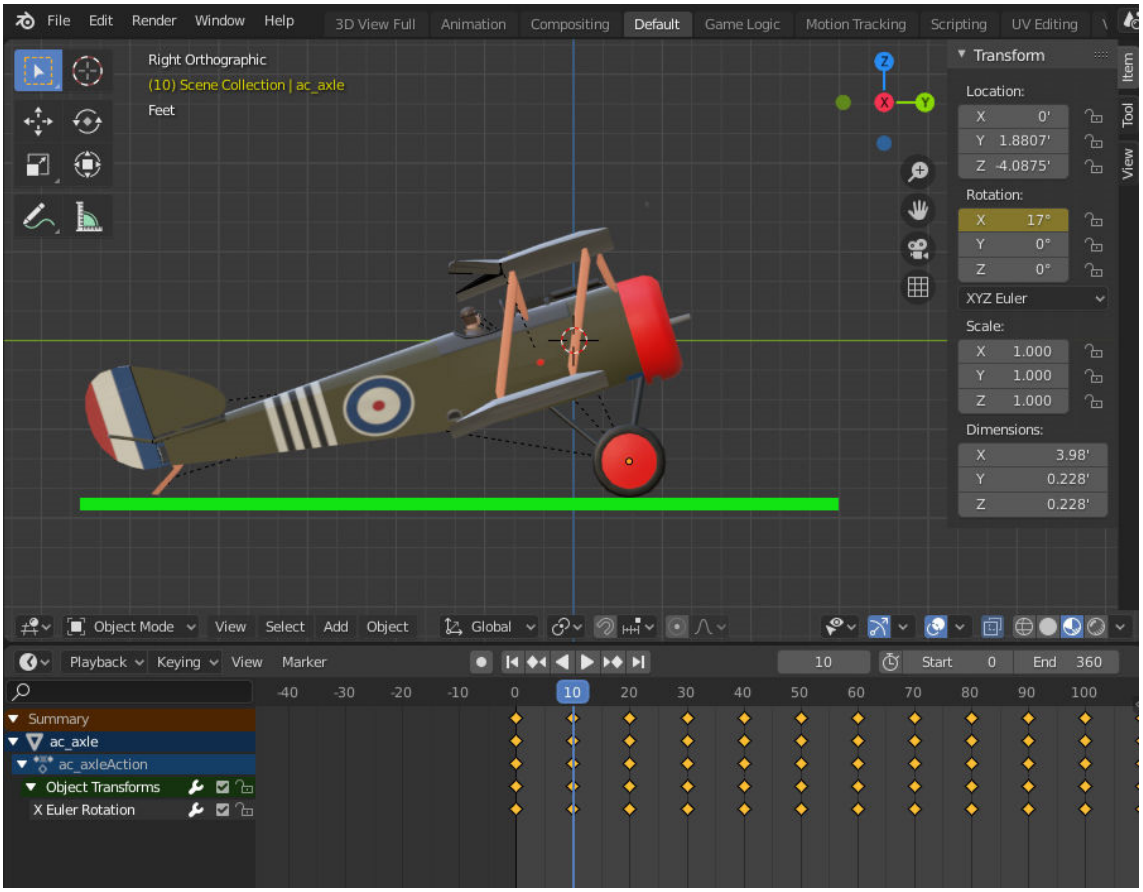
Computing Height of Aircraft Center for Taildragger on Ground

ThreeJS positions an object using the object center.

Where a taildragger aircraft is on the ground, the height of the aircraft varies with the aircraft pitch.

