EECS 1011 – Lab D: Drawing 3D Objects

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Summary: Sketch, by hand, some 3D objects and then draw one in MATLAB.

Pre-Lab: (1) Watch the YouTube tutorials: https://youtu.be/4nu9BXHccTs, https://youtu.be/BVnnPGoF1Iw and (2) **Print** off two (*or more*) sheets of isometric paper. Use the first sheet for the practice drawing. Do the practice shape using the isometric paper. During the lab session **show the TA** your practice shape. (3). Use the second sheet during the lab. Use the second sheet for the in-lab sketching activity. (print off *more sheets, just in case you make mistakes!*)

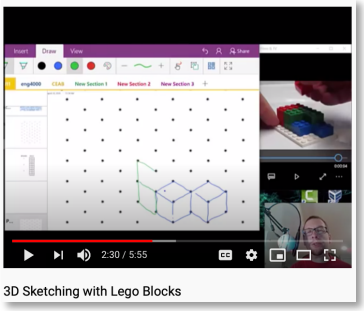

Figure 1 Watch the videos: https://youtu.be/4nu9BXHccTs and https://youtu.be/BVnnPGoF1Iw

Intro

The lab is divided up into two parts:

- **Part 1**: Sketch, by hand, the three objects described below.
- **Part 2**: Create, using MATLAB, a 3D figure: an 3D isometric view of an object from Part 1.

There are many "**isometric dot paper**" templates on the web. Here are a few:

- https://www.formsbirds.com/free-isometric-dot-paper
- http://mathcentral.uregina.ca/RR/database/RR.09.98/loewen2.10.pdf

There are also interactive isometric web applications that you can use for practice:

- http://bit.ly/1WgFP0v

Due date for Lab Report. The reports are all due on Sunday, Oct 4 at 11:55pm. Submit report to the eClass server at *eclass.yorku.ca*

Marking Guide: each component of the lab is equally weighted. See eClass for details.

Lab Instructions

Part 1: Sketch three objects

As we have discussed in class, draw the three objects described on the following page. Make sure to choose the three objects for your particular lab section.

You are to do these sketches on isometric graph paper. You can either do it on paper (print out the paper ahead of time) or using your own personal tablet computer (iPad, Surface, etc.) or a regular laptop with a Wacom digitizer tablet.[1,2]

Having trouble? Here are some suggestions:

- Consult with your TA or other students in the class
- Try out on online program for isometric drawings (e.g. http://bit.ly/1WgFP0v)
- Watch basic drawing tutorial:
  - https://youtu.be/4nu9BXHccTs
- Watch the Matlab "patch" drawing tutorial:
  - https://youtu.be/BVnnPGoF1Iw
- Use some Lego blocks and build the model before sketching

Here's an example

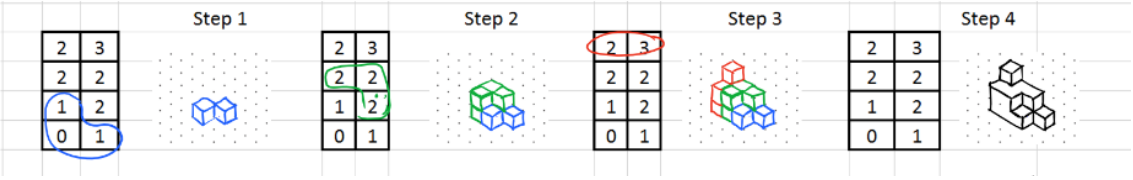

Figure 2 Example of using a "coded plan" to create a drawing of the object using isometric dots. Compare to the Lego blocks in Fig. 2.

Colour-coding the steps helps break up the problem into manageable chunks. Use light pencil in the first three steps and then "ink" in the final result using a pen in Step 4. What does something like this look like in real life? Let's model it in Lego!

