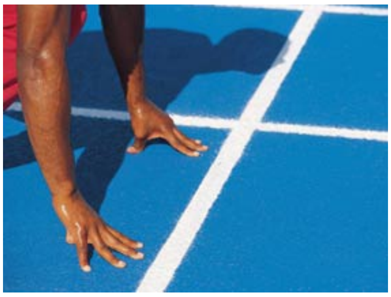
maXbox



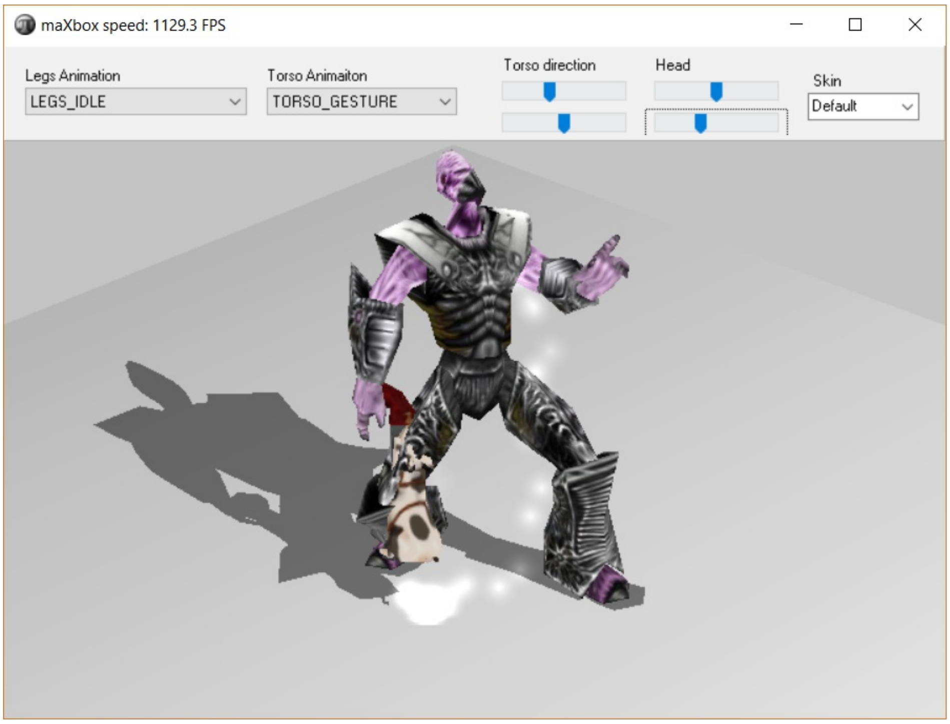
maXbox Starter 45

Work with maXbox Robotics

1.1 Command with maXbox Operation Server

The Robots industry is promising major operational benefits, although no one is quite sure where robots and the Industrial Internet of Things (IIoT) will take manufacturing. IoT represents a closing of the gap between production and IT and is seen as the next big step for automation.

In reality, the Internet of Things can mean anything to anybody. For example, in the domestic context, it can involve connecting household appliances – even vehicles or robots - to a home hub and having some kind of central intelligence control how the house or robots operates. Try it first in maXbox with a simulation on Menu `/Options/OpenGL mX/` Then change `Torso animation/direction` and `Head...`



