

## Assignment 2: Transformation

This assignment has one writing task and one programming task.

### 1. Due Date

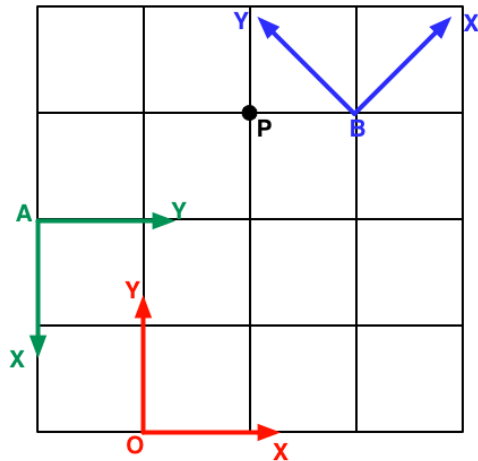
Assignment 2 is due on **03/02 11:59pm**.

### 2. What to Submit:

Submit the following items to Mycourses:

- A document with answers to the writing task.
- A zip file containing all source files (.h and .cpp files) for the programming task and a description how to use your program. Make sure your code can be compiled and run in Visual Studio.

**3. Writing Task (24pts):** Consider the following three coordinate systems  $O$ ,  $A$  and  $B$ , and answer Q1-Q5.



**Note:**

- Cells of the grid are unit cells, which means the cell edge length is equal to 1.
- We denote  $M_{ST}$  to represent the  $3 \times 3$  matrix transforming the coordinate system  $S$  to  $T$ .  $M_{ST}^{-1}$  represents the inverse matrix of  $M_{ST}$ .

**Q1 (4pts):** What are the coordinates of  $P$  in the coordinate system  $O$ ?

**Q2 (4pts):** What are the coordinates of  $P$  in the coordinate system  $A$ ?

**Q3 (4pts):** What are the coordinates of  $P$  in the coordinate system  $B$ ?

**Q4 (6pts):** What is  $M_{AB}$ ? (Derive and find the matrix).

**Q5 (6pts):** Use  $M_{AO}$  and  $M_{BA}$  to represent  $M_{OB}$ .

#### 4. Programming Task (76pts):

You are required to write a program using OpenGL to create a 2D robot. The body parts should be rotatable. Your program should allow users to select and rotate body parts. I would suggest you to look at the *2DTransformTree.cpp* uploaded to Mycourses on 02/09. An executable of this assignment (.exe) is in Mycourses. Please run it and get a feel of the work you should deliver.

The robot must have at least **16 body parts**, as shown in Figure (A). The relationships of these body parts are shown in Figure (B). Your program must correctly control the rotations of the 16 body parts (5 points for each body part). Note that the coordinates of a child part should be defined in the coordinate system of its parent, as shown in (B). Your program must allow the user to select and rotate a particular body part. For example, you may use a key on the keyboard to cycle through the indices of body parts, and then use another key for rotation.

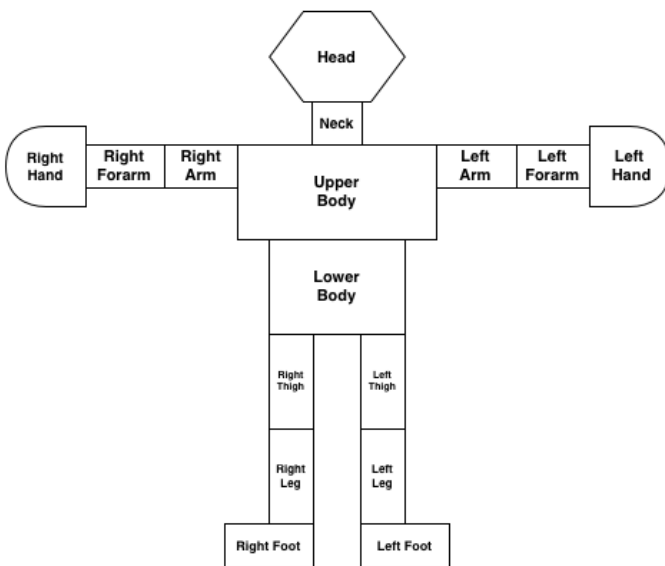


Figure (A)

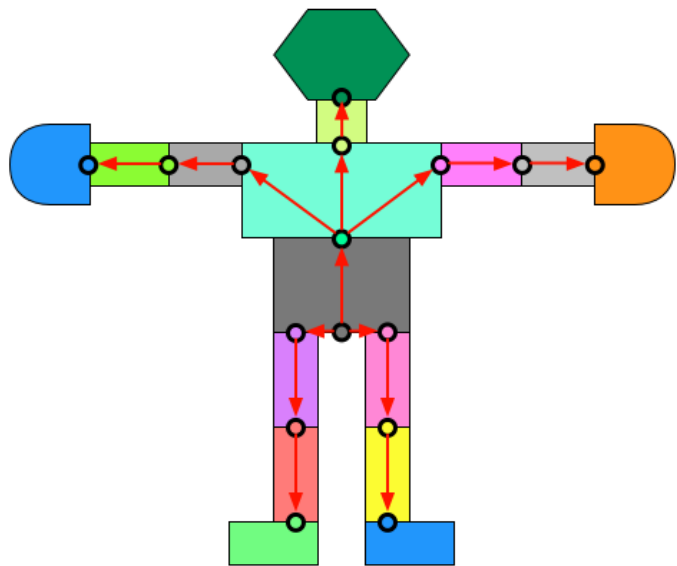


Figure (B)