Design of a SESLogo Program for Mobile Robot Control

Nwankwo E. Linus, Okolie C. Sampson, Martins J. Gani, and Echegini S. Ngozi

Abstract—This paper presents a step by step procedure for writing a control program for SES mobile robots. Detailed explanation of APPLIC 37, a microcontroller usually referred to as heart of the robot which receives data or programs, process it and send it to the robot for execution were given. Also the programming software (SESLOGO) which enables the operation of the APPLIC-37 interface and the robot directly is discussed.

Key words—Robot control, SESLogo Software, Applic-37.

I. Introduction

IN today's world, robots have of great extent solved problems which were very hazardous and difficult for man to achieve in its environment. Sequel to this reason, its control becomes a prerequisite so as to achieve maximum use of its capabilities in solving problems in our environment. A robot is a computerized controlled system which allows us to use a computer and computer software to supervise the operation of a control system. These operations can be easily and cheaply changed by making software modifications, without making any complicated modifications to circuitry or apparatus. The computer serves as a relatively cheap and reliable control device. Its main advantage is in the ease with which we can change the operating conditions of the control system.
It is not necessary to make any changes in the electric circuitry. It is not necessary to design new electronic circuits. All that is required is to adapt the computer program to the new operating conditions and to run the system.

The APPLIC-37 interface is used to connect the control devices (the mobile robot) to the computer. It has 8 digital input channels, 8 digital output channels, 2 analog inputs and one analog output.

There are also special programming methods for controlling – flow charts, ladder diagrams or control diagrams but in this paper Scientific Educational Systems Logo (SESLogo) is used.

II. DESIGN CONSIDERATION FOR APPLIC – 37 AND SESLOGO

A. Why Applic - 37?

The APPLIC 37 is a customized micro controller based control system designed specifically for automation of Scientific Education System (SES) Equipment. Inside the controller is located an integrated circuit chip of the family AT89xx series.

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4Kbytes of Flash programmable and erasable read only memory (EPROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non volatile memory programmer.

The APPLIC-37 interface is actually a controller, which receives commands or a program from the computer. The interface performs the commands immediately and stores the program in its non-volatile memory (data in the memory is saved even after the power is OFF). When the interface receives a new program, the new program replaces the previous one stored in the memory.

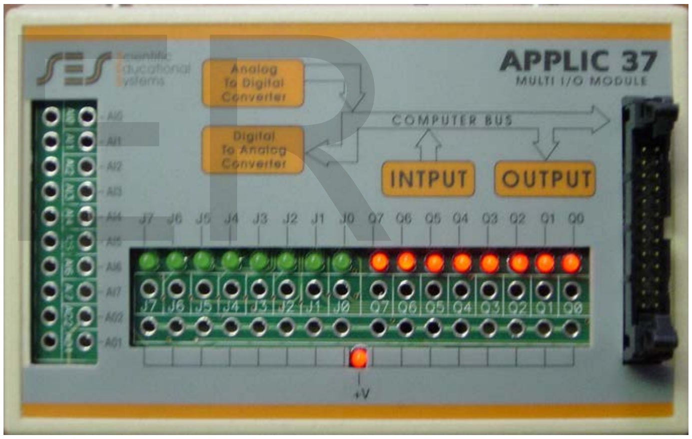

APPLIC 37
MULTI I/O MODULE
Analog To Digital Converter
Digital To Analog Converter
COMPUTER BUS
INTPUT
OUTPUT
J7 J6 J5 J4 J3 J2 J1 J0 Q7 Q6 Q5 Q4 Q3 Q2 Q1 Q0
+V

Fig.1-1 Pictorial view of the Applic – 37 Microcontroller

The interface includes eight digital output channels (Q0-Q7), eight digital input channels (J0-J7), two analog output channels (A01, A02) and eight analog input channels (AI0-AI7). A digital output channel enables us to operate a motor or a lamp in two levels – ON and OFF. An analog output channel enables us to output different voltages to a motor or to a lamp in a continuous manner at 0-10V range. The digital input channel identifies a sensor or a switch in two levels only – ON and OFF (0 and 1).An analog input channel enables us to read a sensor value (actually voltage) at 0-5V range. The interface includes banana type plugs inlets for input and output channels. A line of banana plugs inlets is located against the digital output channels (Q0-Q7) and the digital input channels (J0-J7). All these points are connected to the +12V voltage line. Another line of banana plugs inlets is located against the analog output channels (A01, A02) and the analog input channels (AI0-AI7). All these points are connected to the 0V (GND) line. The GND line is the negative pole of the interface voltage source. The interface also includes a flat cable connector. This connector enables a permanent connection of the interface to a controlled system. Connecting and disconnecting the interface to the controlled system can be done very fast with the flat cable connector. The digital output channels and the digital and analog input channels reach this connector. We connect the robot to this connector via an adapter cable and to the computer via a USB cable. A number of components are installed on the rear side of the interface as shown in the figure below.