maXbox speed: 1129.3 FPS

Legs Animation: LEGS_IDLE

Torso Animaiton: TORSO_GESTURE

Torso direction

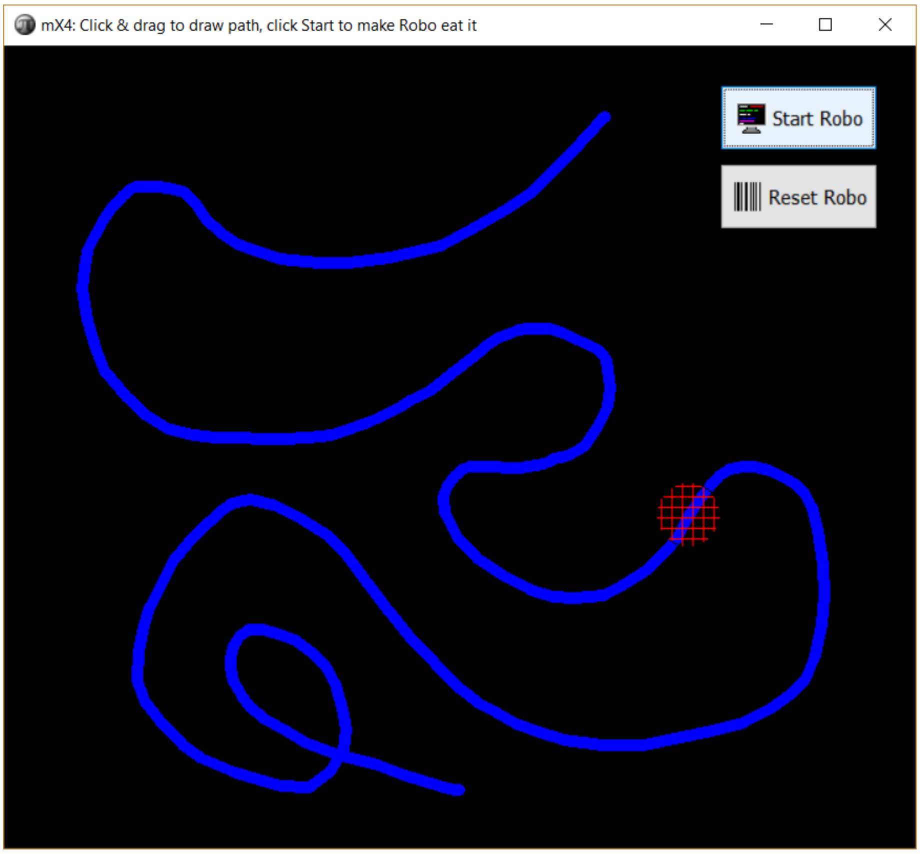
Head

Skin: Default

Be aware that you need the subdirectory `/exercices/Model/` of maXbox3 to work with OpenGL. Here you find resources and a configuration file for your own study.
Please read also the Tutorial 38 concerning 3D Lab, simply because robots live in 3D. We can program robots in G-code. In fundamental terms, G-code is a language in which people tell computerized machine tools or robots what to make and how to make it. The "how" is defined by instructions on where to move to, how fast to move, and along what path to move. For example:

```
G1 X0.0 Y0.0 Z0.0
G1 X10.0 Y10.0 Z0.0 F1000
```

These instructions can then be sent to a machine that will interpret these lines and execute them one by one. The G Code instructions frequently have an X, Y and Z coordinate, these are the points in 3D robot space that the for example head will move in. We can also develop this with Turtle in `maXbox/Arduino` these steps to test the behaviour.


mX4: Click & drag to draw path, click Start to make Robo eat it
Start Robo
Reset Robo

Today we step through this robot simulation to find him its way along a line. As you my know we script it in maXbox4. This tool is great for fast coding but also provides mechanism for extending your functions and quality with checks and tests.
The script is called: `examples\667_URobo2_tutor45.pas`

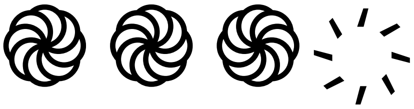
First I want to show how we track the blue line for the robot:

```
procedure FormMouseMove(Sender: TObject; Shift: TShiftState; X, Y: Integer);
{User moved mouse}
begin
  If drawing then begin
    form1.canvas.lineto(x,y);
    sleep(sleepms);
    inc(count);
    if count>length(saved) then setlength(saved,length(saved)+maxpoints);
    saved[count]:= point(x,y);
  end;
end;
```

Its done with the `mousemove` event which also remembers the speed of the tracking! Means the slower we paint the more points to track we have (like slow-motion). The same goes for the robot and its done by measuring milliseconds as the resolution of the track. The last point measured is finished by a `mouseup` event:

```
procedure FormMouseUp(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
{User released the button}
begin
  Drawing:= false;
  Robo.left:= saved[1].x-robo.Width div 2;
  Robo.top:= saved[1].y-Robo.Height div 2;
end;
```

The `robo` itself is just a shape object.
A canvas or shape object’s Brush property determines what kind of color and pattern the canvas uses for filling graphical shapes and backgrounds. Controls also specify an additional brush in their Brush properties, which they use for painting their backgrounds.



Challenging domains such as robot-assisted search and rescue, operations in space require humans to interact with robots.
These interactions may be in the form of supervisory control, which connotes a high human involvement with limited robot automation (e.g., semi-autonomy, where the robot is truly autonomous for portions of the task or mixed-initiative systems, where the robot and human are largely interchangeable.

The interactions between humans and robots are often interchangeably referred to as “coordination” or “collaboration”.

