There's an app for that… Testing geologic smartphone apps against the Brunton Pocket Transit

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Introduction

In geological mapping, attitudes of rock strata are described by measuring strike and dip. In the field, the locations and attitudes of strata can make measurements difficult, even dangerous, to make. Recently, smartphone apps have been developed that take strike and dip measurements quickly and easily, and even map them using GPS with the option to include notes or photographs. This has provoked debate among geologists as to their utility, especially regarding the quality of the measurement. It is expected that a conventional magnetic compass will be more precise, as well as accurate, but there is an argument for being able to take measurements quickly and easily, especially in physically challenging situations.

Since the app reads the phone's accelerometer and magnetometer to orient itself, the choice of app should not influence the results, but the device itself may. Therefore, we tested one application each on two Android phones, an iPhone, and an iPad for precision versus the Brunton compass. Results confirm that the compass gives more precise results when used correctly. While the precision of the compass is to be generally preferred, these tests also show that, depending on the degree of precision required, readings given by these devices have the potential to be acceptable for geologic mapping, when used with care. This is expedited by the app's ability to make many measurements quickly, as well as its virtually nonexistent learning curve. While it is unlikely that the compass will soon be replaced, the speed, convenience and safety offered by the smartphone app may be appealing enough to warrant its careful use in certain situations.

Questions

-Can a smartphone app for strike and dip be a viable choice in structural geology and what are its advantages and pitfalls?

-Will choice of orientation affect accuracy of smart phone app's reading?
-How much variance is there across devices and platforms?
-Which is more precise, smart phone or Brunton compass?
-When will the smart phone app be preferred to the Brunton compass?

Assumptions

-Strike & Dip app simply reads phone's magnetometer, accelerometer, and GPS.
→ Choice of app will not directly affect results
→ Quality may be determined by phone's *hardware* more than *software*
-Brunton compass will likely be more precise, but the smart phone app may be preferred in certain situations.

Methods

Planar surface test for precision
-**Measured surface**:
Finished-surface board at steep angle (~55°) against flat spot on tree, and firmly grounded.

-**Smart phone app**:
Approx. 100 measurements per device, with approx. 50 each in two orientations: right side up and upside down. Measurements made within 10x10 inch square area. Android device measurements made by CV, Apple measurements by JM.

-**Brunton compass**:
60 measurements, 30 by each author, within same area on same surface.

Results

- Test results are displayed in figures 1 – 3, at right: measurements arranged by device are represented in Fig. 1, measurements arranged by orientation are shown in Fig. 2, and azimuths of strikes for electronic devices over the duration of testing are shown in Fig. 3 (total time per test is less than ten minutes).

Discussion

- The Brunton Pocket Transit clearly renders the highest precision when used correctly (Fig. 1).
- Pre-ANOVA results of precision tests arranged by device (Fig. 1) suggest that the orientation of the device likely affects the quality of the strike measurement. For example, the LG V10, in the upright position is relatively consistent, whereas upside down, it has produced a bimodal distribution. The iPhone 6, on the other hand, performed better when upside down, giving a significantly bimodal distribution while upright.
- Dip angle appears to be highly precise (mean 2σ standard deviation = 1.26) on all electronic devices at the moderately high angle of the plane used in this test.
- When measurements are contrasted by orientation (Fig. 2), some devices perform better than others. Depending on the level of precision needed, these devices may be capable of producing effective results. For example, the LG V10 when upright, and the LG G4, the iPad, and iPhone 6, when upside down, produced strike results with 2σ standard deviations below 5°.
- One of the most striking results of this study regards the precision of the strike reading for the electronic devices over time (Fig. 3). The variance of the reading appears to change over time with the iPhone 6, especially when right side up, the LG G4, and to a lesser degree, the LG L-10.

Conclusions

- It is probable that the electronic devices' orientation affects the reading they give.
- These results show there may be significant variance across devices and platforms.
- This test hints that the precision of devices may vary over time, suggesting the influence of unrecognized variables.
- The Brunton compass, when used correctly by a skilled operator, is clearly more precise than the devices tested here.
- Previous work has suggested that electronic devices can give results that are useful in structural geology, depending on the degree of precision required (Vanderlip, 2016). This study shows that care must be taken when high degrees of precision are required, and emphasizes the value of testing devices.