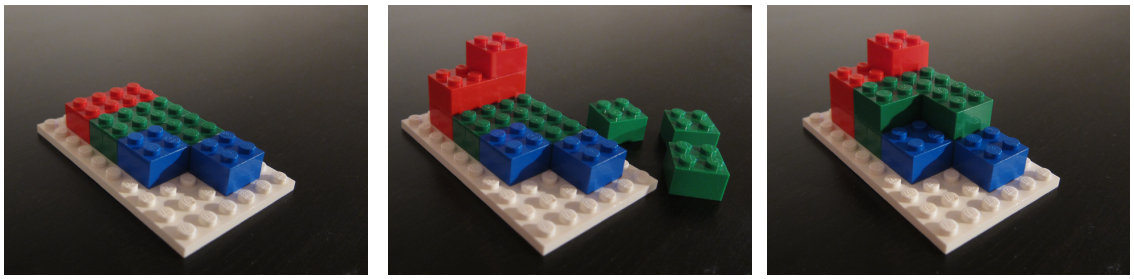

Figure 3 A Lego-based version of the coded plan. First layer, on the left. Second and third layers, on the right. Compare it to the drawing in Fig. 1.

[1] Smartphones tend to have really small screens that make these kinds of sketches impractical, but your mileage may vary depending on your own phone.

[2] Using a "pointy" stylus (like on the iPad Pro, Surface 4, or external Wacom tablets is recommended)

Lab section	Sketch 1	Sketch 2	Sketch 3
1	2 1 1 2 1 1	3 2 2 1 1 2	1 3 2 1 3 4
2	2 2 1 1 1 2	3 2 2 2 1 1	1 4 3 1 2 3
3	1 2 1 2 2 2	1 1 3 1 2 2	1 1 2 4 3 3
4	2 1 1 2 1 1	1 2 3 1 2 2	1 3 3 2 2 4
5	1 2 2 2 1 2	2 2 1 1 3 1	1 1 1 4 2 3
6	1 1 1 2 2 2	2 1 1 1 3 2	2 3 1 1 1 4
7	2 2 1 2 2 1	3 1 1 2 2 2	1 2 2 3 2 4
8	2 1 1 2 1 2	2 1 3 2 1 2	1 4 3 3 1 1
9	1 1 1 1 2 2	1 2 3 2 2 1	4 4 3 3 3 1
10	1 2 2 2 1 1	2 2 1 2 3 1	1 2 1 3 1 4
11	2 2 1 1 1 1	1 1 2 2 3 1	2 4 2 3 2 2

Lab section	Sketch 1		Sketch 2		Sketch 3	
12	2	2	3	3	3	4
	1	2	2	1	2	1
	1	1	1	2	3	4

During the lab session **show your TA** your hand sketches via video conference.

Part 2: Draw Your Object in MATLAB

Now, using MATLAB draw one of your sketches from Part 1, as per the table below. The "last name" is the last name of one of the partners in the group. You get to choose which one. Just make it clear in your report who you chose.

Last Name: A-H	**Last Name: I – O**	**Last Name: P - Z**
Part 1, "Sketch 1"	Part 1, "Sketch 2"	Part 1, "Sketch 3"

Define important points ("corners") in your drawing as components in vectors describing x, y and z positions. Then use the MATLAB patch() function to create "walls" for your object. Here is an example of how a house can be illustrated in this manner.

