OPTOFIDELITY

TEST REPORT
FORCE SENSING TESTING WITH OPTOFIDELITY™ GOLDFINGER

1. Force Sensing and industry landscape

Force sensing is a relatively new input method for smartphone displays giving application and OS developers an opportunity to utilize force data to create new applications and gestures. There are already devices available for public like Apple Iphone 6s &7s, Apple Iphone 6s & 7s plus, Huawei Mate S Premium, ZTE Axon Mini, Huawei P9 plus, Meizu Pro 6 and based on the rumors many more will be available in the near future.

Testing was done by using Apple iPhone 6s & 7s, Huawei Mate S Premium and ZTE Axon Mini. At the moment force data has mainly been used for gestures like peek and pop by Apple, Magnifier by Huawei and application preview with Pressure by ZTE. These gestures do not have so strict requirement for the reported weight or time between pressing the screen and reporting the press. There are many use cases which would benefit from having very exact force measurement with rapid reporting tied to touch screen reporting interval.

Examples:

- Drawing applications could utilize the data by modifying the line width based on the applied pressure.
- Games with improved drive controls (turning, throttle, brake) without lifting the finger from the screen i.e. more pressure, more throttle.
- Keyboard accuracy and reliability improvements

Force sensing is not a new thing in the industry and it has been used in so called active styluses already many years by Wacom, Microsoft and Apple. It has also been trying to get traction in touch pads used in PC and Mac computers.

2. Force Sensing Testing with OptoFidelity GoldFinger

In this example, tests were done by using the OptoFidelity™ GoldFinger and device specific holders to make devices steady during testing.

OptoFidelity™ GoldFinger is a versatile non-intrusive test system designed to support both production line testing and calibration as well as R&D testing. System is perfectly suited to production line force calibration and testing due to its fast software controllable weight control, which makes it possible to apply several weights to the same position just by setting the wanted weights by software. No need to change “dead weights” and use time for robot movements. Test station can be equipped with several DUT holders to improve tester tact time like seen in Figure 1.

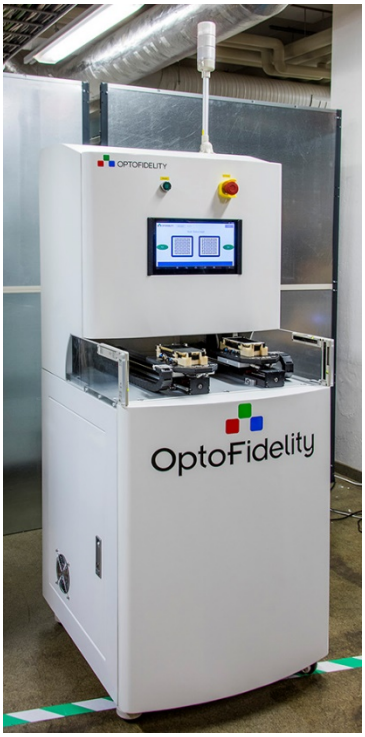

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Figure 1 OptoFidelity™ GoldFinger Production Tester

OptoFidelity™ GoldFinger will also give a lot of opportunities for non-intrusive end to end R&D testing as well as competitor analysis with supported Android and iOS applications. GoldFinger test system can be also installed to R&D testing robots e.g. used for touch testing.

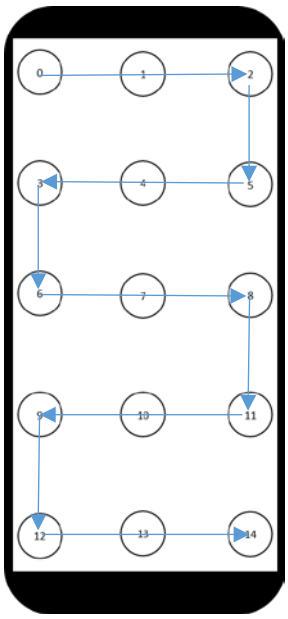
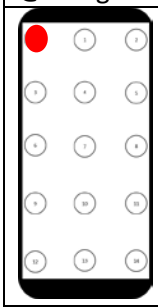
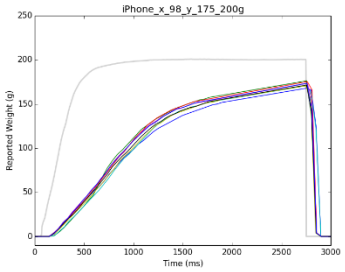
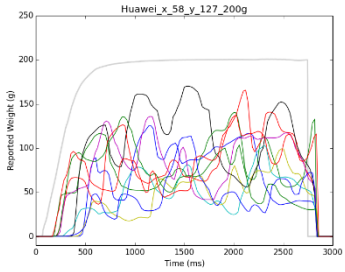
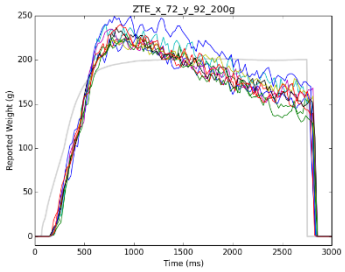


