



Logo to VRML

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Outline

1	3D graphics in MSWLogo	1
3	VRML	3
5	Logo to VRML	5
6	Commands of Logo2VRML package	6
8	Simple example	8
10	3D Hilbert curve	10
11	3D graph drawing	11
12	3D graph drawing	12
13	Conclusions	13
14	References	14

3D graphics in MSWLogo

MSWlogo has already for a long time commands that support 3D positioning of turtles and drawing their traces in a projection.

Essentially all turtle movement commands can be treated as 3D commands.

Besides these there are additional 3D commands:

PERSPECTIVE, **SETTURTLE -1** (eye position), **SETTURTLE -2** (eye direction), **SETXYZ**, **ZCOR**, **SETPOSXYZ**, **POSXYZ**, **TOWARDSXYZ**, **DISTANCEXYZ**, **ROLL**, **LEFTROLL**, **RIGHTROLL**, **SETROLL**, **PITCH**, **UPPITCH**, **DOWNPITCH**, **SETPITCH**, **ORIENTATION**, **SETORIENTATION**.

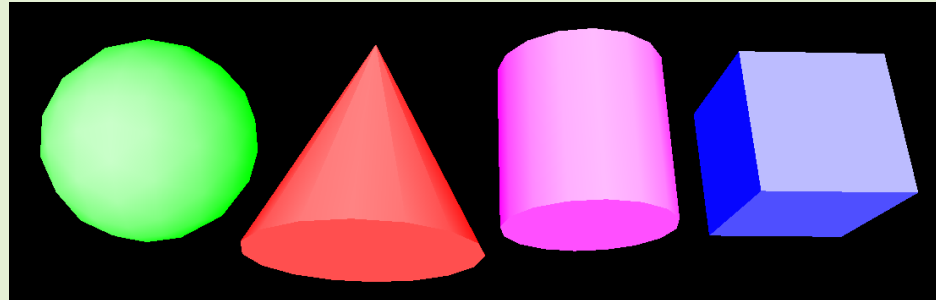
... 3D graphics in MSWLogo

In the year 1998 George Mills extended MSWLogo with a support for drawing 3D solids by introducing some basic commands to define and draw surfaces (filled polygons):

- **POLYSTART**: Start a new polygon (a surface of pencolor);
- **POLYEND**: End the definition of the polygon and display it;
- **POLYVIEW**: Shade and view all polygons that have been defined;
- **SETTURTLE -3**: Use this turtle to position light source;
- **SETLIGHT**: Use to set how objects should be illuminated;
- **LIGHT**: Current illumination setting.

The **PEN** color when drawing 3D surfaces is the color of the surface. Color is effected by the angle of the surface between your eye (**TURTLE -1**) and the light source (new **TURTLE -3**).

VRML



During the first Web Conference in May 1994 some experts for virtual reality formed a group that should prepare some additions to HTML (HyperText Markup Language) in the field of virtual reality. So the idea of VRML (Virtual Reality Markup Language) was born.

On the next conference, in October 1994 in Chicago, first version of VRML was announced (Bell, Parisi, Pesce, 1995). Designers decided that HTML and VRML should be orthogonal but connected languages. VRML became Virtual Reality Modeling Language.

First shareware VRML browser WebSpace appeared in May 1995. Silicon Graphics was developing its own VRML viewer – CosmoPlayer.

At Siggraph (August 1996) the VRML 2.0 specification was published and made available in its final form. VRML 2.0 allows the user to build user controlled multiuser scenes. In 1997 it becomes as VRML97 an international ISO standard.

In the last years the Web3D Consortium X3D Task Group is designing and implementing the next-generation Extensible 3D (X3D) Graphics specification reexpressing the geometry and behavior capabilities of the VRML97 using the XML (Extensible Markup Language).

VRML is used in many areas: data organization, three dimensional maps, modeling, mathematics, chemistry, medicine,

Logo to VRML

We developed a package of MSWlogo commands to draw basic VRML solids (box, sphere, cone and cylinder) using the surface drawing commands. The displayed solids can be further exported as its VRML description to a file.