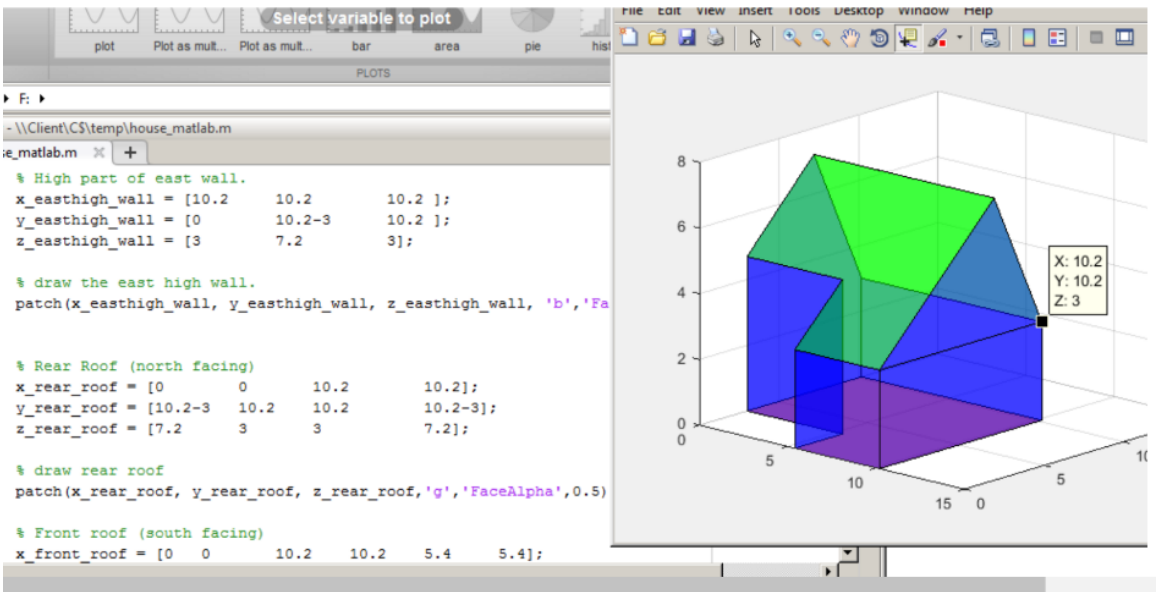

Figure 4 A 3D view of a house, made using the MATLAB patch() function. Look inside the code for how x, y and z components were defined and how the transparency ("alpha channel") was modified.

Turning on transparency in your MATLAB plot is key to being able to see through the object. This is done with the **'FaceAlpha'** option with the **patch()** function. You can also rotate the object in 3D space. Do both.

Here is the suggested approach for solving your drawing problem:

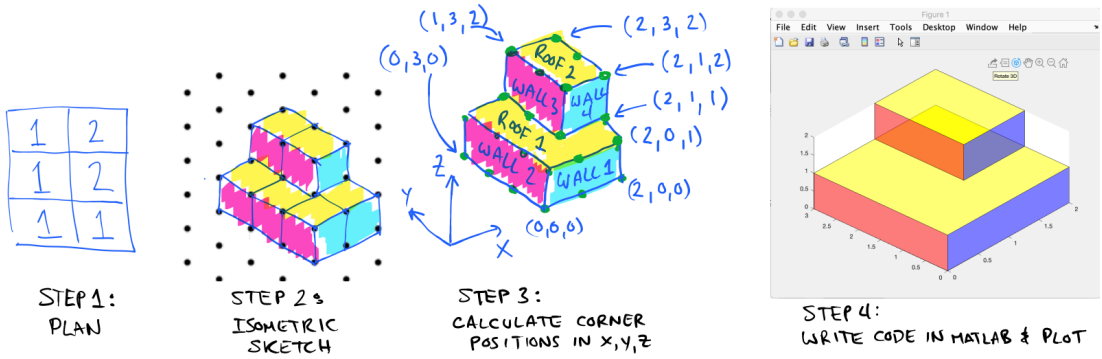

Figure 5 Consider using this approach for solving your problem of drawing the shape. Note that only some of the corner points are listed in step 3, not all! Also note the skew in the perspective in step 4. This is normal.

Between steps 3 and 4 you'll need to write Matlab code to create the shape. I recommend that you first try to reproduce the shape below and then modify the Matlab code to suit your particular shape. You probably won't have the same number or shapes of walls, but this example will get you started.

