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### Assignment 3 Write-Up

Upon launching my application, the user will be able to view output just as if the camera application on their phone was open and the rear camera was viewing the world. There are 8 total buttons for controlling the scene or the wand's modes which I will expand on below. The wand is implemented as a virtual hand which moves in relation to the image target in space. In a top-down left to right order the buttons and their functionalities are as follows:

**Toggle Orbit** - At top of my application closer to where the title appears, there is a button to toggle visibility of orbits. It is toggled on when the application starts by default as the user needs to see the orbits when building and editing their solar system. Once the solar system is complete the user can toggle this button off with a click and all the orbits will disappear making the system much cleaner to look at. It is important to note that this button only affects duplicated orbits that have been selected or placed in the solar system, not the orbit image target. Therefore, if this button is toggled off when trying to select/duplicate an orbit from the image target, it will appear as if nothing was selected when in reality the selected and duplicated orbit is simply toggled invisible. I chose to design this feature this way because it is simple and effective. I placed this button at the top, separate from the others, because it is rarely used and I did not want it to take up valuable space from the wand's control toolbar below. It can be seen in the screenshots below.

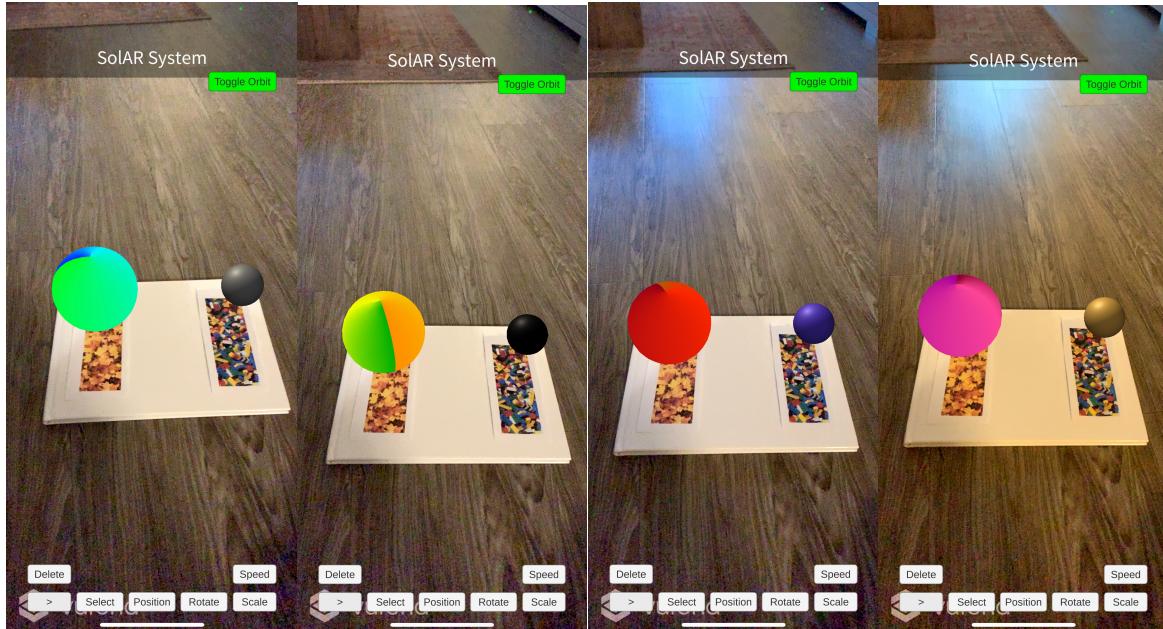
**Delete** – The top-left button of the bottom toolbar is the delete button. Upon clicking this button, it will turn green to indicate delete mode is active and the wand will also turn red. With delete mode active, any **duplicated** object the wand collides with will be destroyed. This excludes base images like the sun, orbit, planet, and moon image targets and applies only to objects that have been added to the solar system. The basic hierarchy of the solar system is such that orbits are parents of planets which are parents of their own orbits which are parents of moons. Since the sun cannot be deleted, if one wanted to erase the entire solar system they simply have to erase the first level orbit on the sun which will erase any and all children planets, orbits, and moons of that orbit. This mode is a bit dangerous as an accidental touch can erase something unintentionally however I have found that the wand allows for quite precise movement therefore I don't believe mistakes like that are very likely. Furthermore, the wand being red is my way of the user confirming they want to delete something which I believe further proved that a user would most likely not delete something unintentionally as there is clear feedback telling them to be wary of what they touch with the red wand.