Commands of Logo2VRML package

- **sphere :color :r :n** – produces at the current position a sphere of radius r and given color. The optional parameter n ($= 20$) is the number of vertices in a polyhedral approximation of the sphere.
- **box :color :a :b :c** – produces at the current position in current direction a box of given color and with edge lengths a , b and c .
- **cone :color :h :r :n** – produces at the current position in current direction a cone with base of radius r , height h and given color. The optional parameter n ($= 20$) is the number of triangles in a polyhedral approximation of the cone.
- **cylinder :color :h :r1 :r2 :n** – produces at the current position in current direction a cylinder of given color, height h and with bases of radius r_1 and r_2 . The optional parameter n ($= 20$) is the number of quadrangles in a polyhedral approximation of the cylinder. If r_2 is omitted $r_2 = r_1$.

... Commands of LogoVRML package

These commands become available by loading the LogoVRML package into MSWLogo. The loading process also runs the command `VRinit` that initializes the VR environment. It contains also a variable `VRMLp` that controls the production of VRML description. If `:VRMLp = "false` these commands simply draw these solids in MSWLogo.

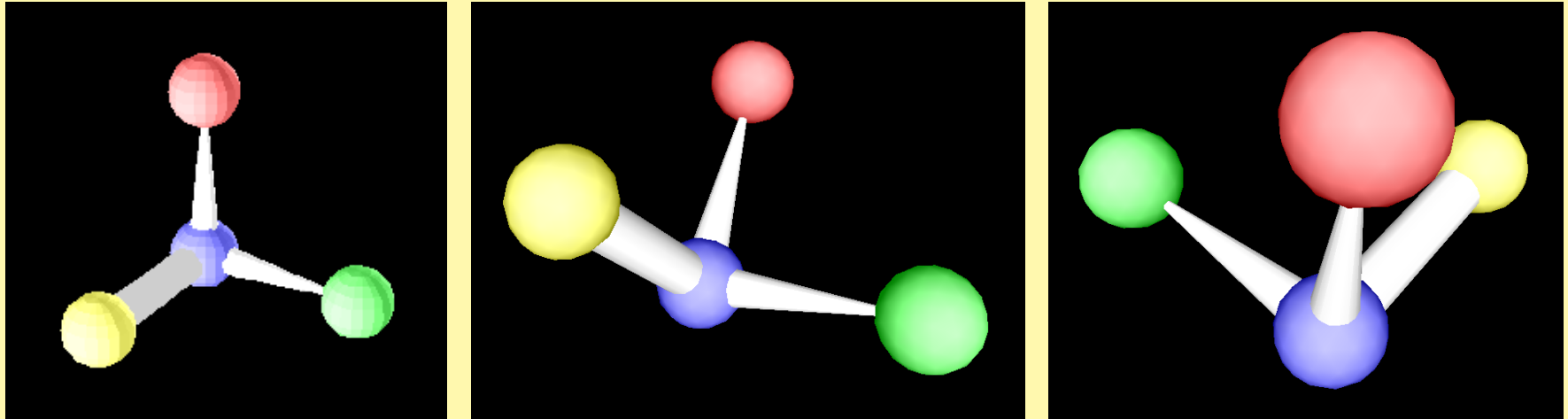
For producing the VRML description we have to enclose the scene description producing commands in the scene pair of braces:

- `SceneStart :pic :bgcolor` – starts a new `pic.wrl` file with a scene of given background color `bgcolor`.
- `SceneEnd` – close the current VRML file.

The additional command

- `VRexit` – restores standard MSWLogo.