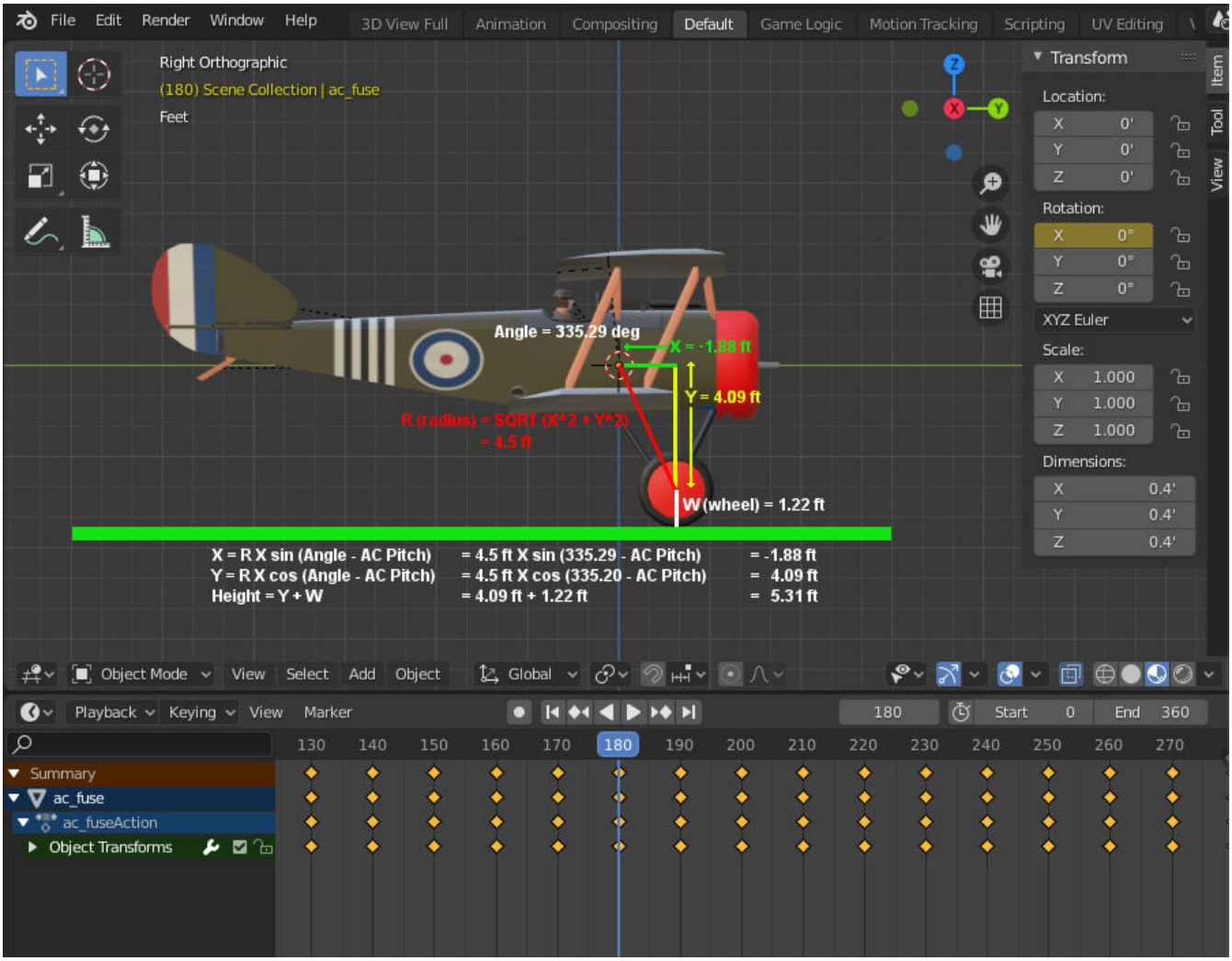


As this figure illustrates, when a taildragger aircraft is pitched back while on the ground, the aircraft center (red dot) is displaced both vertically and horizontally. The aircraft center is lower to the ground. This means that the object height is lower.

The formula for computing this displacement and height is discussed on the next page.

As an alternative to the formula, we tried using an axle-centered animation to achieve the same result. It almost worked! It works fine if the aircraft is level on take-off. However, if the aircraft is pitched back on take-off, there will be a noticeable jump as the aircraft transitions from the axle-centered rotation to the object-centered rotation.

Formula



The formula are as follows:

- X = R * SIN(RADIANS(Angle - ACP))
- Y = R * COS(RADIANS(Angle - ACP))
- Height = Y + W.

where:

- R = the distance between the axle center and the aircraft center.
- Angle = the angle of the line between the axle center and the aircraft center.
- W = the Wheel radius

You can compute R using the formula R = SQRT (X^2 + Y^2) where X is the horizontal distance between the axle center and the aircraft center and Y is the vertical distance. In this case, X = -1.88 ft and Y = 4.09 ft. Therefore, R = 4.5 ft.