Results

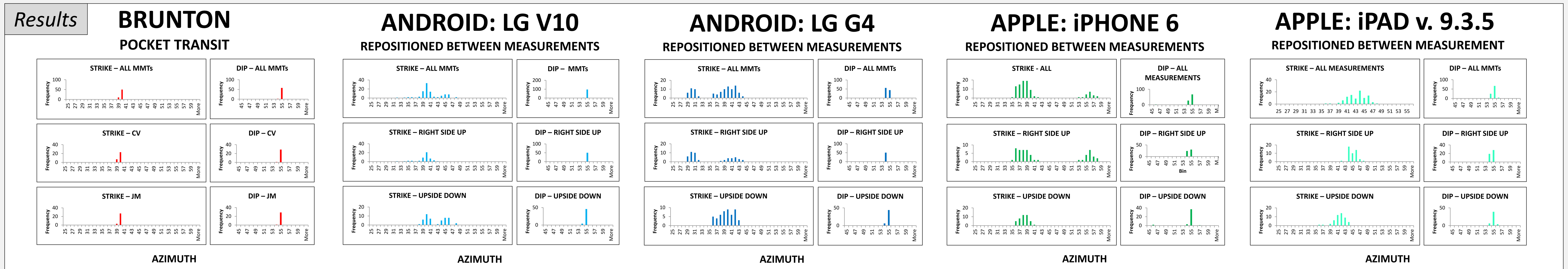

Figure 1 **– Histogram results of precision tests arranged by devices, strike and dip paired horizontally. All measurements shown together in uppermost histogram pair, lower two histogram pairs show subgroups split up by: geologist in the case of the Brunton compass, orientation in the case of the electronic devices.**