Figure 2 Test Cycle

Weight was applied to the screen with 3x5 matrix, which is illustrated in Figure 2. Each position in the matrix was pressed with a selected weight in a sequence, and the sequence then repeated 10 times. The test cycle was executed in the 50-550 gram test range with 50 gram increments. Reported values were gathered from the phones by OptoFidelity testing application and stored for later processing. At the moment Force API's in Android or iOS do not report weight as grams, but rather as a number between 0-1 (Android) and 0-100 (iOS), so a conversion factor was needed to change the reported number to a gram value. Conversion factors were calculated from the data of several measurements at the display center area.

3. Test results and findings

Test results are visualized by showing the waveforms of each measurement and OptoFidelity™ GoldFinger reference curve (Grey) of one test point at a certain weight. This gives an overview how force sensor in the tested devices is behaving in different test points over whole phone display active area as well as showing an indication of the response speed from applied weight to reported force.

Position 0 @ 200g	Apple	Huawei	ZTE
			

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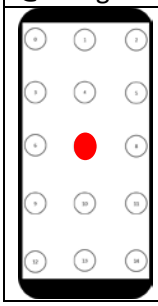
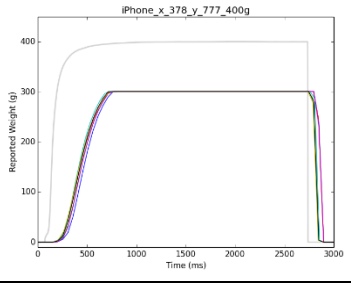
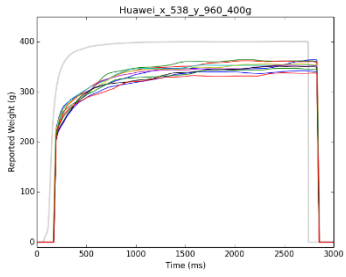
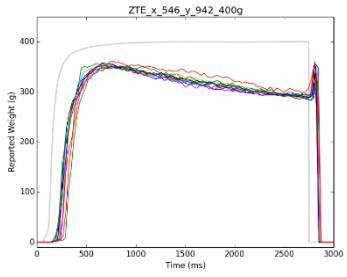
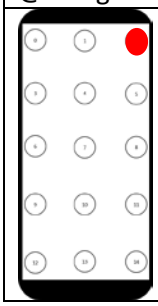
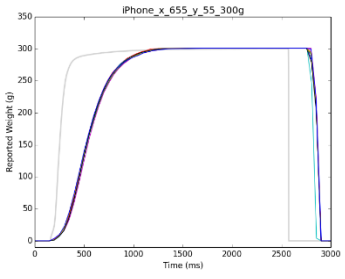
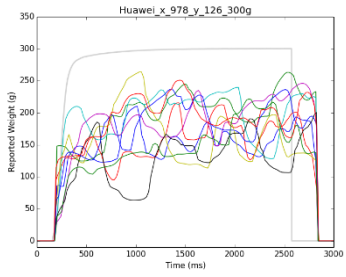
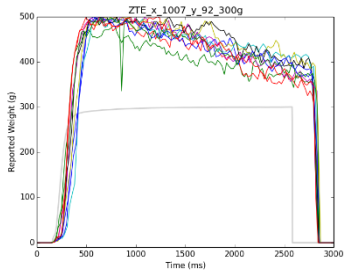
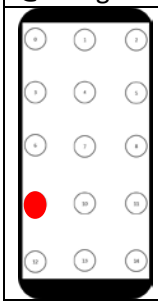
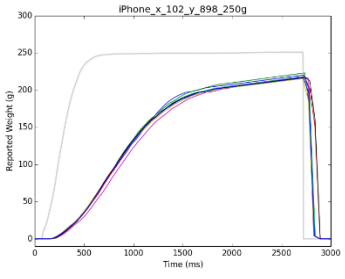
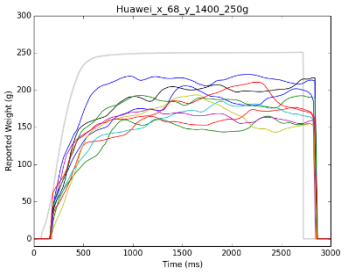
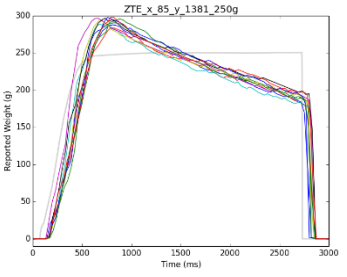
Position 7 @ 400g	Apple	Huawei	ZTE
			

