

# Programming and Playing with RoboSapien Online

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**Abstract**—RoboSapien is famous human like robot toy intended for playing with, of interested in, of all ages, and learning through the game, of some basic characteristics of robots and robotic control. The programming of RoboSapien as described in user’s manual is limited with the internal memory, battery life, and not very convenient input of actions through the multipurpose buttons of the RoboSapien IR remote control device. In order to offer better conditions for experimenting and using of RoboSapien, the web user interface was developed, that provides interactive user control, programming of command sequences of arbitrary length, observing of RoboSapien actions using the web cam that shows the movements and actions on web page. Access and control of RoboSapien by remote user through the web page user interface, is controlled by access levels depending on whether the user is logged in or not. The whole system is implemented in C# as ASP.NET project with NI USB 6501 digital I/O driving the CMOS 4066 analog switches for controlling the RoboSapien IR remote control device.

**Index Terms**—RoboSapien, remote control, web user interface.

## I. INTRODUCTION

RoboSapien [1] is famous human like robot toy intended for playing with, of interested in, of all ages, and learning through the game, of some basic characteristics of robots and robotic control, shown in Fig. 1. It is shipped with small basic paper manual, IR remote control device, and all the rest is upon the interest and imagination of the new owner. Basic management and control of the robot is very easy to learn, and one quickly starts with successful exploration of the robot capabilities. Soon, everything that robot can do and “feel” through its sensors is known and



Figure 1 RoboSapien with IR remote control device

one starts to program it according to the instructions manual.

Although the RoboSapien can do a variety of movements with arms, legs and the body, that can be combined in various interesting sequences, soon it is clear that programming is limited with the robots memory, battery life, and not very convenient input of robots actions through the multipurpose buttons of the robots IR remote control device.

So, the problem appeared, how to make the RoboSapien easier to program, how to create the programs of non limited length, where to keep those programs, and how to show it to a number of others interested in?

## II. SOLUTION DESCRIPTION

RoboSapien itself does not offer some obvious and well exposed interface that can be used for control by computer. Disassembling of the robot might help, but it brings a risk of unintentional damage or simply not being able to reassemble it as it was.

The solution for building the convenient, almost 100% damage safe, universal programming interface was found in strict following of the user instructions manual – use the remote control device supplied with RoboSapien, shown in Fig. 2.

RoboSapien remote control device is large enough, and when opened, offers convenient contacts – places for soldering of many extra wires required for computer control of various buttons - manual switches, as shown in Fig. 3. The idea is to replace the manual press of button on remote control device, with computer controlled closing of electrical analog switch. The principal scheme of RoboSapien or just any other remote control device printed circuit board is shown in Fig. 4.



Figure 2 RoboSapien IR remote control device

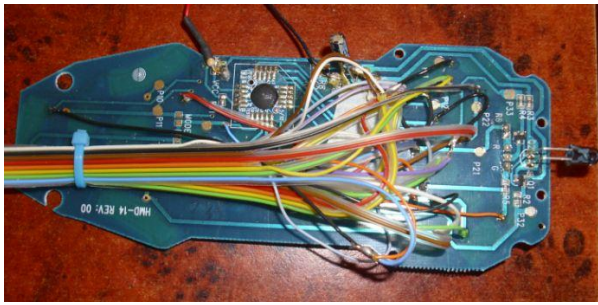


Figure 3 IR remote control with connecting wires

Comb like contacts provide convenient contact area when pressing the rubber buttons on remote control device. At some appropriate points A and B in Fig. 4, that can be easily found on RoboSapien remote control device printed circuit board, wires are soldered for connection with digitally controlled analog switch that is connected in parallel. The 4066 CMOS integrated circuit [2] with 4 digitally controlled analog switches in DIP package was used. Fig. 5 show the layout of integrated circuit contacts. Analog contacts have solid lines, while digital control line is dashed. Each of 4 digital control lines controls the corresponding analog contact. For 16 analog contacts from RoboSapien IR remote control device, 4 x 4066 IC's were used.

### III. SYSTEM ARCHITECTURE

Digitally controlled analog switches on 4066 IC are driven by the NI USB-6501 [3] with 24 programmable digital input / output lines, as shown in Fig. 6. The NI 6051 digital I/O device is connected to and controlled by the software on web server in RoboSapien web control system. Rest of the system architecture is very similar as in previous web experiments [4]. Fig. 7 shows the general system architecture with main hardware and software components. Microsoft Windows 2008 Web server runs the Microsoft Visual Studio 2010 C# ASP.NET project which implements the web user interface for RoboSapien. Web page in Fig. 9 represents the web remote control for RoboSapien.