Simple example

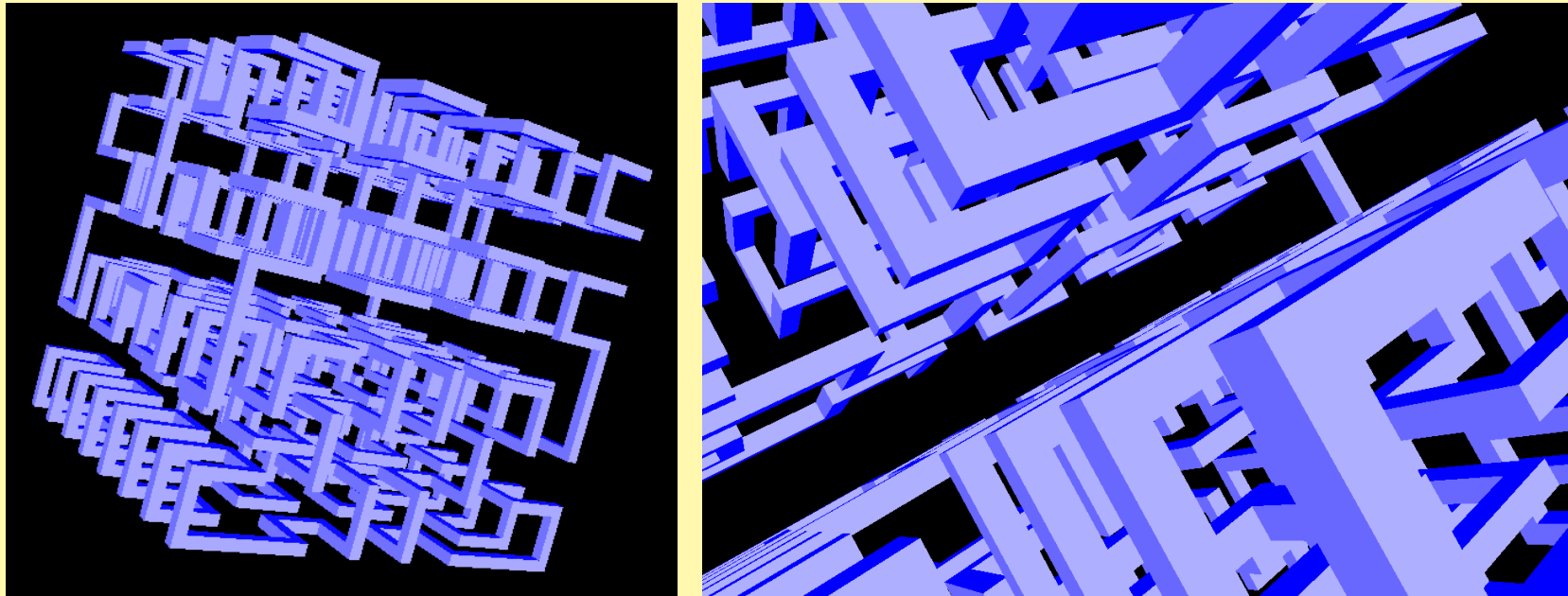


In the figure on the left a 3D drawing produced in MSWLogo by command **Simple** is presented. Its VRML description was saved on file **test.wrl** and inspected in Cosmo Player. Two selected views are presented in the middle and on the right side figure. As we can see an VRML viewer allows us to view the described construction from different viewpoints.

... Simple example – Code

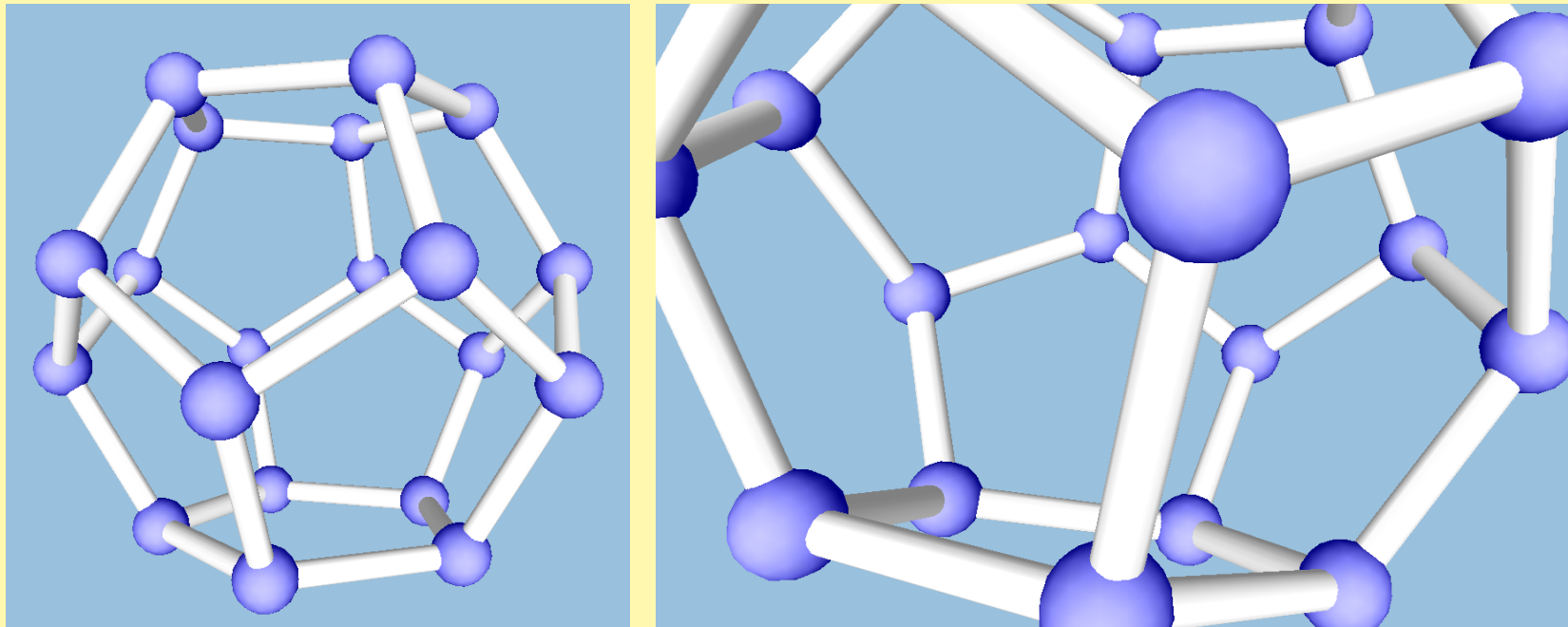
```
to Simple
penUp ht
sceneStart "test
  setPosXYZ [0 0 0] sphere [ 0 0 128] 20
  setPosXYZ [100 0 0] sphere [ 0 128 0] 20
  setPosXYZ [0 100 0] sphere [128 0 0] 20
  setPosXYZ [0 0 100] sphere [128 128 0] 20
  setPosXYZ [ 50 0 0] setOrientation towardsXYZ [100 0 0]
  cone [128 128 128] 100 10
  setPosXYZ [ 0 50 0] setOrientation towardsXYZ [0 100 0]
  cone [128 128 128] 100 10
  setPosXYZ [ 0 0 50] setOrientation towardsXYZ [0 0 100]
  cylinder [128 128 128] 100 10
sceneEnd
penDown
end
```

