



SHADOWSENSE PERFORMANCE
REPORT: RESOLUTION

1.0 Objective

The purpose of this experiment is to measure the touch resolution of a ShadowSense frame and show its relationship to the screen resolution.

1.1 Equipment

The equipment used during the entire test:

- Baanto SDW565W1 ShadowSense touch frame with firmware version 9.00
- 55" 1920 x 1080 HD Display
- PC running Windows 10
- Baanto Dashboard software
- ShadowSense stylus

2.0 Method

Once the touch frame was setup correctly and the logging function was enabled from Dashboard, the first step was to capture all possible X-coordinates recorded by the touch frame. To accomplish this, a stylus was used to draw a line from the rightmost side of the screen to the leftmost side. The resultant pattern is shown in Figure 2.

The reason for using a stylus as opposed to a finger to perform the test is because ShadowSense applies motion filters to all touch points except when a stylus is detected. Small movements in touch (jitter) are undesirable while small movements in a stylus are tracked for more accurate writing.



Figure 2: Horizontal Test

As the stylus is moved across the screen, there are two main processes taking place. In the first process, the touch frame captures the location of the touch point and passes this through a USB connection to the computer. In the second process, the computer takes this information and maps it to the resolution of the display and draws the corresponding line.

Since the horizontal resolution of the ShadowSense frame of 4096 is greater than the screen's horizontal resolution of 1920, the computer must interpret this data. It does this by using a maximum limit that is passed by the touch frame to the computer with every USB message sent. The computer then multiplies the X-coordinate of the touch frame by the scaling factor to get the actual X-coordinate on the screen. This is illustrated in the following formula.

$$X_D = X_T \times \frac{1920}{4096}$$

Where X_D is the X-coordinate of the display and X_T is the X-coordinate of the touch frame. This represents a scaling factor of about 0.47, which means that for every one pixel displayed on the screen the touch frame is actually detecting approximately two movements in the horizontal direction.

A similar test was done to capture the Y-coordinates using the same stylus to draw a line from the topmost of the screen to the bottommost. The resultant pattern is shown in Figure 3.