The application of a script to interleave human and robot coordination is both logical and natural. Scripts simplify the relationship between human and robot making the task comprehensible to both novice and expert system users.

```
procedure StartBtnClick(Sender: TObject);
{User clicked start}
var  i:integer;
  drawtime:integer;
  startcount,stopcount:int64;
begin
  for i:= 2 to count do begin
    {put center of robo on the point}
    Robo.left:= saved[i].x-Robo.width div 2;
    Robo.top:= saved[i].y-Robo.height div 2;
    queryperformanceCounter(startcount);{Get time before we repaint}
    application.processmessages;
    queryPerformanceCounter(stopcount);{Get time after repaint}
    drawtime:= (stopcount-startcount) div freq;  {Compute ms to repaint}
    writeln('test freq ms: '+itoa(drawtime))
    sleep(max(0,sleepms-drawtime));   {wait whatever time is left, if any}
  end;
end;
```

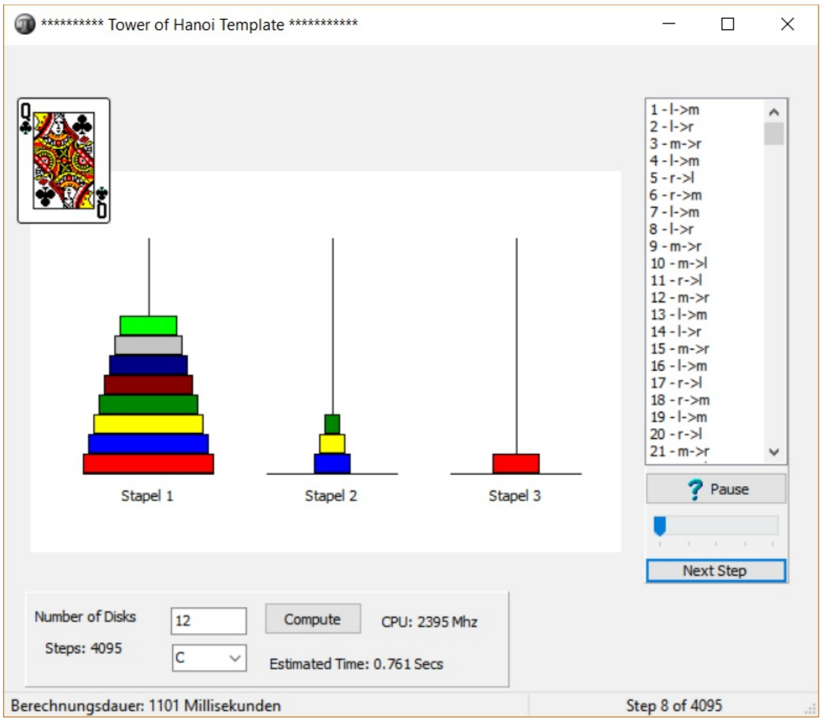
The ability to simplify a task as a series of simple steps is necessary for this comprehension. The available or possible actions for the human operator at any particular time are clear in the script because of the GUI. This approach can be applied to any task, with any level of human-robot coordination.

Due to the highly proprietary nature of robot software, most producers of robot hardware also provide their own software. While this is not unusual in other automated control systems, the lack of standards of programming methods for robots does pose certain challenges.
For example, there are over 30 different manufacturers of industrial robots, so there are also 30 different robot programming languages required.
Fortunately, there are enough similarities between the different robots that it is possible to gain a broad-based understanding of robot programming without having to learn each manufacturer's proprietary language.

Another interesting approach is worthy of mention. All robotic applications need or explore parallelism and event-based programming.
Robot Operating System is an open-source platform for robot programming using Python and C++. Java, Lisp, Lua, Pascal and Pharo are supported but still in experimental stage.

https://en.wikipedia.org/wiki/Robot_Operating_System

Another example is the tower of hanoi which can be solved for example by Lego mindstorm or other arduino frameworks:



```
1 - l->m
2 - l->r
3 - m->r
4 - l->m
5 - r->l
6 - r->m
7 - l->m
8 - l->r
9 - m->r
10 - m->l
11 - r->l
12 - m->r
13 - l->m
14 - l->r
15 - m->r
16 - l->m
17 - r->l
18 - r->m
19 - l->m
20 - r->l
21 - m->r
```

Number of Disks: 12

Steps: 4095

C

CPU: 2395 Mhz

Estimated Time: 0.761 Secs

Berechnungsdauer: 1101 Millisekunden

Step 8 of 4095

The script is called: `examples\712_towerofhanoi_animation.pas`

Programming errors represent a serious safety consideration, particularly in large industrial robots. The power and size of industrial robots mean they are capable of inflicting severe injury if programmed incorrectly or used in an unsafe manner. Due to the mass and high-speeds of industrial robots, it is always unsafe for a human to remain in the work area of the robot during automatic operation.
A few following concepts should improve this safety:

