* **How to operate my program**

**"Keyboard :"**

"Press T to enter geometrical Translation mode”

"Press R to enter geometrical Rotation mode"

"Press S to enter geometrical Scaling mode"

"Press E to enter eyes' position mode"

"Press L to increase x coord."

"Press J to decrease x coord."

"Press I to increase y coord."

"Press K to decrease y coord."

"Press M to increase z coord."

"Press O to decrease z coord."

"Press P to toggle projection mode"

"Press Q to reset "

"Press left arrow or right arrow to change current model pointer"

**"Mouse :"**

"Press E/other keys(T, S, R) to switch between geometry mode and eye position mode"

“Press middle button to reset.”

“Press T, R or S to enter geometry mode”

"If in geometry mode,"

"Press left button and drag to translate current model"

"Press right button and drag to rotate current model"

"Wheel up and down to scale current model"

“Press E to enter eye position mode”

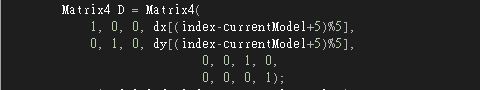
"If in eye position mode,"

"Press left button and drag to move both eye position and center position"

"Press right button and drag to move only eye position in the x and y axes"

"Wheel up and down to move eye position in the z axis"

* **Implementation and problems I met**

首先先將所有OBJ都讀進程式中，並為每個model maintain一個structure，讀進來的同時算出每個model的長寬高及圖的中心記錄在structure中。接著進入計算MVP矩陣的階段。我將Model Matrix分成五個矩陣，分別是Init、R、S、T與displace\_matrix。Init matrix的功能是將model移到中心點 (0, 0, 0) 的位置，並normalize；R是Rotation matrix；S是scaling matrix；T是translation matrix；displace\_matrix的作用是當我有五張圖時，若我要把他們都擺在window中，不可能把他們全部都擺在中心，所以我在normalize與model matrix乘完以後會再進行一次translation，並以flag決定每張圖應該在位置。

透過mod的方式，使geometry可以操作的圖永遠位於window正中間，即座標

(0, 0, 0)，最後M = displace\_matrix \* T \* S \* R \* Init，即可得到最後的Model Matrix。View Matrix也是在每次畫之前，根據eye position render出一個新的matrix。