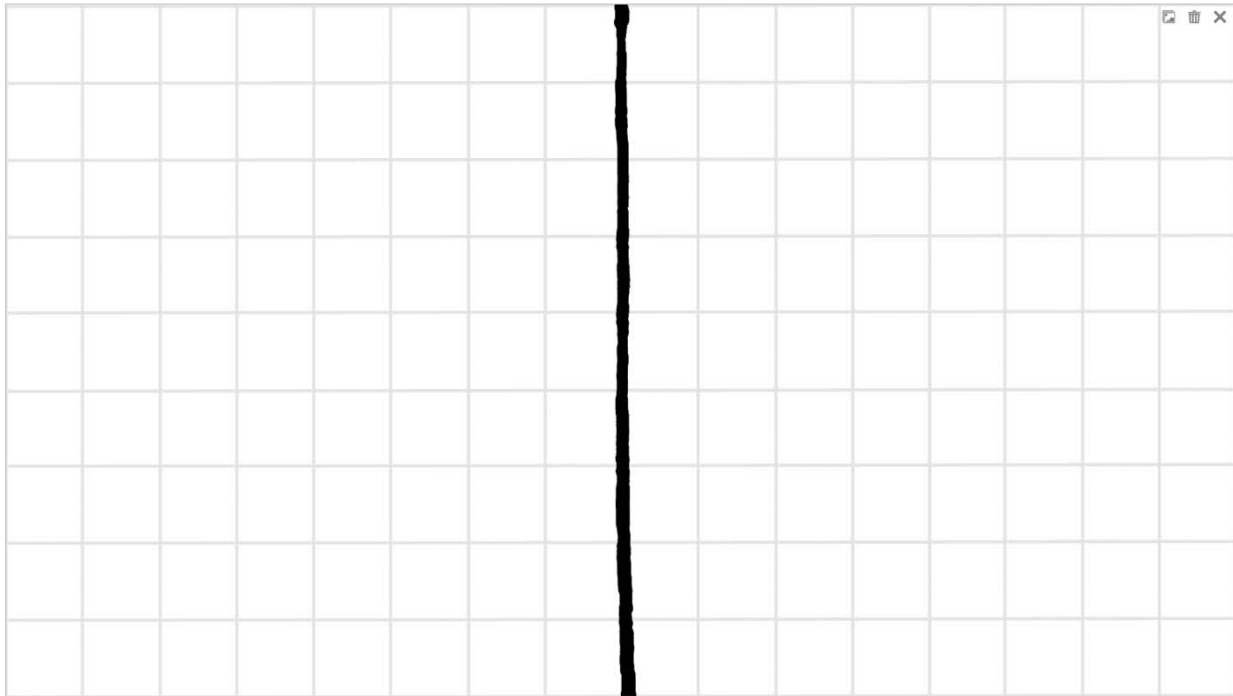


Figure 3: Vertical Test

In the case of the vertical resolution, the ShadowSense frame still captures 4096 values, but the actual screen resolution is only 1080 lines. The computer must also interpret this information in a similar manner as the horizontal resolution, using the following formula.

$$Y_D = Y_T \times \frac{1080}{4096}$$

Where Y_D is the Y-coordinate of the display and Y_T is the Y-coordinate of the touch frame. This represents a scaling factor of about 0.26, which means that for every one pixel displayed on the screen the touch frame is actually detecting approximately four movements in the vertical direction.

2.1 Results

The log file for the horizontal test captured over 31,000 entries. The reason for the large number of entries is because the speed at which the stylus was moved across the screen was inconsistent. If the stylus was moved too slowly then multiple entries would report the exact same coordinates. If the stylus was moved too quickly then there wouldn't be enough time to register a coordinate.

The logs for both the horizontal and vertical tests were analyzed by importing them into Excel, removing all of the duplicate values and then using conditional statements to determine if and when, any of the values between 0 and 4095 were missed. The log file and Excel file for the horizontal test are available in the Appendix at the end of this document.

For the horizontal test, 320 out of the 4096 possible values were missed, amounting to 7.8% of the total data set. These missed values can be attributed to the fact that it is nearly impossible for a human to consistently move the stylus slow enough across the screen that the center of the stylus is on a point long enough for it be captured and sent over USB, before moving onto the next point.

Using the formula for the X-coordinate defined in the previous section, a user would need to be able to move the stylus about half a pixel and stay there long enough for it to be read by the USB interrupt. For a SDW565W1 ShadowSense frame, previous performance tests have shown that the median time for this process is 9.05 ms. Adding to this challenge is the fact that the pixel pitch on a 55" display is only about 0.63 mm.

Taking this information into account, in order to capture every value in the horizontal direction, a user would need to ensure that they do not move the stylus faster than a rate of 0.30 mm ($0.63 \text{ mm} \times 0.47$) per 9.05 ms as they traverse across the horizontal length of the screen.

It is even more difficult to capture this information in the vertical direction, since it requires a user to move only 0.16 mm ($0.63 \text{ mm} \times 0.26$) in the same 9.05 ms interval.

3.0 Conclusion

Using the results observed in the previous section, it is reasonable to conclude that a ShadowSense frame is capable of registering 4096 unique positional points in the horizontal span of the touch area. Although it is more difficult to interpolate the data in the vertical direction, it is reasonable to extrapolate the results of the horizontal test and apply it to the vertical test as well. This is based on the fact that the algorithms used by the ShadowSensors to calculate the X-coordinates are the same as those used to calculate the Y-coordinates. Therefore, a ShadowSense frame is capable of producing a touch resolution of 4096 x 4096.

It's important to note that depending on the resolution of the associated display, the number of pixels represented on the display with each movement will vary. As the resolution increases, the scaling factors will approach unity. For example, a UHD display has a resolution of 3840 x 2160 so the horizontal and vertical scaling ratios will be 0.94 and 0.53 respectively. Additionally, with a larger display, the physical size of each pixel will increase so if the same tests were repeated on a larger display with the same resolution, it would be easier to capture more values in both the horizontal and vertical directions.

Appendix: Log Files

The log file produced during the horizontal test has been embedded below as *log_position_horz.txt* and the corresponding Excel file is embedded as *log_position_horz.xlsx*.

Note: The links below are not active on the PDF version of this document. Please contact you regional Baanto Technical Representative for access to these files.



log_position_horz.t
xt



log_position_horz.x
lsx