Table 1 Example code to achieve the shape described in Fig. 4.

```
% labd_basic_blocks.m
% James Andrew Smith, 2019
%
% ------------------------------------------------------------


% ------------------------------------------------------------
% Wall 1
% ------------------------------------------------------------
%                  corner1    corner2    corner3    corner4
wall1_x_values = [0          2          2          0        ];
wall1_y_values = [0          0          0          0        ];
wall1_z_values = [0          0          1          1        ];

% Draw Wall 1
patch(wall1_x_values, wall1_y_values, wall1_z_values, 'blue','FaceAlpha',0.5);

% ------------------------------------------------------------
% Wall 2
% ------------------------------------------------------------
%                  corner1    corner2    corner3    corner4
wall2_x_values = [0          0          0          0        ];
wall2_y_values = [0          0          3          3        ];
wall2_z_values = [0          1          1          0        ];

% Draw Wall 2
patch(wall2_x_values, wall2_y_values, wall2_z_values, 'red','FaceAlpha',0.5);



% ------------------------------------------------------------
% Roof 1
% ------------------------------------------------------------
%                  corner1    corner2    corner3    corner4
roof1_x_values = [0          2          2          0        ];
roof1_y_values = [0          0          3          3        ];
roof1_z_values = [1          1          1          1        ];

% Draw Roof 1
patch(roof1_x_values, roof1_y_values, roof1_z_values,
'yellow','FaceAlpha',0.5);
```

```


% ------------------------------------------------------------
% Wall 3
% ------------------------------------------------------------
%                  corner1    corner2    corner3    corner4
wall3_x_values = [1          1          1          1        ];
wall3_y_values = [1          1          3          3        ];
wall3_z_values = [1          2          2          1        ];

% Draw Roof 2
patch(wall3_x_values, wall3_y_values, wall3_z_values, 'red','FaceAlpha',0.5);

% ------------------------------------------------------------
% Wall 4
% ------------------------------------------------------------
%                  corner1    corner2    corner3    corner4
wall4_x_values = [1          2          2          1        ];
wall4_y_values = [1          1          1          1        ];
wall4_z_values = [1          1          2          2        ];

% Draw Roof 2
patch(wall4_x_values, wall4_y_values, wall4_z_values, 'blue','FaceAlpha',0.5);


% ------------------------------------------------------------
% Roof 2
% ------------------------------------------------------------
%                  corner1    corner2    corner3    corner4
roof2_x_values = [1          2          2          1        ];
roof2_y_values = [1          1          3          3        ];
roof2_z_values = [2          2          2          2        ];

% Draw Roof 2
patch(roof2_x_values, roof2_y_values, roof2_z_values, 'yellow','FaceAlpha',0.5);
```

Writing a Report

You need to submit a lab report as a single PDF to Moodle that includes

1. A standard cover page
2. A copy of the marking guide
3. A short abstract of the work that you did, based on the abstract template
4. A scan (or photo) of your sketches from Part 1
5. A copy of your MATLAB code and a copy of the figure you generated. Including the Matlab code will **exceed the three page limit**. That's okay.

Abstract Template

For the abstract in your report, please follow this template. **Keep** the bolded headings ("introduction", "lab objectives", "solution", etc.) and **replace** the rest of the words with what you did and how you did it in the lab.

> **INTRODUCTION**: This is my introductory sentence, in which I give context for my experimental work. **LAB OBJECTIVES**: The objectives of this experiment was to determine whether a 7kg spacecraft should use solid or liquid propellant to reach orbit. **SOLUTION**: The experiment used two SuperZoom Inc. Rockets, a MegaByte Ltd. Model 45 launch computer, a SuperZoom Liquid Propellant Unit and a UltraBoom Solid Rocket Booster. The two rockets were assembled, one with the solid booster and one with the liquid unit. Two separate rocket launches were performed, twenty minutes apart at the York University launch pad located at Black Creek Village. The launch computer sent a signal to the first rocket, and then a signal to the second rocket. **RESULTS**: The liquid propelled launch vehicle crashed and burned after 7 seconds of flight, taking out the GAP advertisement above the Eaton Centre. The solid booster rocket achieved orbit after 20 minutes of flight. **CONCLUSIONS**: The solid rocket booster design is better and is recommended for future trials.

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