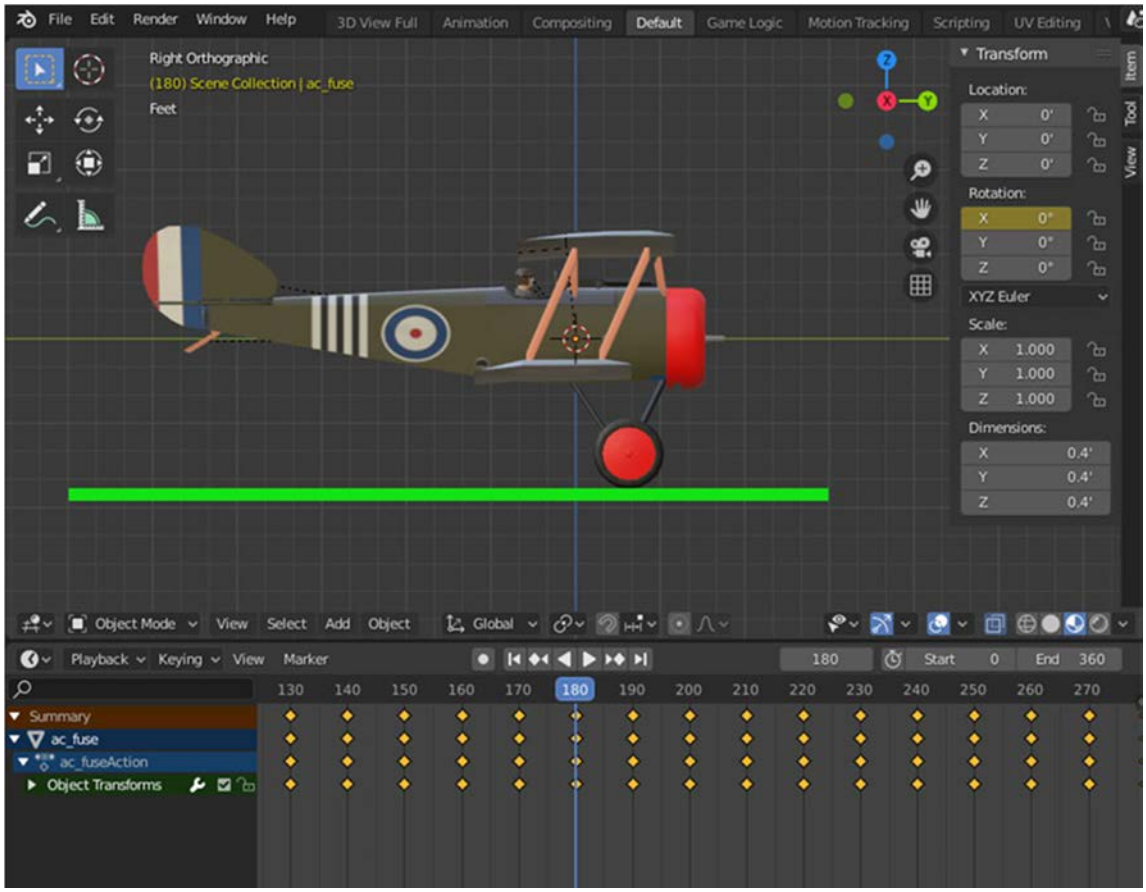
You can compute the Angle using the formula Angle = DEGREES(ATAN (X/Y)). Plugging in the values for X and Y gives you the result Angle = 335.29 deg.

The Wheel Radius (W) = 1.22 ft.

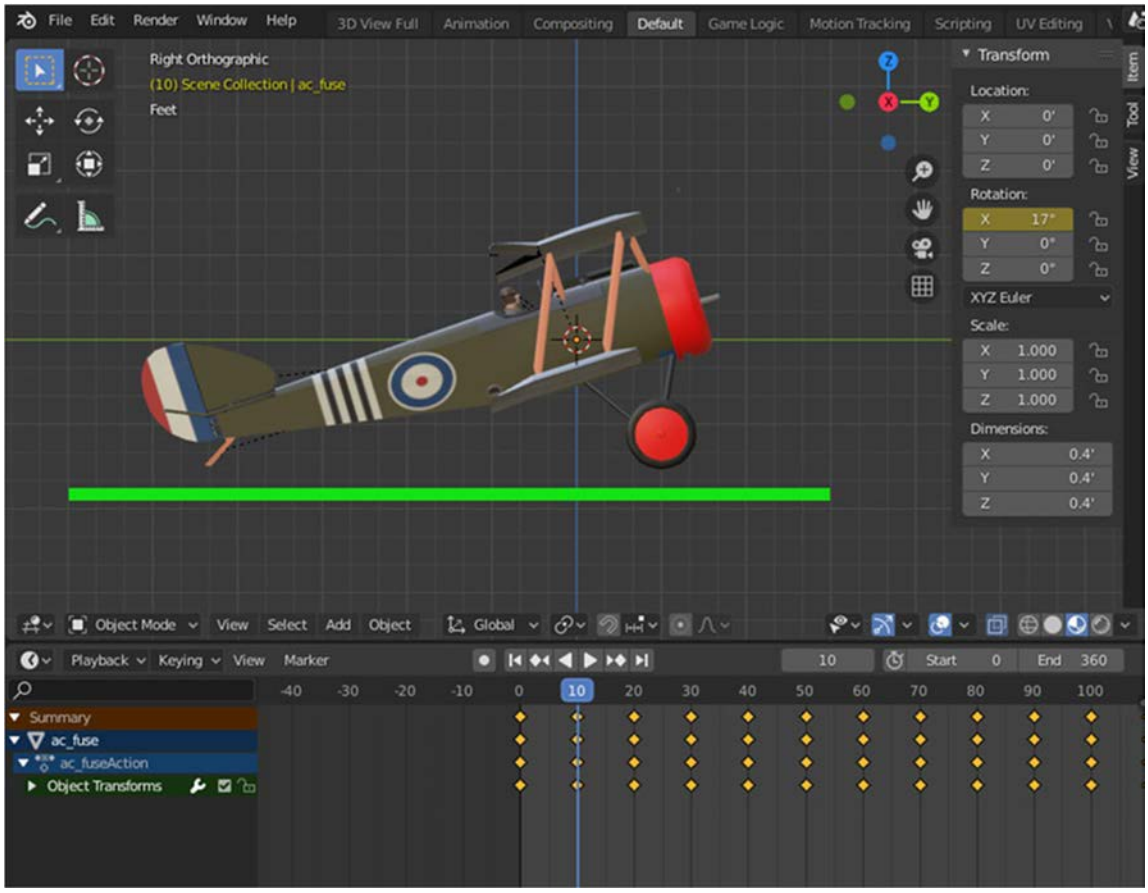
Plugging these values into the formulae gives the following:

