as well as automated robot control and configuration of some important parameters (figure 3).

The interaction between an operator and the Robot Arm is implemented by software on the host PC.

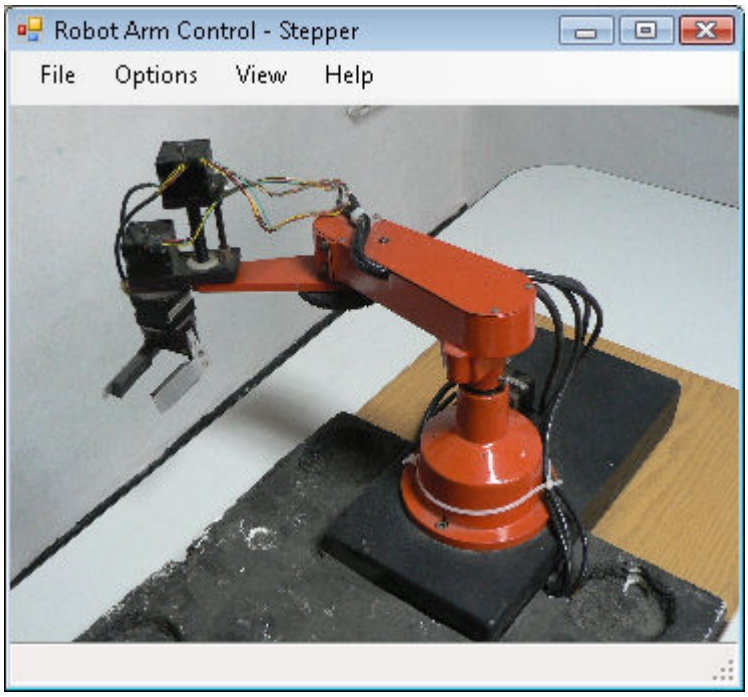

Fig. 3 ROBCO SCARA Graphical User interface

The software is developed using Visual Studio Express and provides for the following functions:

- Manual control of individual joints of Robot Arm using a mouse or a key from the keyboard;
- Monitoring the state of all joints and the Robot Arm as a whole;
- Programming series of actions (scripts) that can be executed automatically later;

The software has 4 items in the main menu: File, Options, View and Help.

The File option allows for saving and restoring robot positions and scripts.

The Options menu contains items for assigning and changing keys for different actions. The View menu contains options for changing Robot’s image appearance in the main program’s window.

Help item contains instructions of how to operate with the software.

5. Command Line Interface

Command Line Interface (CLI) is an interface to Robot’s Controller, allowing the user to control the robot using simple text input and output through RS-232 serial

interface using common terminal programs (Hyper Terminal, PuTTY, etc.) or custom software that communicates through PC's serial (COM) port (hardware or emulated through USB, etc.).

This interface allows for custom robot control using user software written in any language (i.e. C++) that utilizes PC's COM port (real or virtual) to send text commands to CLI.

An example control scripts for ROBCO SCARA program execution are presented below.

```
// Prepare "brake" mode where necessary
st 0 -b
st 3 -b

// Go to flask
bw 0 5 4200 0 -s

// Close grabber
bw 4 5 6000 0 -s

// Lift
bw 2 5 3500 0 -s

// Go to the new position
fw 0 5 2100 0 -s

// Descend flask
fw 2 5 3500 0 -s

// Open grabber (release the flask)
jg 4 5 0 0 -s

// Return home
jg 0 5 0 0 -s
```

6. Conclusions:

Having our Robot – ROBCO SCARA as a good example tool for learning about robotics, we will develop a family of mini Robots for a variety of applications in service and industry.

Educational Robotics is very good test bed for education of students, young specialist and researchers and is necessary for all technical schools, colleagues, laboratories and Universities.

Literature:

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Authors Data:

Nayden Chivarov, Dr. techn., Central Laboratory of Mechatronics and Instrumentation of the Bulgarian Academy of Sciences, Bloc II Acad. Bonchev str., Sofia 1113, Bulgaria, e-mail: nshivarov@code.bg

Nedko Shivarov, Assoc. Prof., Central Laboratory of Mechatronics and Instrumentation of the Bulgarian Academy of Sciences, Bloc II Acad. Bonchev str., Sofia 1113, Bulgaria, e-mail: nedko@code.bg

Peter Kopacek, Prof. Dr. Mult., Intelligent Handling and Robotics, Vienna University of Technology, Favoritenstr. 9-11, 1040 Vienna, Austria, e-mail: kopacek@ihrt.tuwien.ac.at

Stefan Shivarov. Mag. Eng., Code Assitance Ltd., 20, 20th of April str., Sofia 1606, Bulgaria, e-mail: shivarov@code.bg