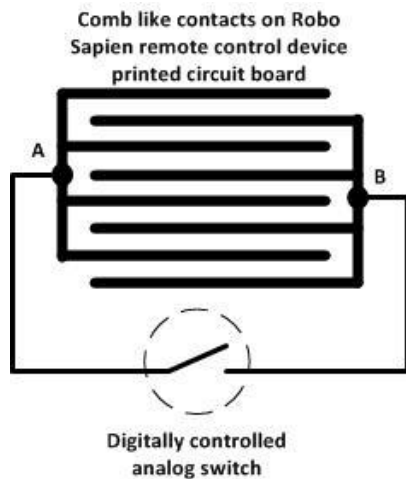


Figure 4 Contacts on remote control device printed circuit board

### Analog switch 4066

Analog CMOS switch. A switch is closed if the appropriate control line is HIGH, otherwise it's open.

#### Pinout

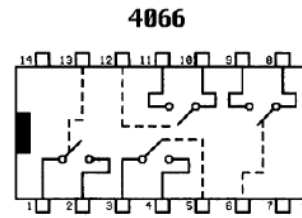


Figure 5 CMOS 4066 integrated circuit

Web cam provides visual feedback for a remote user. C# code uses NI-DAQmx [5] class library for controlling the NI USB 6501 digital output lines. Separate C# program running on web server catches picture from the web cam and creates jpeg snapshot file that changes few times per second. JavaScript code in user's web browser periodically refreshes the image from the web cam on a web page

Besides the web server, Microsoft 2008 SQL Express server supports the login service for remote web users and provides convenient memory for defining sequences of RoboSapien commands, programs for RoboSapien. In that way, using the web user interface, remote user with adequate privileges (logged in) can define / memorize in the SQL server database, arbitrary sequences of elementary commands / movements that RoboSapien can perform. Selected, previously memorized program can be played / run, and observed at web page.

### IV. SYSTEM FUNCTIONALITY

RoboSapien web page shown in Fig. 9 consists of 3 main functional areas. In the lower left part of the web page are image buttons for RoboSapien commands, arranged in square area, and resembling the remote control device as shown in Fig. 8. Buttons with arrows are for robot movements - ↑ forward, ↓ backward, ← left and → right. Square button with inner orange square is STOP button that stops the RoboSapien in any action, and also serves for RoboSapien "wake up" after a shorter period of inactivity, when RoboSapien does not react on other buttons. Button with wide arrow directed upwards in the



| Module  | Terminal | Signal     | Module  | Terminal | Signal |
|---|----------|------------|---|----------|--------|
|  | 1        | GND        |  | 17       | P0.0   |
|   | 2        | +5 V       |   | 18       | P0.1   |
|   | 3        | P1.7       |   | 19       | P0.2   |
|   | 4        | P1.6       |   | 20       | P0.3   |
|   | 5        | P1.5       |   | 21       | P0.4   |
|   | 6        | P1.4       |   | 22       | P0.5   |
|   | 7        | GND        |   | 23       | P0.6   |
|   | 8        | GND        |   | 24       | P0.7   |
|   | 9        | P2.7/PFI 0 |   | 25       | GND    |
|   | 10       | P2.6       |   | 26       | GND    |
|   | 11       | P2.5       |   | 27       | P1.0   |
|   | 12       | P2.4       |   | 28       | P1.1   |
|   | 13       | P2.3       |   | 29       | P1.2   |
|   | 14       | P2.2       |   | 30       | P1.3   |
|   | 15       | P2.1       |   | 31       | +5 V   |
|   | 16       | P2.0       |   | 32       | GND    |

Figure 6 NI USB 6501 digital I/O lines

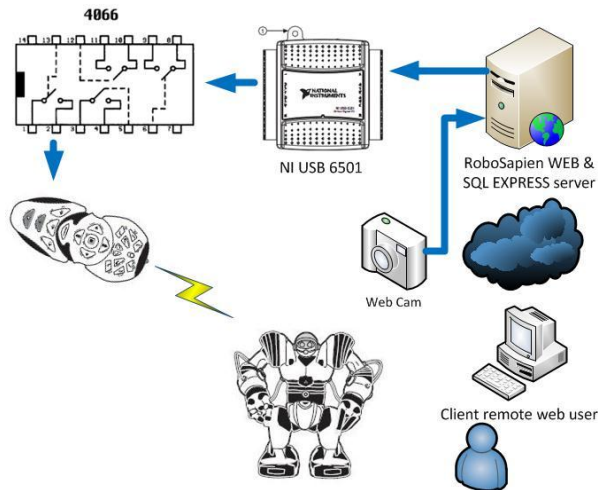


Figure 7 RoboSapien web system architecture

second row next to STOP button is SELECT or SHIFT, which serves for altering the functions of command buttons, in the same way as it is described in the user manual. On the right from command buttons is live picture from the web cam that shows movements of RoboSapien as the commands on the right are issued. In the upper part of the web page are some controls for creating programs – command sequences for RoboSapien. In order to make the RoboSapien safe from possible undesired actions, commands for all movements are disabled for users – guests that are not logged on. Guests are welcome to try all other commands – with all movements of arms and body tilt, including the SELECT command. List of registered users is kept in systems SQL server database. Login page is accessed from the hyperlink in the upper right of the web page. Registered users have also the privilege of creating RoboSapien programs – sequences of elementary commands available from buttons on web page, and also the playing / running of existing programs / command sequences. Logged user also has the exclusive control over RoboSapien, leaving other potential users with possibility of only watching.