- X ft = 4.5 ft * SIN(RADIANS(335.29 - ACP))
- Y ft = 4.5 ft * COS(RADIANS(335.29 - ACP))
- Height ft = Y ft + 1.22 ft

Aircraft Pitch around Object Center Good for Flight, but not Ground

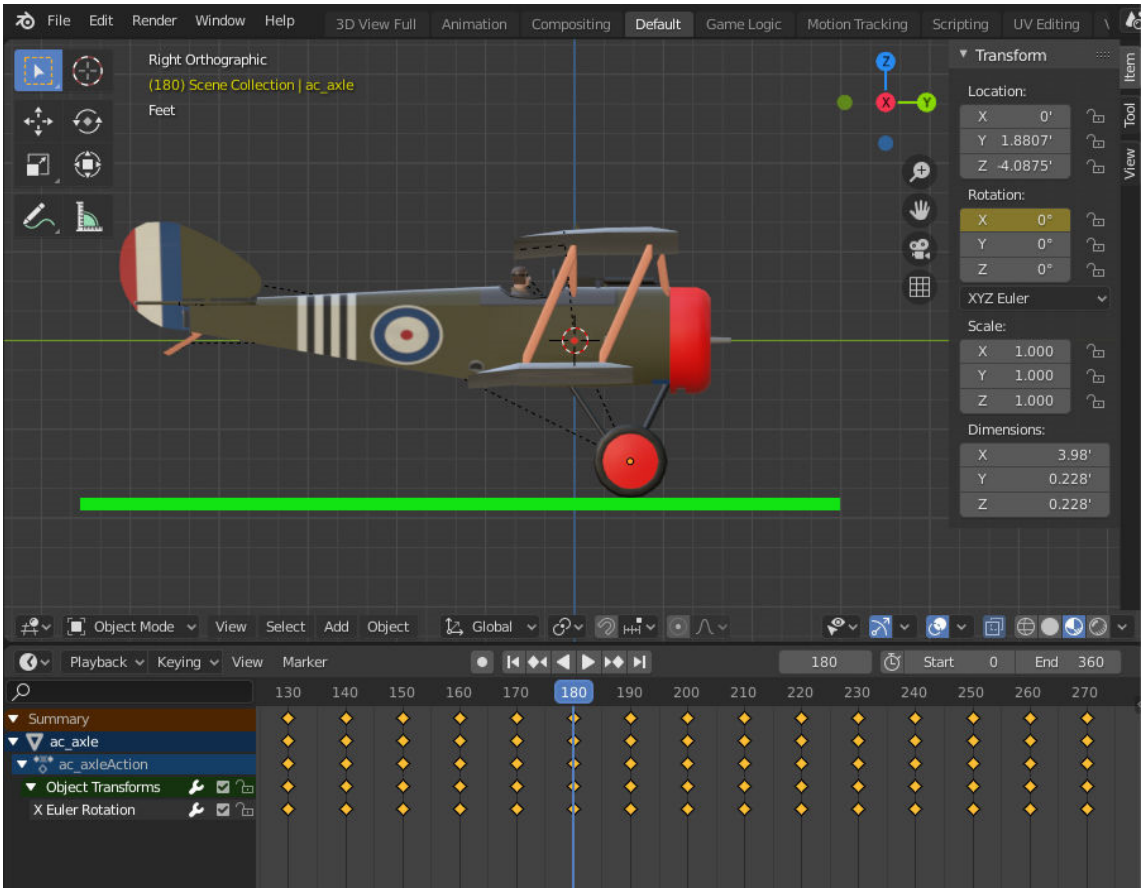


Pitch level, wheels on ground

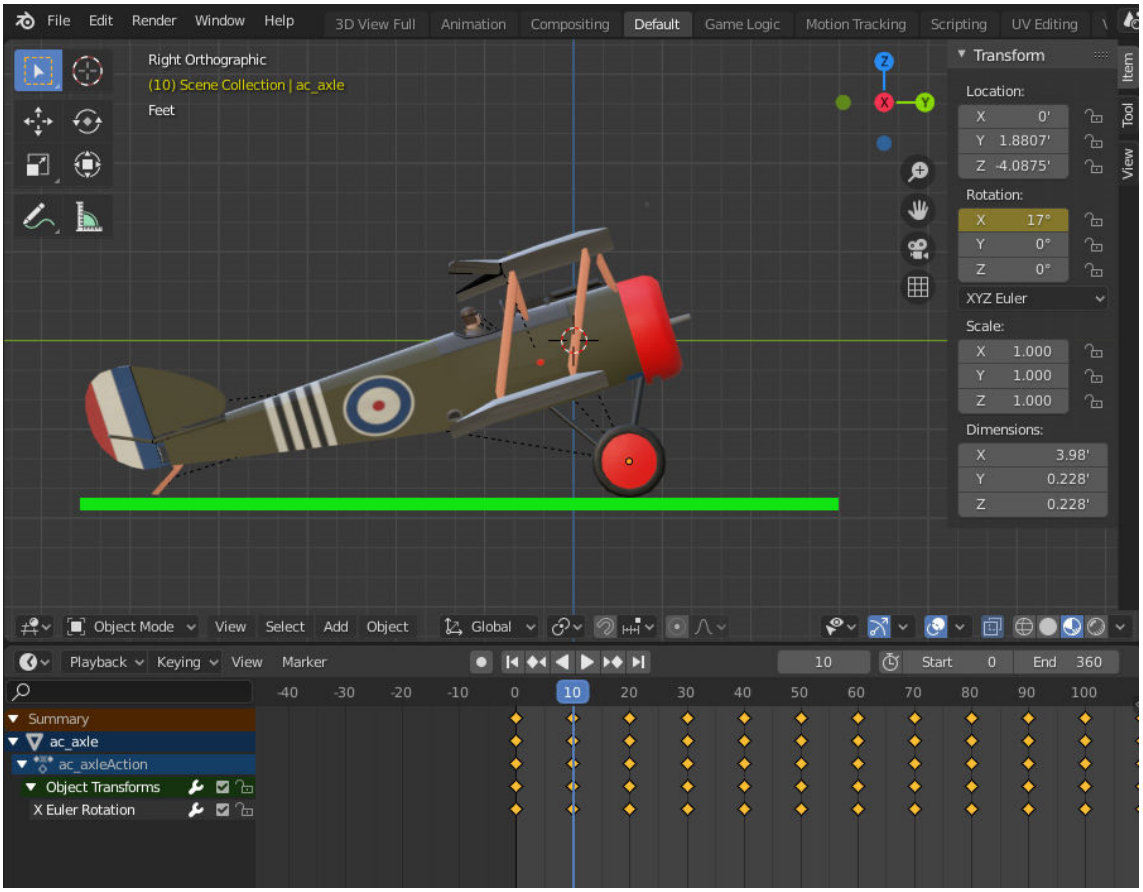


Pitch full back, aircraft has levitated

Aircraft Pitch around Axle Center Works!!

