Discovering your smartphone's local coordinate system

Part A   Vocabulary for the external geometry of a smartphone

The external geometry of a cell phone is roughly that of a box. A box has 6 walls and three axes. When you view your screen in portrait mode, you see a rectangle. We name the two axes of this rectangle the *left-right axis* and the *long axis*. The third axis is the one that runs perpendicular to the screen, which we will call the *camera axis*. You can imagine this last axis as a line going from your eyeballs to the screen surface and through the phone to the back surface.
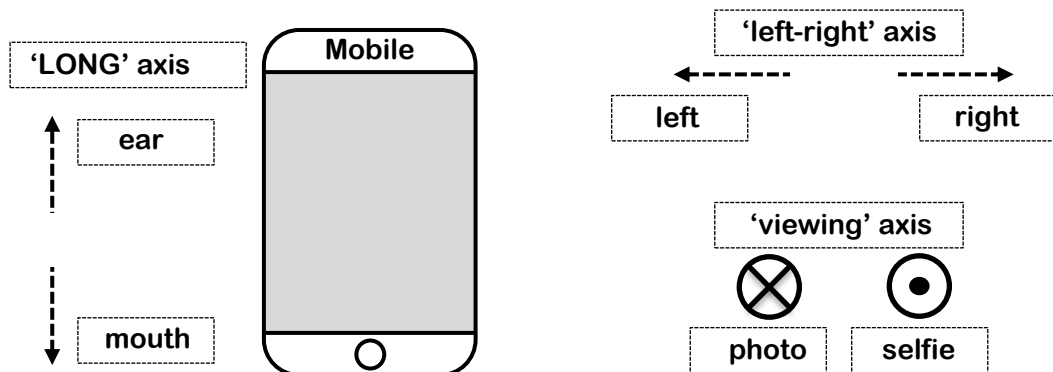
To avoid confusion, we refer to the six walls as follows[1] :

LEFT-RIGHT axis
directions : left, right

LONG axis
directions : « mouth », « ear »

CAMERA axis
directions : « selfie », « photo »

Making 3-D drawings all the time is tedious, so physicists usually stick to "flat" drawings, and use "dot-or-cross" circles to indicate directions that are "out" or "in" perpendicular to the drawing:

Your phone does not use this vocabulary, however. It uses only « x » « y » and « z » for the axis names and positive or negative values to indicate directions. Which axis does « y » refer to? Which direction is positive? The answers depend on how the coordinate system of your phone has been configured by the manufacturer.

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[1] Notice how we have carefully avoided the use of the words "up" and "down", words which become confusing once you start changing the orientation of your phone.

Part B   Determine the configuration of the local coordinate system

1. Start the accelerometer app on your phone. (previously installed)

2. Place your phone with the left side flat on the tabletop. Examine the output. Two axes should be reading values very close to zero, and one axis should have a magnitude close to 1.0 G, or 9.8 m/s^2, depending on how your app displays the data. The color of the graphed line tells you which axis label (x, y or z) corresponds to *left-right* axis. Now invert the phone position, so that the right side is flat on the table top. Which one of the two orientations produces a positive reading? Which direction, therefore, is considered positive for your phone? (** Carefully read "*Understanding accelerometers*" before answering!)

3. Place your phone with the mouth side flat on the tabletop (as if you were going to take a snapshot of the front of the classroom). Next, invert the phone so that it is upside-down with the ear side flat on the tabletop. Examine the output in both cases and draw some conclusions about how the *long axis* is configured.

4. Now place your phone in its normal orientation on the tabletop, i.e. with the back wall flat and the screen facing up. Examine the output. Now invert this orientation. You won't be able to examine the output because the screen is against the table! Instead, hold the phone above your head, as if you were about to take a snapshot of the ceiling. Compare the output in the two orientations and draw the appropriate conclusions about the configuration of the *camera axis*.

5. Continue with enough experiments to be able to confidently complete the figure below: in the large rectangles fill in the label for the axis ("x-axis", "y-axis" or "z-axis"), and in the small rectangles indicate the sign ("+ positive" or "- negative").