Determining the Position of an Accelerometer Sensor using Linear Regression

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Objective

To experimentally determine the position of an accelerometer sensor in a device using Linear Regression.

What is an accelerometer?

» Very small sensor (<1mm in length) that tracks and records a device's acceleration.
» Present in mobile phones, smartwatches, navigation devices, vibration sensors, flight stabilisation, and much more.

Materials

1. Record player (with 78RPM option)
2. SpinFrame (3D-printed frame seen in Fig. 1)
3. PocketLab Voyageur Accelerometer
4. Ruler/measuring instrument
5. Tape

Method

1. Placed accelerometer on top left of SpinFrame. which was attached to record player (see Fig. 1).
2. Recorded acceleration data as it rotated at 78RPM.
   » Found average acceleration.
3. Shifted accelerometer 1cm to the right and repeated.
4. Once complete, replaced the accelerometer at the top left and shifted downwards instead.
5. Compared the measured radius $\vec{R}$ to the estimated radius $\vec{R}_d$ (see Fig. 2) using Linear Regression to obtain $\vec{r}$ (see Fig. 2, Fig. 3, Fig. 4).
6. Found the position of the accelerometer sensor using $\vec{r}$ and $\vec{R}_d$.

Fig. 1: Record player with SpinFrame attached. An accelerometer device would be placed within the frame during testing.

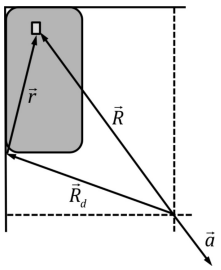

Fig. 2: Vector diagram representing the method of locating an accelerometer sensor.

Results

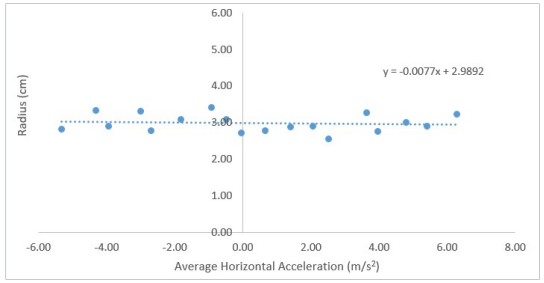

Fig. 3: Radius of rotation ($\vec{R}$) compared to average acceleration when varying the accelerometer's **horizontal** position.

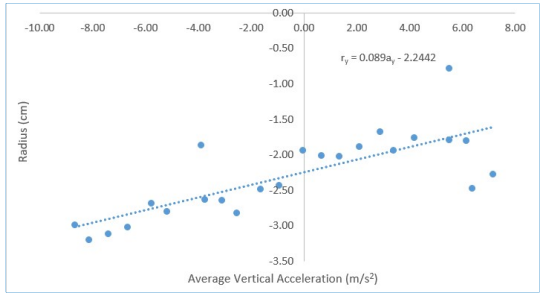

Fig. 4: Radius of rotation ($\vec{R}$) compared to average acceleration when varying the accelerometer's **vertical** position.

Conclusions

Linear Regression conclusions:
» 0.49 cm of horizontal error
» 0.13 cm of vertical error

These are accurate results, but they may be improved with future work:
» Decrease wobble of SpinFrame
  » Ensure correct center of mass during data collection
» Test with various accelerometers
» Build larger SpinFrame to accommodate for larger accelerometer devices.

Fig. 5: Representation of experimental accelerometer positions on figure of PocketLab Voyageur device.

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Sources

Larnder, C. I. (2020). A Purely Geometrical Method of Locating a Smartphone Accelerometer. The Physics Teacher, 58(1), 52–54. doi: 10.1119/1.5141974
Larnder, C. I., & Larade, B. (2019). On the determination of accelerometer positions within host devices. *American Journal of Physics*, *87*(2), 130–135. doi: 10.1119/1.5082536