- Console Capture
- Exception Handling
- Logfiles

1.2 Console Capture DOS

I'm trying to move a part of SysTools to Win64. There is a certain class `TStDecimal` which is a fixed-point value with a total of 38 significant digits. The class itself uses a lot of ASM code.

```
function BigDecimal(aone: float; atwo: integer): string;
begin
 with TStDecimal.create do begin
  try
   //assignfromint(aone)
   assignfromfloat(aone) //2
```

```
      RaiseToPower(atwo)  //23
      result:= asstring
    finally
      free
    end;
  end;
end;
```

But then I want to test some Shell Functions on a DOS Shell or command line output. The code below allows to perform a command in a DOS Shell and capture it's output to the maXbox console. The captured output is sent “real-time” to the Memo2 parameter as console output in maXbox:

```
    srlist:= TStringlist.create;
      ConsoleCapture('C:\', 'cmd.exe', '/c dir *.*',srlist);
      writeln(srlist.text)
    srlist.Free;
```

But you can redirect the output `srlist.text` anywhere you want.
For example you can capture the output of a DOS console and input into a textbox, or you want to capture the command start of demo app and input into your app that will do further things.

```
 ConsoleCapture('C:\', 'cmd.exe', '/c ipconfig',srlist);
 ConsoleCapture('C:\', 'cmd.exe', '/c ping 127.0.0.1',srlist);
```

☝ It is important to note that some special events like `/c java -version` must be captured with different parameters like /k or in combination.

Here's the solution with `GetDosOutput()`:

```
 writeln('GetDosOut: '+GetDosOutput('java -version','c:\'));
```

or like powercfg or the man-pages in Linux

```
 writeln('GetDosOut: '+GetDosOutput('help dir','c:\'));
GetDosOutput('powercfg energy -output
                          c:\maxbox\osenergy.htm','c:\')
```

1.3 Exception Handling

A few words how to handle Exceptions within maXbox:
Prototype:

```
procedure RaiseException(Ex: TIFException; const Msg: String);
```

Description:

Raises an exception with the specified message.
Example:

```
begin
  RaiseException(erCustomError,'Your message goes here');
// The following line will not be executed because of the
exception!
  MsgBox('You will not see this.', 'mbInformation', MB_OK);
end;
```

This is a simple example of a actual script that shows how to do try except with raising a exception and doing something with the exception message.

procedure Exceptions_On_maXbox;

```
var filename,emsg:string;
begin
   filename:= '';
   try
     if filename = '' then
       RaiseException(erCustomError,
                    'Exception: File name cannot be blank');
   except
     emsg:= ExceptionToString(ExceptionType, ExceptionParam);

       //do act with the exception message i.e. email it or
       //save to a log etc

     writeln(emsg)
   end;
end;
```

☝ The `ExceptionToString()` returns a message associated with the current exception. This function with parameters should only be called from within an except section.

1.4 The Log Files

There are 2 log files a runtime log and an exception log:
using Logfile: `maxboxlog.log` , Exceptionlogfile: `maxboxerrorlog.txt`