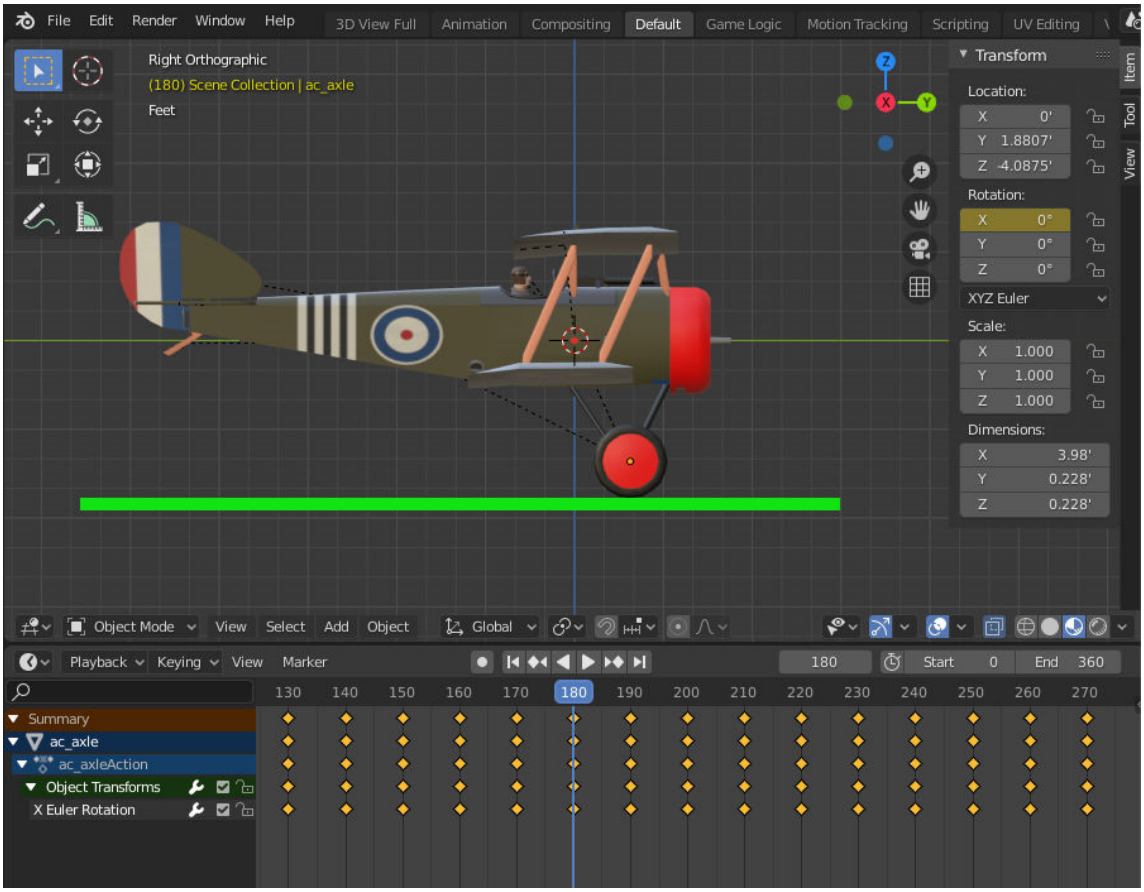


Pitch level, wheels on ground

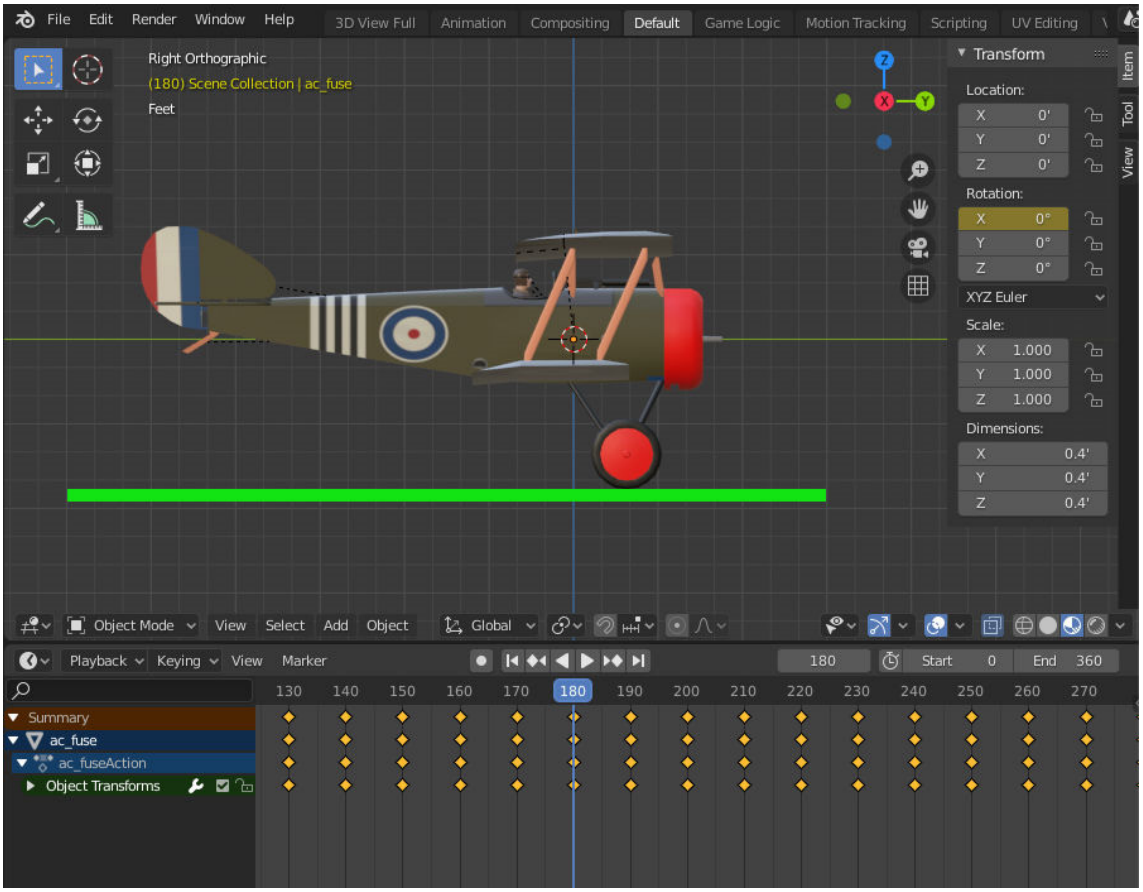


Pitch full back, wheels on ground