3D Hilbert curve



As the second example we present two views of `Hilbert.wrl` obtained by a LogoVRML version of command `Hilbert` from MSWLogo examples.

3D graph drawing



The command `DrawGraph :dodeca` produces a 3D drawing of dodecahedron graph. In the figure two views of `dodeca.wrl` are presented.

The dodecahedron graph is given in list `:dodeca` – the first sublist contains the coordinates of vertices, and the second sublist contains the edges.

3D graph drawing

```

make "dodeca [[
  [79.1 86.7 49.5] [59.1 87.1 75.9] [27.2 87.7 66.5] [27.4 87.7 34.2]
  [59.5 87.0 23.7] [96.4 57.9 49.2] [87.2 40.5 75.4] [64.1 58.6 92.0]
  [35.2 41.5 92.4] [12.4 59.5 76.7] [03.5 42.0 50.7] [12.7 59.4 24.5]
  [35.8 41.4 07.9] [64.7 58.4 07.5] [87.5 40.4 23.2] [72.8 12.2 33.4]
  [72.5 12.2 65.7] [40.4 12.9 76.2] [20.8 13.2 50.4] [40.8 12.8 24.0]
]]
[[
  [ 1  6] [ 1  2] [ 2  3] [ 2  8] [ 3  4] [ 3 10] [ 4  5] [ 4 12]
  [ 5 14] [ 6  7] [ 6 15] [ 7 17] [ 7  8] [ 8  9] [ 9 10] [ 9 18]
  [10 11] [11 12] [11 19] [12 13] [13 20] [13 14] [14 15] [15 16]
  [16 17] [16 20] [17 18] [18 19] [19 20] [ 1  5]
]]

to DrawGraph :g
  make "v first :g make "e last :g penUp ht
  (SceneStart "dodeca [153 192 220] [100 200 300] [0 0 0] [0 455 834])
  foreach :v [ setPosXYZ ? sphere [0 0 128] 5 ]
  foreach :e [ make "x item first ? :v make "y item last ? :v
    setposXYZ :x make "d distanceXYZ :y setorientation towardsXYZ :y
    fd :d/2 cylinder [128 128 128] :d 2
  ]
  SceneEnd
  penDown
end

DrawGraph :dodeca

```

The command **DrawGraph** is a general procedure that produces a 3D graph drawing of a given graph described by such a list. **Pajek**.

Conclusions

The LogoVRML package is still in development. Its current version with documentation and additional examples is available at

<http://www.educa.fmf.uni-lj.si/logo/logoVRML/>

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