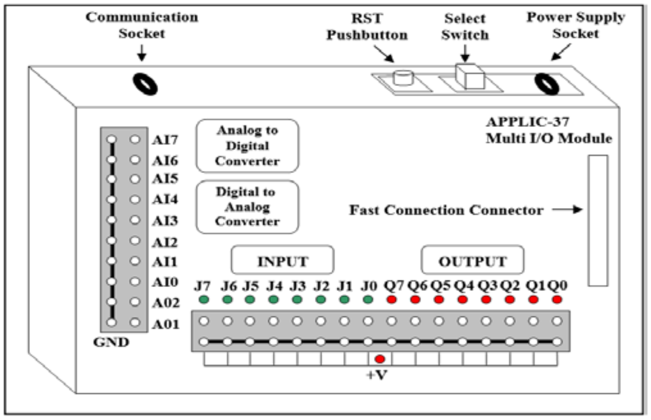

Communication Socket
RST Pushbutton
Select Switch
Power Supply Socket
APPLIC-37 Multi I/O Module
Analog to Digital Converter
Digital to Analog Converter
Fast Connection Connector
AI7
AI6
AI5
AI4
AI3
AI2
AI1
AI0
A02
A01
GND
INPUT
OUTPUT
J7 J6 J5 J4 J3 J2 J1 J0 Q7 Q6 Q5 Q4 Q3 Q2 Q1 Q0
+V

Fig.1-2 Applic – 37 Microcontroller schematic layout

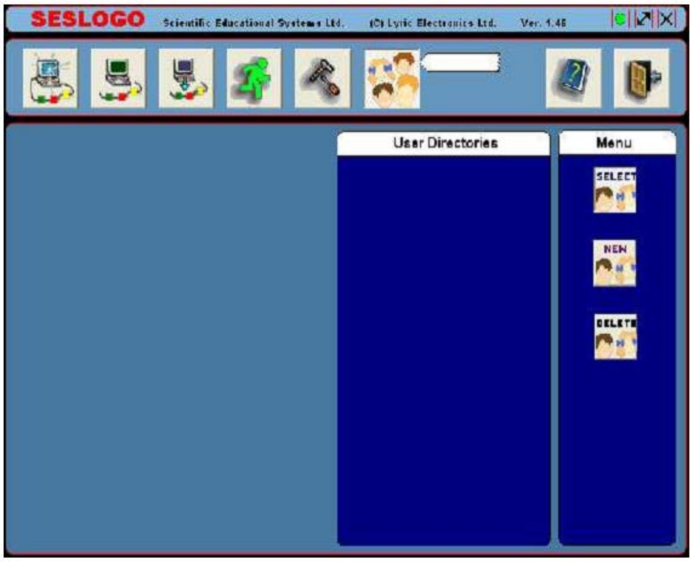
B. Why SESlogo programming?

There are many ways of programming robots: LOGO, BASIC, PASCAL, C and others. The LOGO language was the first programming language using structured programming rules. The language includes basic and primary set of commands. With these commands, series of instructions were created. Each instruction series were given a name. Each instruction series is called a procedure. Reading the procedure by name caused the execution of an instruction series. In this way, the procedure becomes a new command. In this way also, the LOGO language can be expanded infinitely. It is similar to using a limited number of letters to create a large number of words and sentences.

Today all programming languages are built similarly and use structured programming rules.

SESLOGO also use structured programming rules. In the SESLOGO we use icons (buttons) as commands. To create a procedure, used as a new command, we need to create a new button for it that will be used as the procedure name.

The SESLOGO software is designated to work under windows. The SESLOGO software enables the operation of the APPLIC-37 interface directly. Clicking over a command button causes the interface to execute it.


SESLOGO
Scientific Educational Systems Ltd.
(C) Lyric Electronics Ltd.
Ver. 1.46
User Directories
Menu
SELECT
NEW
DELETE

C. The robot

Scientific Education System's mobile robot is an AGV (Automatic Guided Vehicle) robot. It includes two wheels, a range sensor on its front and two range sensors on its right side, a white line sensor located on its bottom, a sound sensor is located on its back, a light sensor located on the front side of the robot each powered by 12V motors and a support wheel which serves as a direction guide.