Position 2 @ 300g	Apple	Huawei	ZTE
			

Position 9 @ 250g	Apple	Huawei	ZTE
			

Position 14 @ 350g	Apple	Huawei	ZTE

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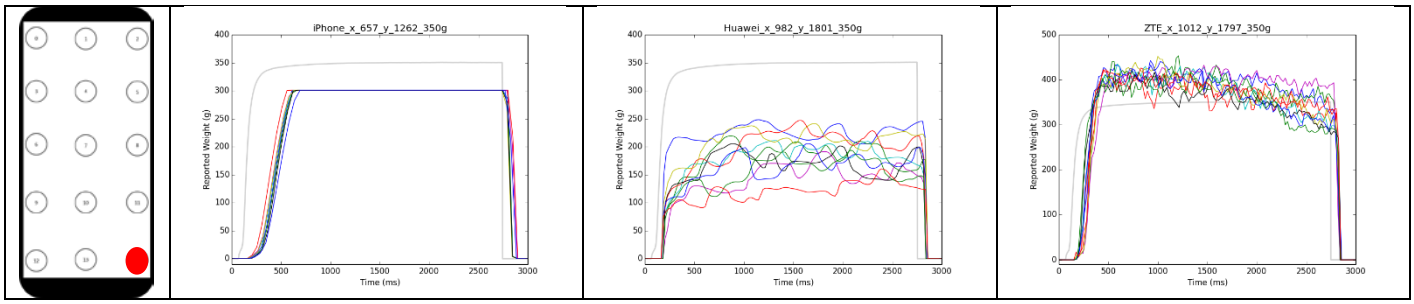
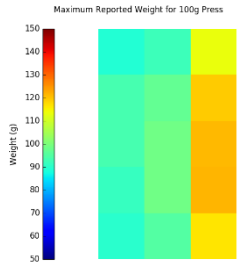
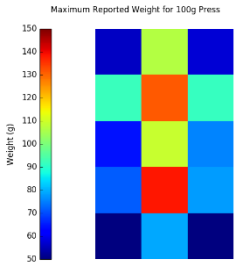
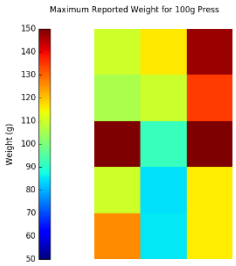
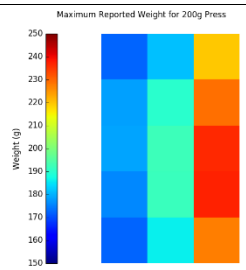
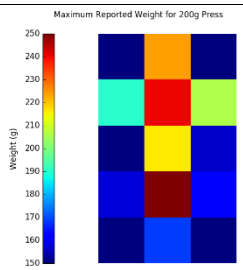
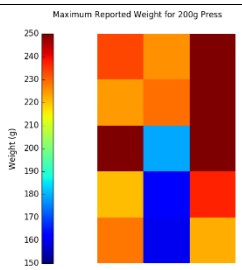
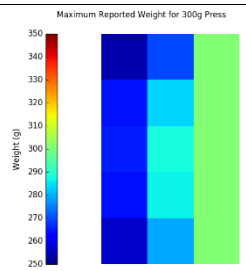
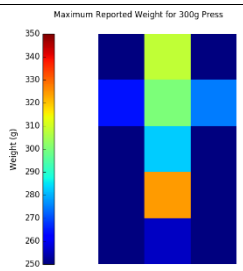
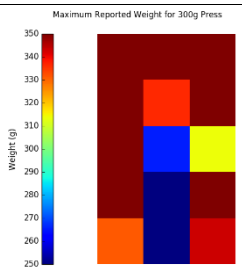