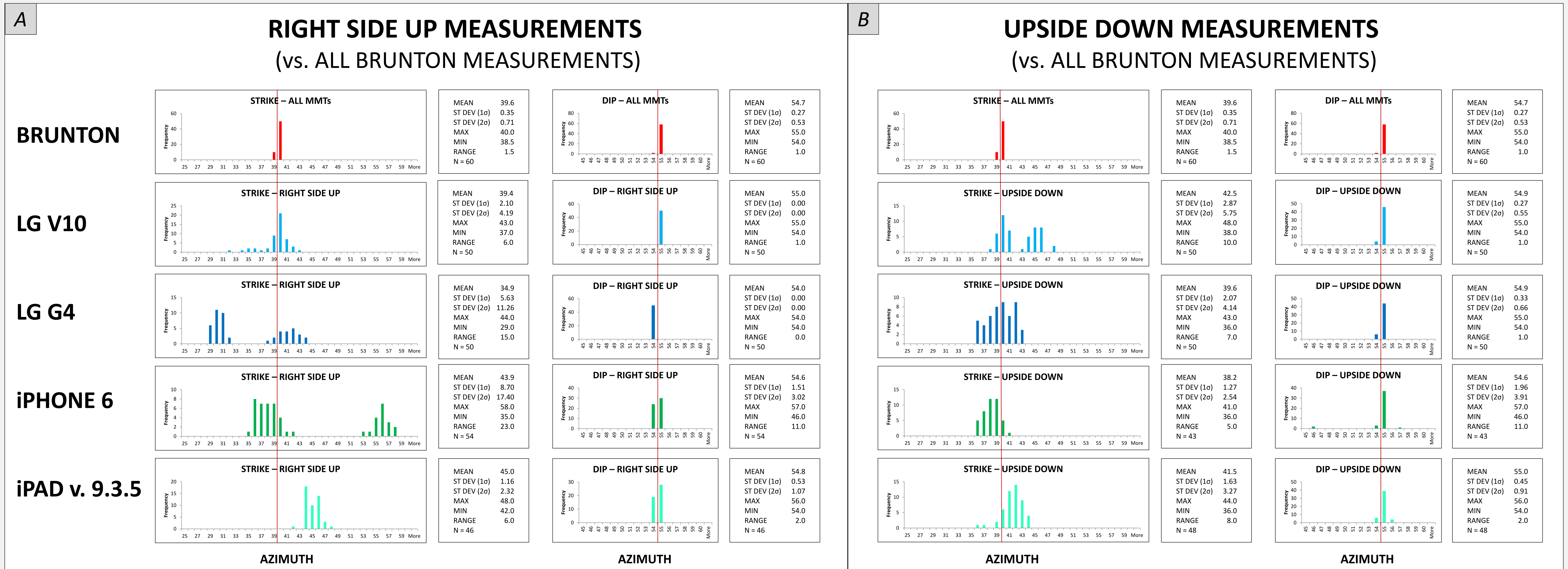

Figure 2 **– Histogram results of precision tests arranged by orientation, with basic parametric statistics in boxes at right. All Brunton compass measurements are compared against right side up (A) and upside down (B) orientation results for individual devices. Red vertical lines represent approximate mean strike and dip values for Brunton compass, assumed most accurate orientation of strike and dip.**

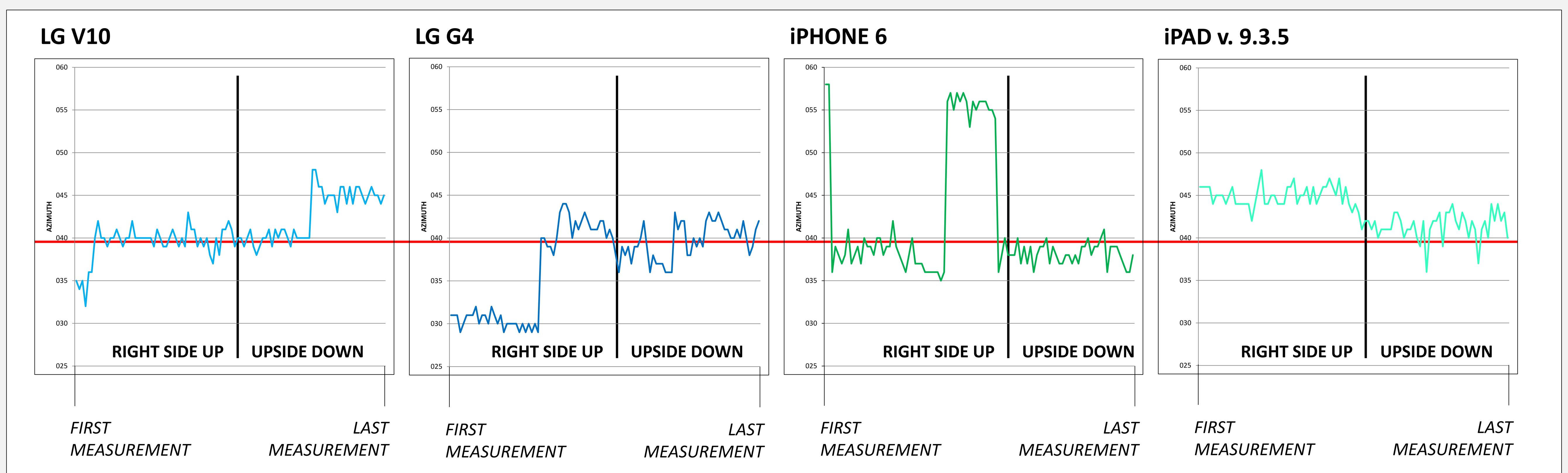

Figure 3 **– Azimuths of strike for sequential measurements electronic devices with time, from beginning of test at left to end at right. Average length of test per device is approximately five minutes. Left of black vertical bar shows right side up orientation, right shows upside down orientation. Red horizontal line represents most accurate orientation of strike, as in figure 2.**

Further Work

- With respect to this dataset, further statistical tests such as ANOVA will help elucidate the extent to which the orientation of the device affects the precision of its measurements.
- Further testing of these devices versus the Brunton compass aimed at quantifying accuracy of measurement are in progress.
- Tests similar to this should be run at a variety of dip angles to reveal how accurate and precise the measurements are on shallower and steeper planes.
- More extensive testing may reveal the effect of the devices' readings over time (Fig. 3), and allow for development of a workaround.
- More devices should be tested to see if technological improvements over time produce more precise readings.

Work Cited

Vanderlip, C. A., 2016, Structural geology with a mobile phone?: Testing smartphone apps for strike and dip, Geological Society of America South-Central Section Meeting, 22 February 2016.

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