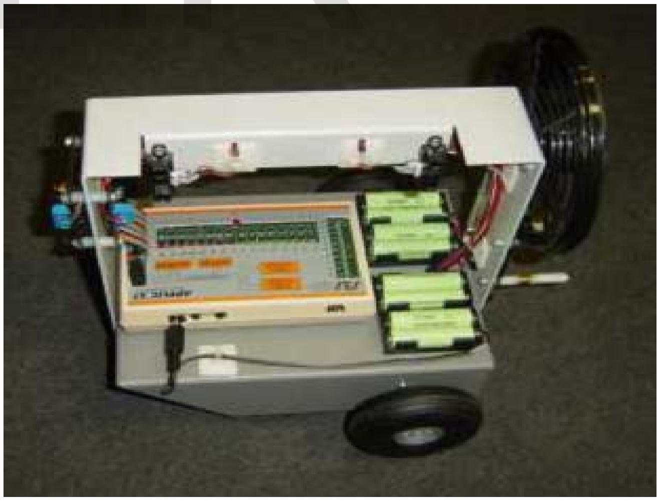


Fig.1-3 Pictorial view of the robot

D. Programming Procedures and steps

The software windows are dynamic ones. They check all the time the communication with the interface. If the communication is OK, a green circle appears inside the third square on the top right. If a red circle appears, it means that there is no communication with the interface. If there is no communication with the interface, change the communication channel number according to the communication output in the computer you have connected to. Afterwards click over the OPEN button (the button with the cable drawing). This clicking will close the previous communication channel and opens the new one. Check that the green circle appears. Open the TOOLS window even if the communication is OK. In the TOOLS window you will find another button called INIT (Initialization). INIT. This button initializes the interface, so it can respond to direct commands (Direct Mode). Click over this button. The initialization program will be downloaded into the interface. This operation should be done on the first installation of the interface or when the interface stops responding to direct commands, although there is communication. The programming comprises drawing buttons with the paint software. The TOOLS window includes a button that searches the PAINT application directory in your computer.

The table below gives a brief summary of the functionality of some of the icons to be used in the programming:

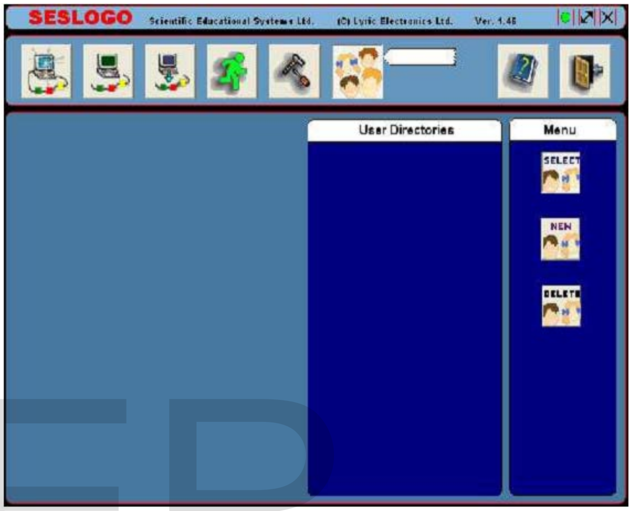
INIT means to initialize	means to search for a folder
means to go offline	0 means analog input
DIGITAL IN 0 means digital input	150 means speed variation
↷ means clockwise	↶ means anti clock wise
↔ means auto change directions	DIGITALOUT 0 means digital output
NEW means to make a new folder	means general commands
0.1× SEC means delay	STOP means stop
RESTART means restart	means to run the program

Table 1: Showing Seslogo Window's Icon for writing the program

E. Operating the robot directly

A multi-wire flat cable comes out from the robot with a male 26 pins connector. The APPLIC-37 also includes a similar connector. Connect the robot flat cable to the APPLIC-37 flat cable connector. Pay attention to the right direction of the connectors. Connect the interface to the PC and to the power. Activate the SESLOGO software as follows:

Check that the APPLIC-37 interface is properly connected to the computer and to the Mains. Check that the select switch is on the RST side. Press on the RST pushbutton at the back of the interface. All the red lights should be ON. Turn ON the computer. Double click over the SESLOGO icon. The following screen will appear:


SESLOGO
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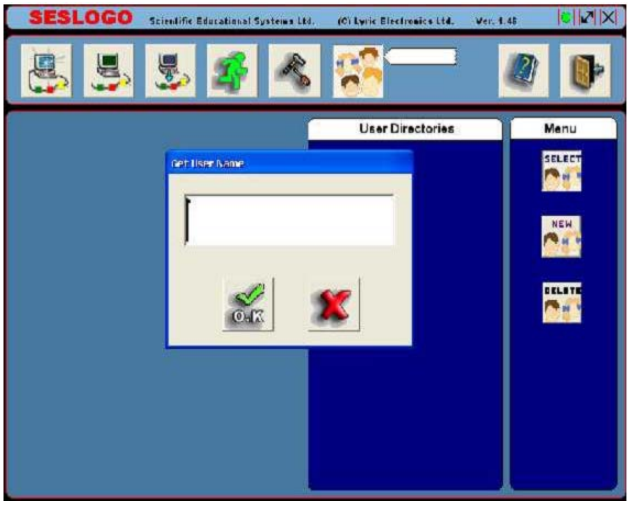
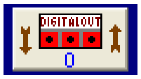
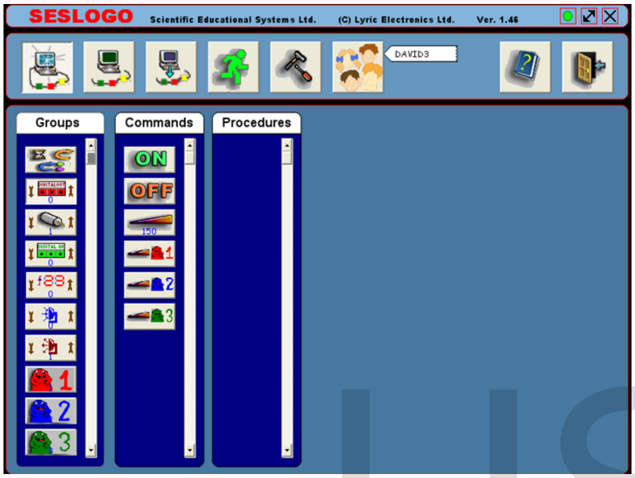
User Directories
Menu
SELECT
NEW
DELETE

Check that a green circle appears at the upper right corner, if a red circle appears, move with the mouse cursor on the different buttons on the screen. If the cursor stays long enough on one of the button, a short explanation of the button appears.

Click over the NEW button NEW, the following screen will appear:

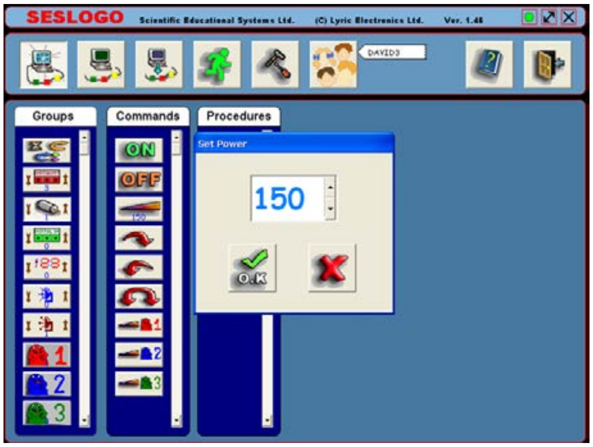


Write a different name from the name list appearing at the "User Directories" field (if there are any names). All the procedures that we will write will be stored in this directory. Click over the Direct Mode button .The screen included three fields – Procedures, Command, and Groups. Because we created a new library, the Procedures column is empty of previous procedures. Every button in the Groups field has command set belonging to it. The robot has a fan connected to the digital output Q7. Click over the Digital Out button. The following screen will appear: 



SESLOGO Scientific Educational Systems Ltd. (C) Lyric Electronics Ltd. Ver. 1.46
DAVID3
Groups
Commands
Procedures
ON
OFF
150
1
2
3

The Digital Out button has six commands – ON, OFF and four Set power commands. The Set Power command determines the power volume at the output channel when it is activated. The Digital Out button has two arrows ↑and ↓, which enable to determine the desired output channel. Set the number 6 with the arrows. Click over the ON button at the Commands field. The Fan should rotate in one direction. Click over the OFF button. The Fan should stop. On the Set Power button, the number 150 appears (The maximal volume is 255). Click over the ON button the fun should rotate slower. Click over the number in the Set Power button. The following screen will appear:

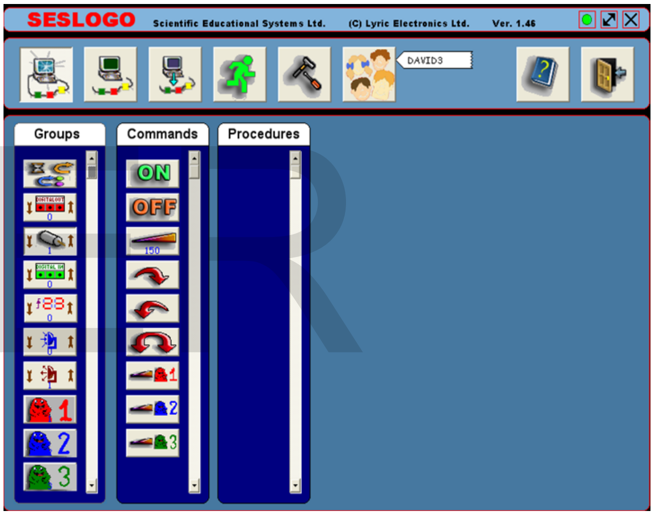


SESLOGO Scientific Educational Systems Ltd. (C) Lyric Electronics Ltd. Ver. 1.46
DAVID3
Groups
Commands
Procedures
ON
OFF
Set Power
150
O.K