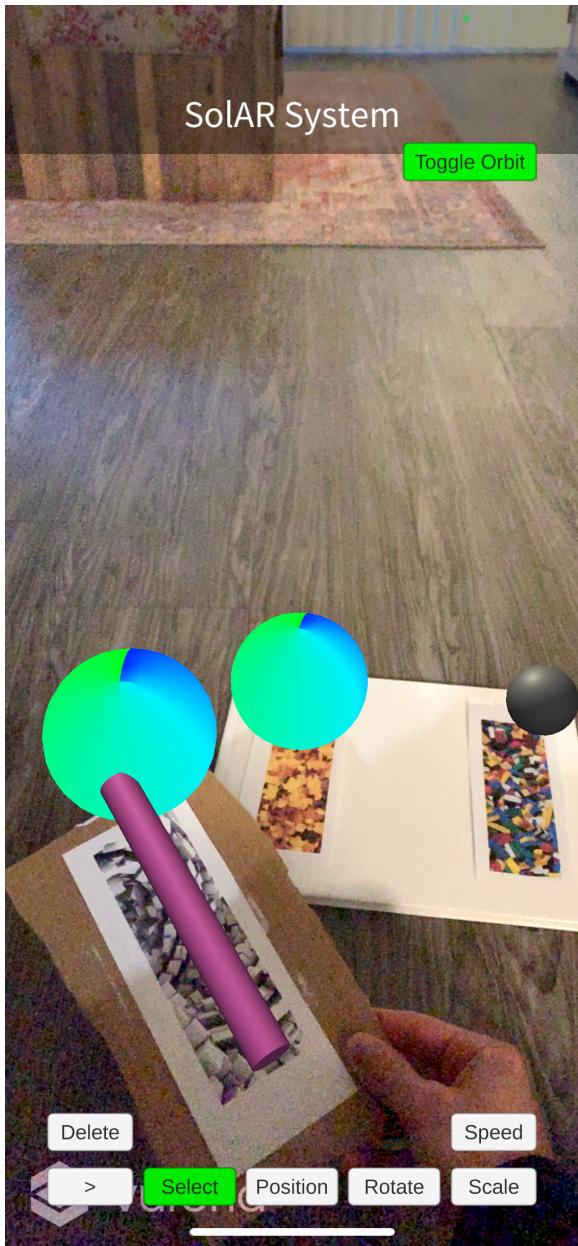
**Speed** – The top-right button of the bottom toolbar is the speed button. Upon clicking this button, it will turn green to indicate speed mode is active. When active, the wand will increase the speed of any orbit it touches **Upon Exiting** a collision with that orbit. This effectively speeds up the velocity of any planet or moon on the orbit resulting in quicker full rotations. I decided to make it upon exiting to ensure only one speed change is logged at a time. The wand also changes to a pink color when colliding with anything therefore one can know for sure which orbit they are toggling when on speed mode. There are 3 possible speeds for each orbit representing slow, medium, and fast. I chose to only give only three options because once the system is large and complicated with many orbits, especially when there are planets with their own orbits as well, it can sometimes be difficult to touch specific orbits as everything is constantly moving and hectic. With this approach, two quick and simple touches of an orbit can change the speed efficiently and ensures the user can make the necessary adjustments before a planet or its orbit is out of reach. It can be seen in the video of my assignment.

> **Button** – The bottom-left button of the bottom toolbar is the next button. The purpose of this button is to cycle between options for planets and moons (4 each). While looking at the planet and moon image targets and clicking this button, one can view the available options of planets

and moons they may wish to select and add to the solar system. Planets and moons can be mixed and matched however the user sees fit.



**Select Button** - The middle-left button of the bottom toolbar is the select button. Upon clicking this button, it will turn green to indicate select mode is active. The purpose of this button is to instantiate a clone of whatever the wand is currently touching on the wand and make the instantiated clone a child of the wand so that it will follow it and can be taken to a desired location. Once the clone collides with the appropriate object (an orbit to the sun or a planet, a planet or moon to an orbit, etc) it will react accordingly and leave the wand. It is important to note that once an object leaves the wand that the user needs to **turn off** select mode before being using it again to select another object. If a user accidentally selects something, erasing it is as easy as pressing the delete button. Since the instantiated clone is already colliding with the wand, it will simply be erased and the user can reselect their desired choice.