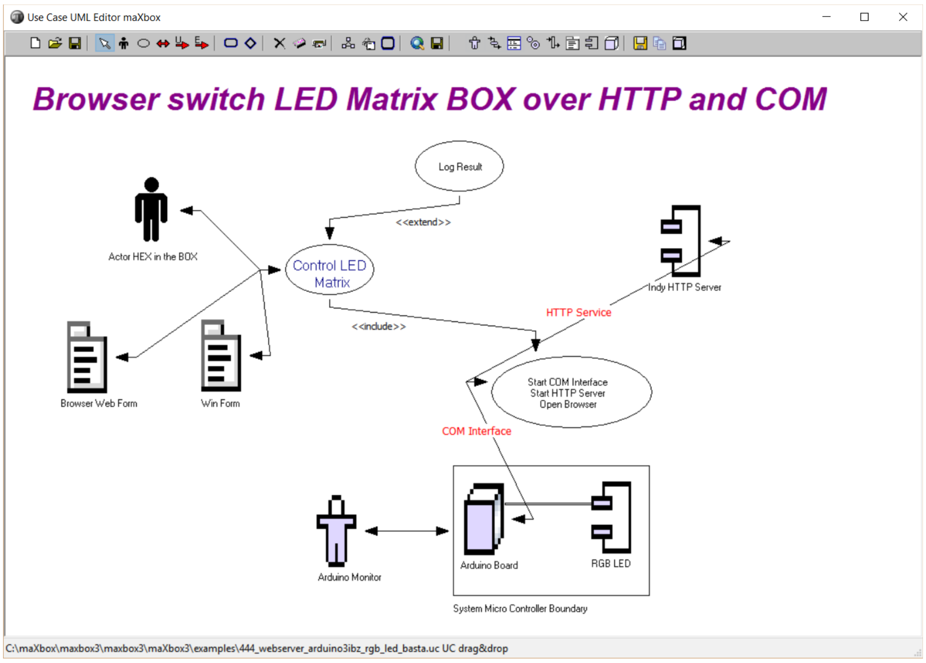
```
New Session Exe Start C:\maXbox\tested
>>>> Start Exe: maXbox4.exe v4.0.2.80 2016-02-03 14:37:18
>>>> Start [RAM  monitor] : Total=2147483647,
Avail=2147483647, Load=30% ; [Disk monitor] : Available to
user=671317413888, Total on disk=972076589056, Free total on
disk=671317413888 ; 2016-02-03 14:37:18
```

```
>>>> Start Script: C:\Program Files
(x86)\Import\maxbox4\examples\640_weather_cockpit6_1.TXT
2016-02-03 14:37:33 From Host: maXbox4.exe of
C:\maXbox\maxbox3\work2015\Sparx\
>>>> Stop Script: 640_weather_cockpit6_1.TXT
[RAM  monitor] : (2147483647, 2147483647, 30%) Compiled+Run
Success! Runtime: 14:37:33.267

New Session Exe Start C:\Program Files(x86)\Import\maxbox4\
examples\640_weather_cockpit6_1.TXT
>>>> Start Exe: maXbox4.exe v4.2.2.95 2016-05-19 09:15:17
>>>> Start [RAM  monitor] : Total=2147483647,
Avail=2147483647, Load=25% ; [Disk monitor] : Available to
user=675888001024, Total on disk=972076589056
```

After completing the tasks as directed, the compiler proceeds to its second step where it checks for syntax errors (violations of the rules of the language) and converts the source code into an object code that contains machine language instructions, a data area, and a list of items to be resolved when he object file is linked to other object files.

At least there are two ways to install and configure your box into a directory you want. The first way is to use the unzip command-line tool or IDE, which is discussed above. That means no installation needed. Another way is to copy all the files to navigate to a folder you like, and then simply drag and drop another scripts into the /examples directory.
The only thing you need to backup is the ini file **`maxboxdef.ini`** with your history or another root files with settings that have changed



C:\maXbox\maxbox3\maxbox3\maXbox3\examples\444_webserver_arduino3ibz_rgb_led_basta.uc UC drag&drop

You simply put the line above on the boot script and make sure the ini file has it set to Yes. BOOTSCRIPT=Y //enabling load a boot script

“Wise men speak: Hand made by robots.

Feedback @ max@kleiner.com
Literature: Kleiner et al., Patterns konkret, 2003, Software & Support

https://github.com/maxkleiner/maXbox3/releases

https://en.wikipedia.org/wiki/Robot_software

Here are 5 actions to make your computer more secure:

1. Use an antivirus program and keep it up to date
2. Do not open email messages from unknown sources or suspicious attachments even if you know the sender
3. Use a personal firewall
4. Keep your software up to date and enable Windows automatic updates
5. Use a pop-up blocker with your browser

EKON 20 Input for Robots & Components

1. AsyncPRO,	2. BigInteger,
3. Hotlog,	4. WMILib,
5. StBarCode,	6. XMLUtils,
7. LockBox,	8. cX509Certificate,
9. OpenGL,	10. WaveUnit,
11. OpenSSL,	12. Kronos,
13. HiResTimer,	14. Kmemo,
15. BigDecimals,	16. SynEdit,
17. SFTP,	18. Sensors,
19. PasScript,	20. ALJSON

1.5 Appendix External links External links

- "*The Basics* - *Robot Software*". Seattle Robotics Society.
- G.W. Lucas, "*Rossum Project*".
- "*Mobile Autonomous Robot Software* (MARS)". Georgia Tech Research Corporation.
- "*Tech Database*". robot.spawar.navy.mil.
- Adaptive Robotics Software at the Idaho National Laboratory
- A review of robotics software platforms Linux Devices.
- ANSI/RIA R15.06-1999 American National Standard for Industrial Robots and Robot Systems - Safety Requirements (revision of ANSI/RIA R15.06-1992)

1.6 References

- *O. Nnaji, Bartholomew. Theory of Automatic Robot Assembly and Programming (1993 ed.). Springer. p. 5. ISBN 978-0412393105. Retrieved 8 February 2015.*
- *"Robot programming languages". Fabryka robotów. Retrieved 8 February 2015.*