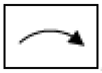
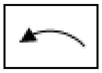
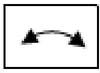
Change the written value to 255 and click OK. Click over the Set Power button. The fan should rotate faster. Click over the OFF button to stop the fan. Using the motor commands: To control the motor direction, we connect the motor between two output channels. Each pair of output channels has a motor number:

M1	–	Q0, Q1
M2	–	Q2, Q3
M3	–	Q4, Q5
M4	–	Q6, Q7

One of the mobile robot motors is connected to Q0, Q1 and we shall call it MOTOR1 (M1).The second motor is connected to Q4, Q5 and we shall call it MOTOR3 (M3) (although there are only 2 motors).Put the robot on the table upon something to support it, so its wheels will not touch the table. Click over the MOTOR button. The following screen will appear:



SESLOGO Scientific Educational Systems Ltd. (C) Lyric Electronics Ltd. Ver. 1.46
DAVID3
Groups
Commands
Procedures
ON
OFF
150
1
2
3

Click over the ON button. The motor M1 will start to rotate. Click over the OFF button to stop it. Click over the CW (Clock Wise) button. . Click over the ON button and then the OFF button. The motor will rotate slowly clock wise. Change the motor's speed to slow speed with the Set Power button . Click over the CCW (Counter Clock Wise) button.  Click over the ON button and then the OFF button. The motor will rotate counter clock wise. Click over the "Change Direction" button , Click over the ON button and then the OFF button. The motor will change its rotation direction.

It is recommended to change direction of the motor only while the Motor stops. Operate the other motor (M3) in the same way and observe the robot's reaction. The two motors are in opposite directions. Find the right rotating direction of each motor for going forward and register that.

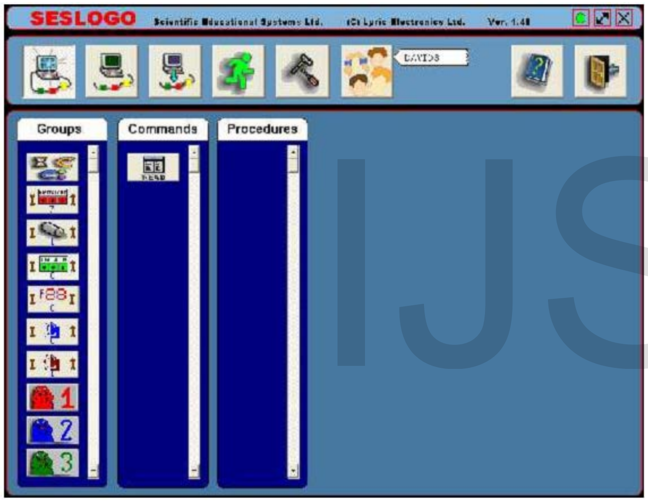
Light sensor:

Digital sensors (with two possible states) and switches are connected between the digital input (J0-J7) and the +V line.

The robot has two light sensors. One sensor on its bottom identifies white surface while going on black surface or vice versa. This sensor includes a LED beside it. The light sensor senses the LED's light reflected from the floor. A black surface absorbs the light and the light sensor does not sense it.

We call such sensor an active light sensor because it senses its own light. The output of the light sensor is connected to the digital input J6. Click over the Digital Input button

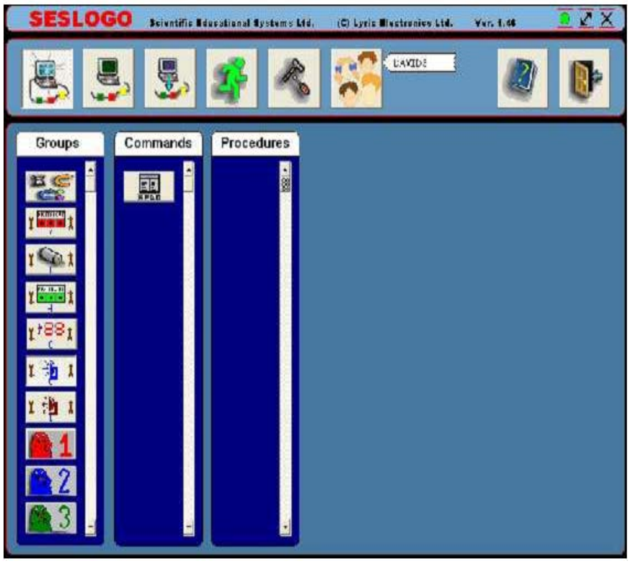
. The following screen will appear:


SESLOGO
Scientific Educational Systems Ltd.
(C) Lyric Electronics Ltd.
Ver. 1.48
DAVID8
Groups
Commands
Procedures
READ
1
2
3

Change the number on the DIGITAL IN button to 6. The only direct command for executing is the READ command for reading the input state. Put a black thick paper under the light sensor. Click over the READ command button. The number 1 will appear on the READ button. Put a white paper under the light sensor. Click again over the READ command. This time the number 0 will appear. The robot also includes a sound sensor (located on the robot's back), which is connected to the digital input J4. Change the number of the Digital Input button to 4, in order to address the input channel 4. The robot includes a buzzer. Connect the 9V battery to the buzzer's battery holder. Press the buzzer pushbutton near the sound sensor microphone and observe the green LED of J4. Click over the READ button several times while the buzzer is ON. In some cases you will read 1.

Analog reading:

APPLIC-37 has 8 analog input channels. The analog input voltage (0-5V) is converted to a number at the range 0-255. The robot has 3 range sensors. The distance between the range sensor and the wall is converted by the range sensor to a number. The range sensor is not a linear sensor. Click over the Analog Input button .The following screen will appear:

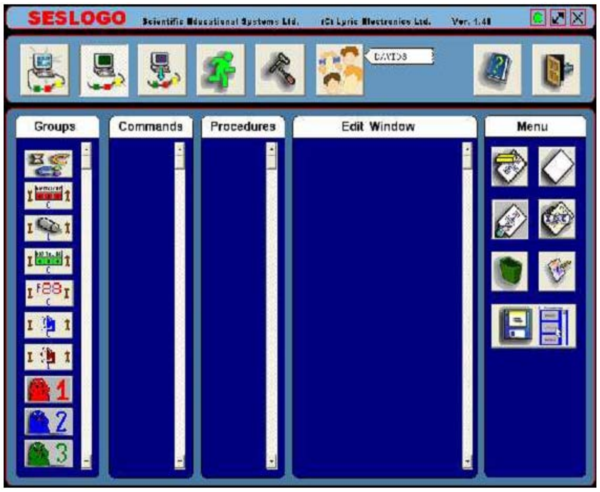

SESLOGO
Scientific Educational Systems Ltd.
(C) Lyric Electronics Ltd.
Ver. 1.48
DAVID8
Groups
Commands
Procedures
READ
1
2
3

The Front Range sensor is connected to AI0 (Analog Input 0). Place the robot 15 cm opposite a wall. The only direct command for executing is the READ command for reading the input state. Click over the READ button. Record the value for 15 cm. put the robot at a 20 cm distance and click over the READ button. Record the value for 20 cm. Repeat step 50 for a distance of 25, 35, 40, 45 and 50 cm. Record the results in a table. Turn the robot to the left so the side sensors will be opposite the wall. Change the number of the Analog Input button to 1. Fill a table with the analog input values for every 5 cm distance increasing from 15 cm to 50 cm. Change the number of the Analog Input button to 2. Fill a table with the analog input values for every 5 cm distance increasing from 15 cm to 50 cm.

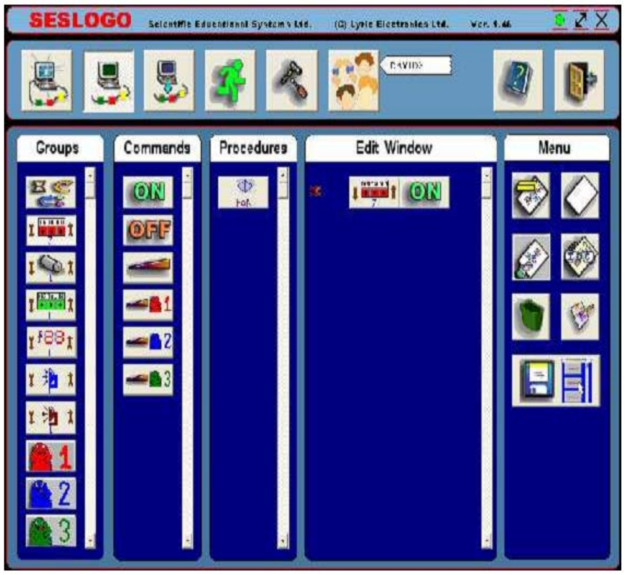
Writing new Program and Procedure

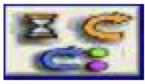
Click over the Off Line Mode button .