Current colors of “START recording” and “STOP recording” buttons show the current status of recording / playing. START button enabled – red, and STOP button disabled – gray, indicates playing mode, when the user can interactively play with commands or start playing of some existing program from the “Existing programs” drop down list. Pressing the START button changes the mode in recording, when the START button becomes disabled – gray and STOP button becomes enabled – red. When some command button is pressed in recording mode, that command is memorized in proper sequence and added to list box on the left from START button. If some command button is mistakenly pressed, “DELETE command” button removes the last memorized command, while repeated pressing of “DELETE command” button removes memorized commands in sequence. Pressing the “STOP recording” button, finishes the recording mode and toggles to playing mode. Memorized commands are saved under the unique name in “New program name” text box after the SAVE button is pressed. Existing program can be deleted with selecting the program name in the

Red Commands directly control RoboSapien's movements.

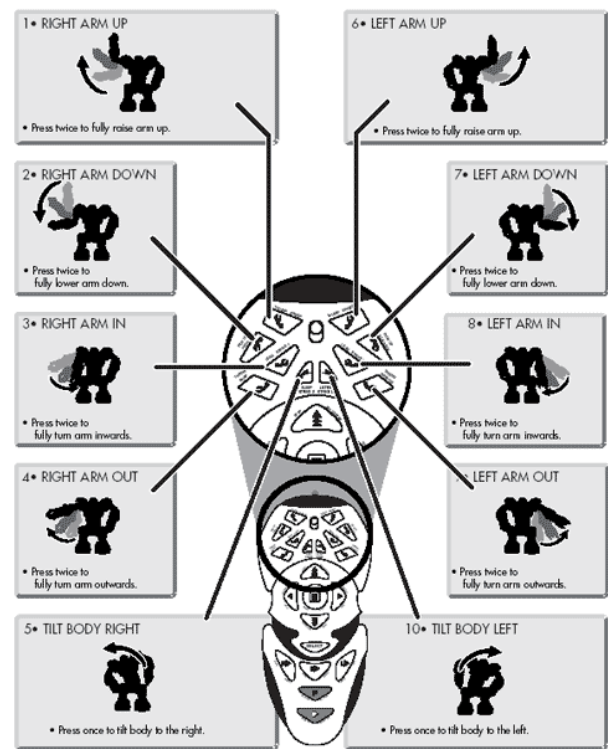


Figure 8 RoboSapien commands

“Existing programs” drop down list and pressing the “DELETE program” button.

Logged user can log off on the same web page for log in, and to release in that way, the exclusive control of RoboSapien web system.

#### V. SOME OPERATIONAL DETAILS

As the RoboSapien automatically turns off itself after 2 hours of inactivity, program sends regularly the STOP command to prevent the RoboSapien automatic shutdown.

In the quite possible scenario when the web server is turned off for more than 2 hours, RoboSapien will automatically turn off itself. In that case, the only possibility is to manually turn OFF and ON the switch on the RoboSapien.

To enable the remote RoboSapien “RESET” after the automatic shut down, the additional serial contact with RoboSapien battery supply is made, and that contact is controlled remotely, using the NI USB 6501 digital output line, with RESET button in the upper left of the RoboSapien web page.

Robot playing field can be arranged in a number of different scenarios, with various objects as intentional obstacles that robot should go around, move, pick up, place to another position, etc.

#### VI. SOME POSSIBLE FURTHER IMPROVEMENTS

Playing field for the robot can be arranged according to needs and good ideas. RoboSapien movements can be limited by some physical obstacles or by some more sophisticated mechanisms using pointer lasers and photo