Transition from Ground to Air OK when Pitch is 0 degrees

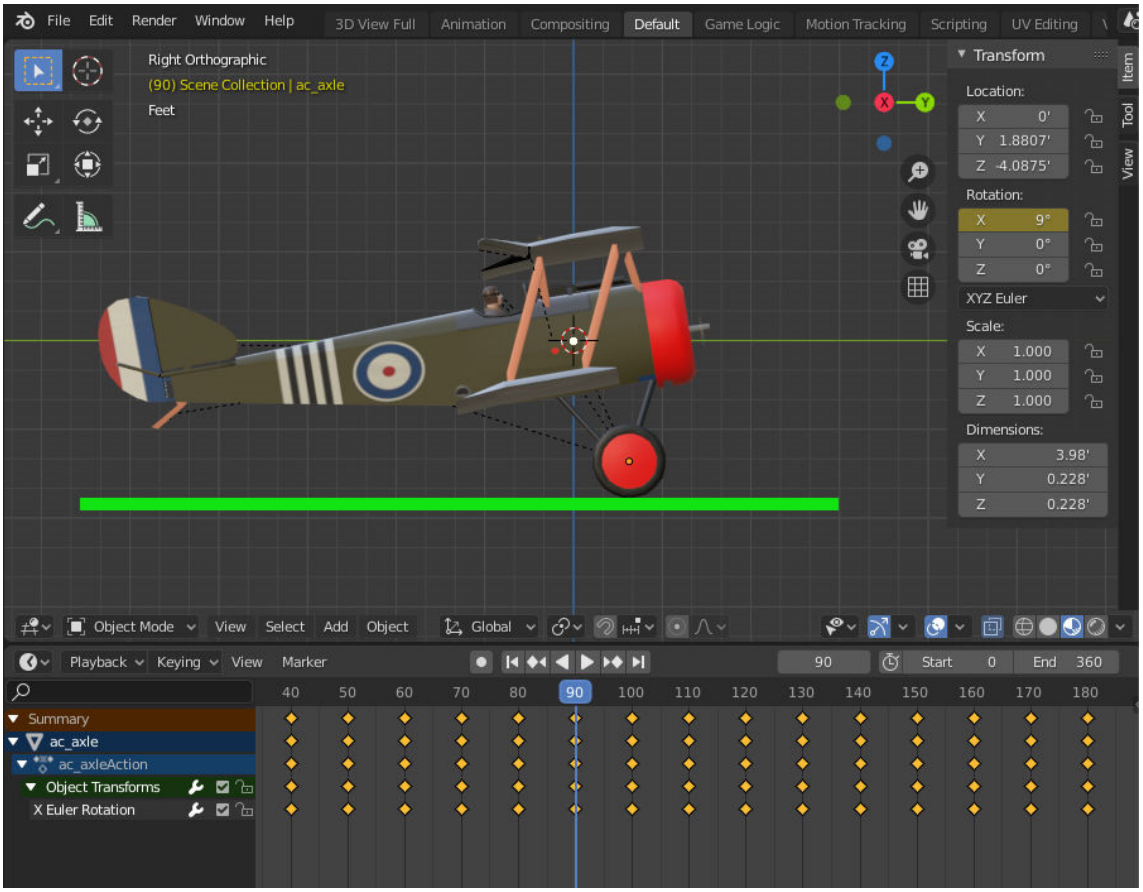


Aircraft pitch around axle center - aircraft center (red dot) = object center.