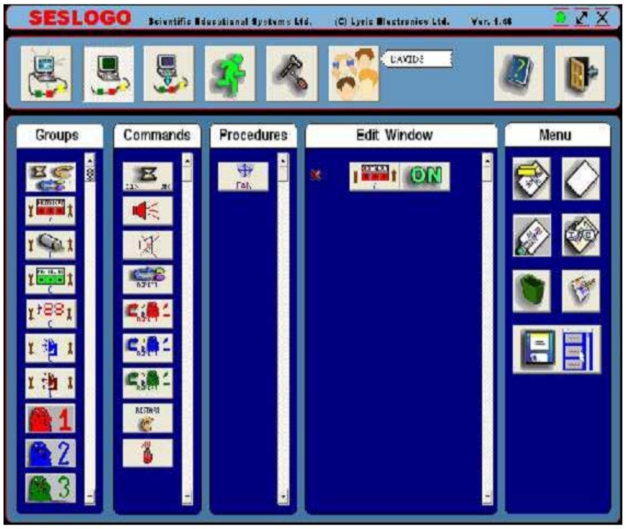
The following screen will appear:

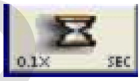

SESLOGO
Scientific Educational Systems Ltd.
(C) Lyric Electronics Ltd.
Ver. 1.46
DAVID
Groups
Commands
Procedures
Edit Window
Menu

Two additional windows are added to the previous windows – Edit Window and Menu. Move with the cursor over the Menu field buttons and identify their meaning. The upper right button in the Menu window is used to create a new procedure button. Click over this button. A new button will appear on the Procedures window. Each button can be edited as a drawing and as text. Click over the Edit Procedure Icon button on the Menu window. The computer's Paint screen will appear with the button square at the upper left corner. Enlarge the square with the magnifying glass. With the Paint colours and tools draw two arrows at the centre of the square. Exit the Paint program by clicking on the X at the upper right corner or by clicking the FILE function and EXIT. The Paint program will ask you: "Save changes?" Click OK to save the drawing. Another window opens with a field to type the button name as text. Type the name and click OK to save. The button at the procedures window will change to the following button:

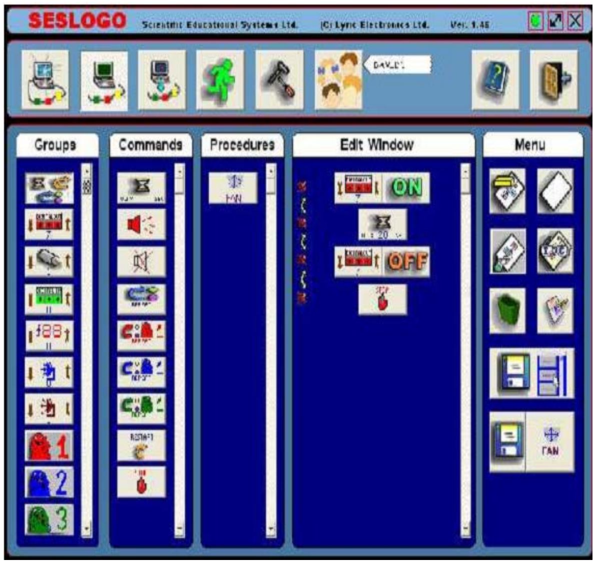


Click over the general group button , the following screen will appear



This group's commands are: delay, sound, repeat the command, back to the beginning, repeat by variable and stop. Click over the delay button . the delay is measured by tenths of a second. Click over the number appearing on the button.

A window with a field for writing the desired delay will open. Type the number 20 for a two seconds delay. Click OK and the window will be closed. Click again over the DIGITAL OUT button and choose the OFF command. Click again over the general group button. Choose the STOP button to stop the procedure. Check that you receive the following procedure:



Identify the Save As button in the Menu window and click over it. The button will be pressed inward. The system waits for clicking on any procedure button. Click over the procedure button. The procedure is saved under this button

We distinguish between two similar expressions – commands and instructions. Instruction is a command written in the procedure and executed only when the procedure is executed. Command is executed immediately upon addressing it. Most of the group's commands are also used as instructions inside the procedures, but not all of them.

III. DESIGN IMPLEMENTATION

Each procedure we built, we create a button with an icon and/or name for it. This button can be used as a command or as a new procedure instruction. In this way, a rich computer language is created, which is adapted to the application we want to implement. Now, we will use the above procedures to control the robot. Every computer includes a Central Processing Unit (CPU), which decodes the procedure instructions and executes them.

The main software (SESLOGO in this case), which enables to edit the procedure, save it, run it and operate the various commands, is called operating system.

The main procedure that the computer executes at first is called a computer program. At the end of the program we need to add an instruction, which returns the program to the beginning (if we want the program to be executed again and again), or stops the program and returns to the operating system. The flowchart below shows the program implementation procedures.