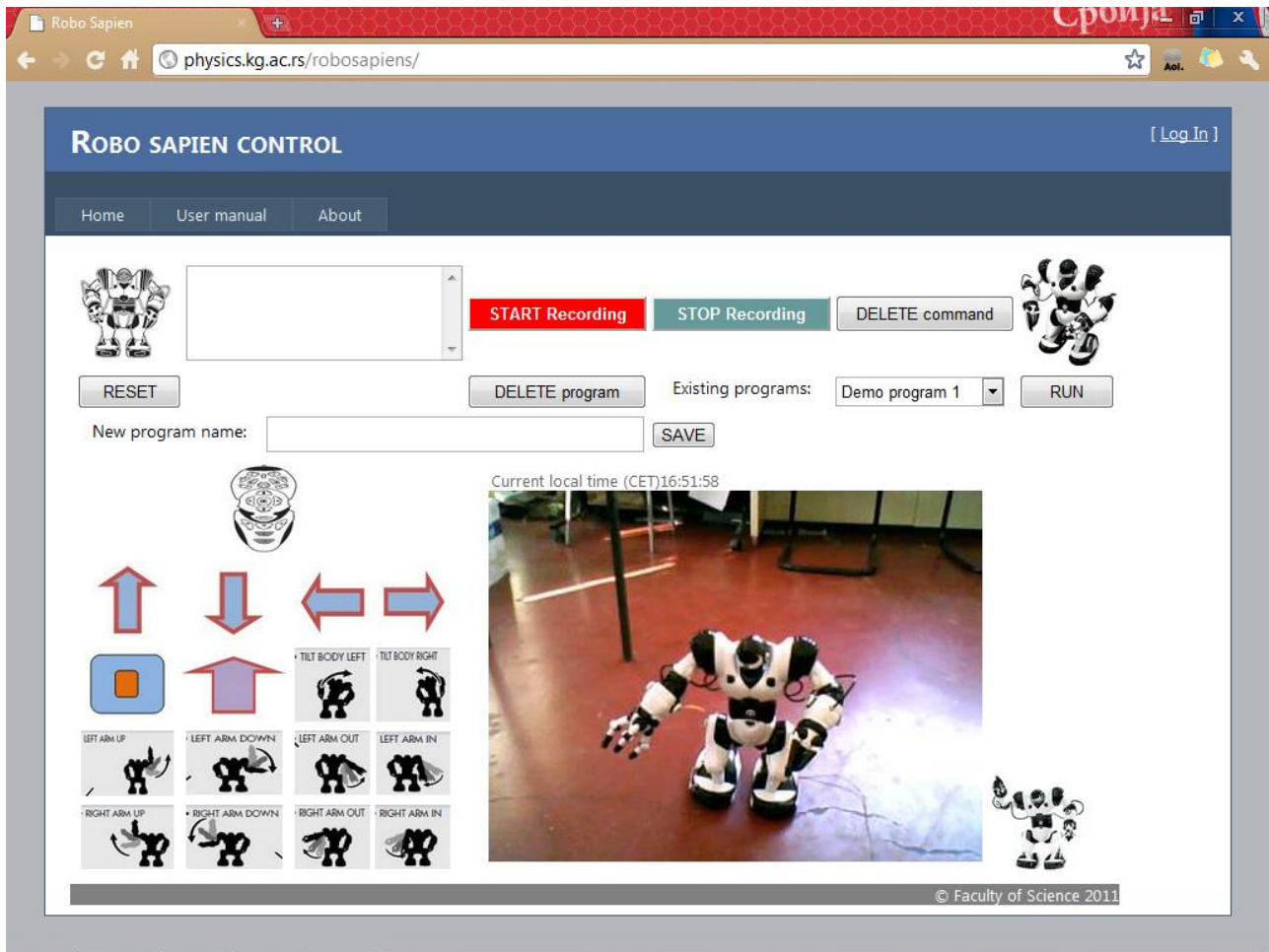


Figure 9 RoboSapien web page

sensitive semiconductor elements. If laser beams are to be used, then the convenient hardware detection of laser beam must be made which will signal the RoboSapien presence on the limit. But, that is just the detection, the decision what to do with the robot on the “edge of the zone” is not an easy one, as it depends on the position of the beam that is crossed, and on the current position and orientation of the robot, which could be almost any. One general rule – heuristics, as a solution to this problem could be choosing one or few “complement” movements that would get the robot back in the allowed – permitted zone. Complement movements that change the position of the robot are forward – backward, and left – right.

Additional web cam could be mounted on the robot to show the “vision” of the robot, in which case the robot could be used for looking around the space in which the robot is in.

## VII. CONCLUSION

RoboSapien web system exposes most of the functions and features that can be accessed from the remote control device, to remote web users. Programming of RoboSapien is enhanced, as the any number of commands can be memorized in proper sequence in database with unique program name. Functions for activating RoboSapien built in demo programs, like dancing, are intentionally omitted,

as they could lead to inadequate and not controlled movements. General architecture of the whole system is quite similar to previously developed systems for remote experiments, with some specifics relating to RoboSapien that were described in detail. Some other solutions for RoboSapien programming can be found on Internet, but such solutions assume risky access to RoboSapien inner parts, and disassembling, which was not necessary for this solution, except for IR remote control device. Remote web control applied to IR controller is simple, safe, elegant and can be applied to any equipment, for instance web remote control of air conditioners, lights, automatic windows, etc, but requires some enthusiasm and background in various disciplines, in the absence of the factory solution.

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PAPER  
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