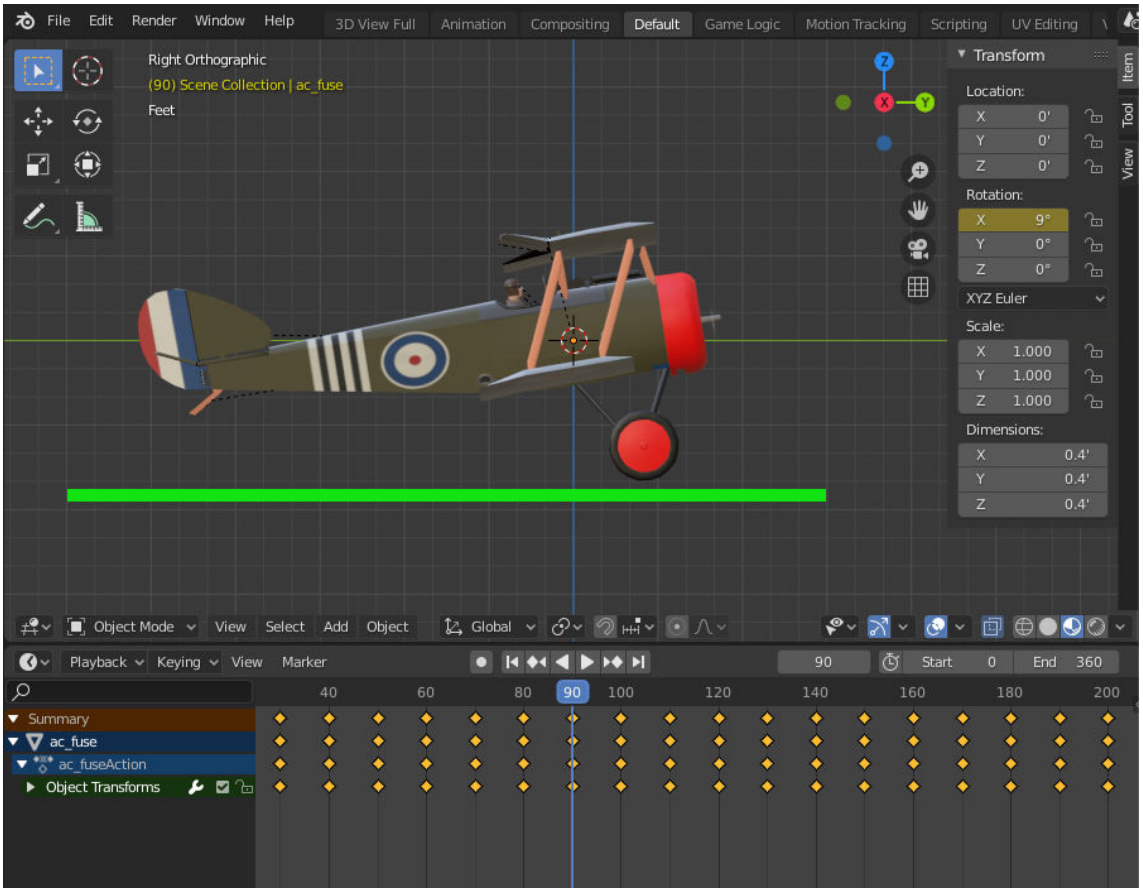


Aircraft pitch around object center = identical

Transition from Ground to Air Not OK when Pitch is Not 0 degrees



Aircraft pitch around axle center. Aircraft center (red dot) not at object center (yellow dot)



Aircraft pitch around object center. Aircraft jumps forward and up into air. Small but noticeable.

Solutions?

- You can fix forward jump by moving axle forward and back while rotating around axle so that aircraft center (red dot) is always horizontally aligned with object center (yellow dot).
- But there does not seem to be a good way to fix vertical jump. If add vertical displacement to axle rotation, aircraft will levitate.
- The best solution appears to be to pull the aircraft down when you transition from ground to air. But this requires you to use the formula. So we might as well skip the axis rotation animation and use the formula.