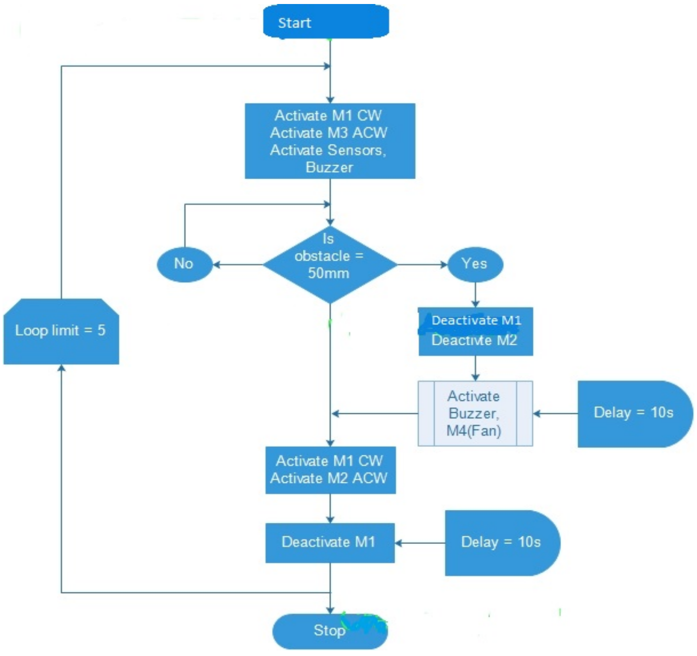


Fig.1-4 Program Flow chart for Implementation

A. Conditions and Decisions

All the procedures and programs we wrote so far operated the controlled system (motors and lamps) only by schedule. This system is called Open Loop system. The controller operates the controlled system without receiving data from the system and relating to this data. A real control system is a system, which operates as a closed loop system. It gathers data from the controlled system and according to this data makes decisions and acts accordingly. This data is received from switches and sensors. The switches and sensors are connected to the input units of the interface. The controller software addresses the input units to get the state of the sensors and switches.

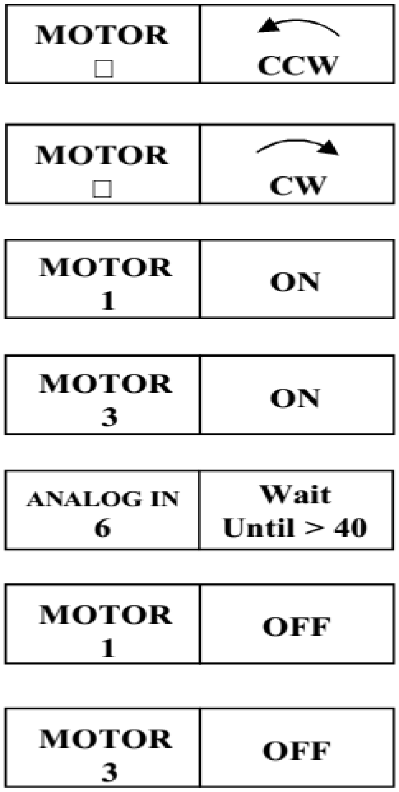
An automatic lighting system is an example for a system which will include a light sensor. The control system will light up the lamp when it is dark and turn it OFF when there is light. This system is automatically adapted to summer time (when the night is short) and to winter time (when the night is long and starts early). Of course, we need to take care that the light sensor will not be influenced by the light turning ON.

The following instructions below for example will command the robot to move forward until it senses a black surface and stop

It is pertinent to note that the instructions related to the digital input channel will appear in the Commands window, and they are: Wait for 0, wait for 1, if equal to 0 do…, if equal to 1 do…

MOTOR □	↶ CCW
MOTOR □	↷ CW
MOTOR 1	ON
MOTOR 3	ON
DIGITAL IN 6	Wait Until 0
MOTOR 1	OFF
MOTOR 3	OFF

Similarly the instruction below will command the robot to go until it gets close to the wall and then stop.



MOTOR □	CCW
MOTOR □	CW
MOTOR 1	ON
MOTOR 3	ON
ANALOG IN 6	Wait Until > 40
MOTOR 1	OFF
MOTOR 3	OFF

The above program was downloaded to APPLIC-37 interface and ran, and the reaction to the wall is much interesting.

IV. CONCLUSION

In this paper, we presented a control program for scientific educational system (SES) mobile robot, the programs was downloaded into the Appli-37 microcontroller interface and tested on the robot, and the robot moved, detected a black surface, the obstacle (wall) and stopped as programmed. Different programming structure can also be used to control the robot to meet with your desired goal.

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