**Position Button** - The middle button of the bottom toolbar is the position button. Upon clicking this button, it will turn green to indicate position mode is active. The purpose of this button is similar to the select button however instead of instantiating a clone of whatever the wand is currently touching, it simply reparents whatever the wand is touching to be a child of the wand so that it will follow it and can be taken to a desired location. **It is important to turn off position mode once an object is picked up and before that object is placed** because while position mode is on, anything the wand touches will become a child of the wand. The wand can hold multiple objects at once however the program is built on the idea that the wand is carrying one object at a time. If multiple objects are accidentally picked up with the position button, the user may need to simply delete them as they will most likely not function as intended. When an object is picked up with position mode and then position mode is turned off, the user is simply

back at the same position they were after just selecting an object. The object on the wand can then be placed wherever the user desires again.

**Rotate Button** - The middle-right button of the bottom toolbar is the rotate button. Upon clicking this button, it will turn green to indicate rotate mode is active. When active, anything the wand touches (and continues to touch) will adopt the **wand's** rotation. While the user continues to collide with an orbit then, they can twist and turn the wand and the orbit will rotate in the same direction making it quite easy and intuitive to rotate orbits. It is important to be careful in general as rotation may sometimes cause the user to unintentionally block or lose an image target. A common mistake that may be made comes from the idea that the orbit will always reset to the wand's rotation upon collision, however I chose to leave this mechanic in for reasons I will explain below. As an example, let's say the user's wrist is straight when colliding with an orbit. The orbit will then establish itself in the straight wand's orientation and the user can rotate the wand and the orbit will follow. Since the wrist cannot rotate 360 degrees, eventually the user will not be able to rotate anymore. If the user then wanted the orbit to rotate more, they would probably try to pull back their wand, straighten their wrist, and collide with the orbit again to try and continue rotating where they left off. This however will not be the case as once the user collides with the orbit with a straight wrist, it will reset to what was seemingly the original position before effectively undoing the previous rotation the user made. While at first, I thought about making it so that the user would always continue, I realized that there were two reasons to leave the mechanic like this. Firstly, this mechanic serves as a great undo button/foundation for rotation which is a good usability heuristic. If the user enters with a straight wand but accidentally performs a rotation they did not want, they can always bring the rotation back to what they know with a straight wand. If the rotation continued to update from the last position, previous desired positions would most likely be lost or have to be navigated to again in reverse. Secondly, it is already possible to go more than 90 degrees in every direction therefore it is not as if lacking continuation means a certain rotation cannot be reached, it can simply be reached a different way. For example, instead of trying to rotate 270 degrees which the wrist and image targets would most likely fail to do, -90 degrees rotation is still possible and achieves the desired result.

**Scale** - The bottom-right button of the bottom toolbar is the scale button. Upon clicking this button, it will turn green to indicate scale mode is active. When active, this mode is similar to rotate as it activates **as long as the user continuously** collides with their desired orbit. While colliding with an orbit, that orbit object will scale up and down between a minimum and maximum threshold set by me for sizes. All the user has to do once they have a size they want is pull back the wand and stop colliding with the orbit or turn off scale mode. The spectrum is not very large as I wanted the solar system to remain manageable and it is quite simple to stop the scaling whenever one wants making this implementation very precise. I also chose to implement this button similarly to the rotate button because it means that the two buttons can actually be used simultaneously. If the user turns on both rotate and scale mode then, while the wand is colliding with an orbit the orbit will scale and also follow the wands rotation allowing more experienced users to work more efficiently (heuristic for expert users being able to speed up workflow).

Overall, I think my program works well, however it could always be improved. I think positioning is the hardest mechanic to control with my interface as it can lead to easy mistakes or multiple objects being attached to the wand which is tricky to handle, however I am particularly proud of being able to implement two modes with a wand simultaneously such as with rotate and scale. I also think that my program provides a lot of good feedback to the user from active buttons being colored, the wand changing colors with every collision or based on modes like delete, and more. In this way I think my program and interface helps prevent many unwanted errors and ensures the user will be able to perform exactly what they want.