

BARRETT BURT HAPTIC WORLD

2017. 10. 09

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1 Background

The Haptic World program is made for the dual-arm rehabilitation robot BURT (previously named Proficio) from [Barrett Technologies](#). It uses a combination of Unity3D and C# scripts, with the former acting as a physics engine that provides the GUI and handles collision calculations. The user can essentially "touch" virtual objects by running this program.

Note that the Haptic World is built based on the [official demo program](#) that only works with a single arm. Additionally, the demo program only has a haptic sphere and haptic box without the effect of texture rendering. Because the BURT robot is still under development for commercial release, I can only share the C# files that I worked on and attach a screen shot of the program.

2 The Program

Below is a screen shot of the program. It consists of the following components: a haptic sphere, a haptic wall, a touch light, and a push button. Additionally, the yellow sphere (the haptic cursor) represents the end-effector of the robot, which shares the same position as the user's hand. Upon activation, the haptic cursors will initialize at their correct positions, simulating the left and right hand.

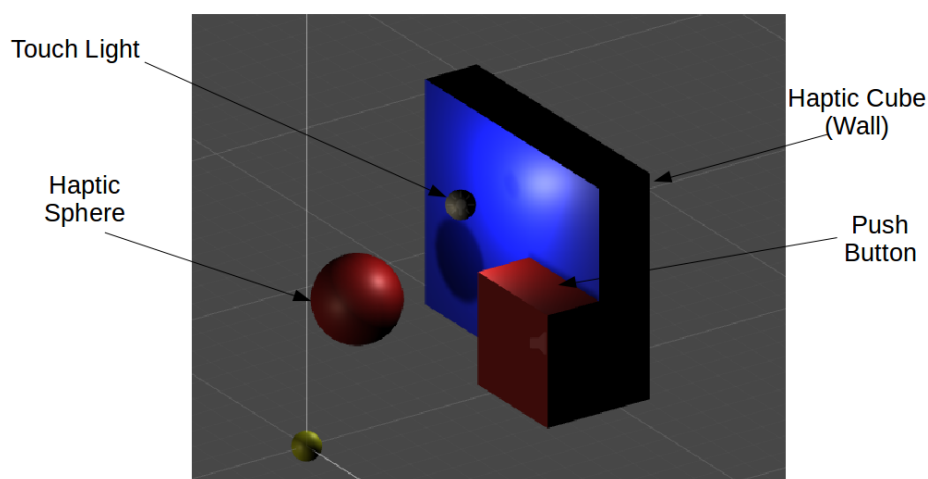


Figure 1: Screen shot of the Haptic World program.

2.1 Haptic Sphere

The haptic sphere is rendered using a very simple algorithm. If a collision between the sphere and a hand (haptic cursor) is detected, the penetration distance is calculated, and the robot will exert a force opposite to penetration direction with magnitude proportional to the penetration distance. The user can change the stiffness value which makes the sphere "softer" or "harder".

2.2 Haptic Wall

The haptic wall is different from the sphere because it is not radially symmetric. As a result, when a collision between the hand and the wall occurs, the program needs to identify the surface into which the hand penetrates, and the robot will then tend to push the user's hand out along the direction normal to this surface. Additionally, if the hand moves along the surface of the wall, the user can feel the texture from a sinusoidal friction along the surface.

2.3 Touch Light

The touch light is created as a subclass of the haptic sphere so it inherits the force calculation. Additionally, whenever touched by the hand, the touch light will toggle its status and turn a point light on/off accordingly.

2.4 Push Button

The push button is created as a subclass of the haptic box. When being pushed in the normal direction for enough depth, the program switches the status of the button and turns a directional light on/off. The equilibrium length of the push button is different depending on its status in order to imitate the retracted or extended position.