Another way to visualize same test results as above is to look the force reporting response from the display area as a whole. In the pictures below is shown the average of the maximum reported weight of all the 10 measurements compared to the applied weight.

Applied Weight	Apple	Huawei	ZTE
100g			
200g			
300g			

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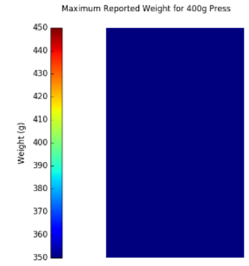
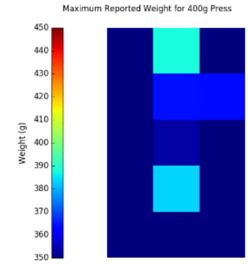
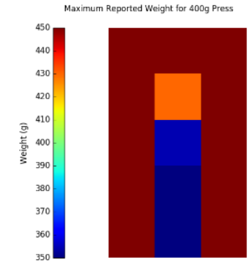
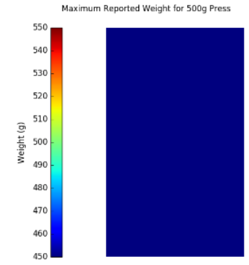
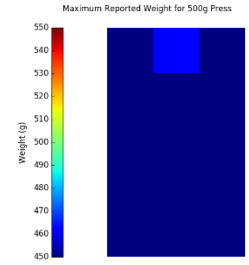
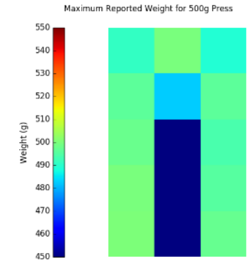
400g			
500g			

According to our testing force sensing solutions used in the devices are not yet usable for measuring exact weights in the whole measurement area and it seems that there can be a lot of variation at the reported weights dependent on the tested position and used weight. Performance seems to be optimized for the area in middle of the screen and weights between 200-400 grams, except for the iPhone which does not report weights over 300 grams.

Weight reporting response rate is not in the same level as with e.g. capacitive touch screen 10 millisecond range and based on the results reporting latency differs from few hundred milliseconds to close to a second.

Out of these three devices iPhone reporting looks to be most stable, but hard to say how much filtering is being applied to the values before those are reported to the use of applications.

4. What this means to application and OS developers

For an application developer, data quality and reproducibility is extremely important when creating applications. If there is a big variability in input data, application and gesture controls need to be optimized according to the biggest variation, which often means slower and simpler applications with sacrificed performance. Applications will often become gesture control based instead of exact information based. One of the most challenging applications is to make scale application or very detailed controls e.g. for car games with force enabled throttle and brake control as those require force data to be exact and stable in the whole operation range.

With OptoFidelity™'s GoldFinger, developer can characterize force supporting devices by applying multiple force levels with software controlled system and get the reported force values from the devices. Testing is non-intrusive and using the publicly available API's from the devices. So the results are comparable to the results that developer would be seeing with their applications as well. As this testing can be easily done to many devices, it is fast and easy to get understanding about the overall force sensing performance level of devices that are available for the end users.

5. Summary

Testing clearly shows that there are differences between devices and in their behavior when different weights are applied to the screen and different parts of the screen. This was the 1st round of testing with force sensing enabled devices and target is to continue testing when new devices come available.

6. About OptoFidelity

OptoFidelity is the global leader of testing solutions for user interactions in mobile consumer electronics products. OptoFidelity works with most of the top 20 technology and consumer product companies in the industry. OptoFidelity's testing solutions and technology is used also in other industries such as automotive.

More information on the OptoFidelity™ GoldFinger and other test solutions is available at http://www.optofidelity.com

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