**Application Name: DVA.apk**

APK shortcut located on tablet home screen

Operator clicks app icon to start program 🡪 SLIDE 1 screen appears

Operator presses either “Static”, “Dynamic Up/Down/Left/Right”, “Compute DVA”, or “QUIT” button

QUIT button quits app and returns to home screen

If operator presses “Static” button:

* Slide 2 appears
* Operator presses “Start New Test” button 🡪 Slide 3 appears and the following happen instantaneously:
  + A filename is automatically generated based on the date/timestamp in which the “Start New Test” button was depressed. The filename is of the following format: “DATE\_TIMESTAMP\_DVA\_static”
    - DATE = year (YYYY)/month/date, eg 20130728 for July 28, 2013
    - TIMESTAMP = hour/min/sec/ms, eg 15302603 for 3:30:26.03 pm
  + An internal timer is started (not to be displayed to the subject; used to track how long it takes subject to do the test)
  + The first Landolt C is displayed to the subject (see #1 below)
* Test progression
  + #1: Program randomly selects one of the Landolt C’s from visual acuity level 2 (see excel spreadsheet [RM – Do the cells in the spreadsheet correspond to pixels on the display? The ASUS TF500T-B1-GR 10.1” display has a 1920x1200 resolution and the Lenovo Thinkpad Tablet 10.1” display has a 1280x800 resolution.] KB: Yes, the cells correspond to pixels. We have switched everything to the ASUS 1920x1200.) and displays it on the tablet screen
  + #2: Subject enters their guess as to which direction the C is facing by pressing the UP, DOWN, LEFT, or RIGHT button
  + #3: Program writes out to the file a new row of data with 7 elements:
    - timestamp when subject’s response was made
    - visual acuity level
    - actual C orientation
    - subject’s response orientation
    - tablet x, y, z accelerometer data [RM – when is the accel data collected and for how long? KB: See below]
  + #4: Repeat #1- #3 four more times (5 total trials)
    - NOTE: selection of Landolt C directions = sample *with* replacement [RM – What does “replacement” mean? KB: the program should randomly choose one of the orientations (up down left or right). Replacement means when the program choses a direction for the first trial, that direction goes “back in the hat” for the second trial. For example, if the program picks the up direction on trial 1, it is possible that it also picks the up direction on trial 2]
  + Repeat steps #1-4 at visual acuity level 1
  + End of test: show slide 4, with subject’s logmar score:
    - Score is computed as: 0.282599 – (# correct @ level 2)\*0.035218 – (# correct @ level 1)\*0.060206

If operator presses one of the “Dynamic” buttons (slide 5):

* Slide 7 appears
  + Minimum head speed to trigger a letter and the shimmer-in-use defaults are selected (120 and #1, as shown on slide) [RM –Is there existing code that is preferred for shimmer data acquisition (e.g. EMGGraph)? KB: aspects of EMGgraph can be used for this, but the DVA program will needs to call the shimmers without using EMGgraph directly (EMGgraph brings in a whole bunch of shimmers, but for DVA we only need 1)]
* Operator presses “Start New Test” button 🡪 Slide 8 appears
  + A filename is automatically generated based on the date/timestamp in which the “Start New Test” button was depressed. The filename is of the following format: “DATE\_TIMESTAMP\_DVA\_dynamicDIRspeed”
    - DATE = year (YYYY)/month/date, eg 20130728 for July 28, 2013
    - TIMESTAMP = hour/min/sec/ms, eg 15302603 for 3:30:26.03 pm
    - DIR = UP, DOWN, LEFT, or RIGHT corresponding to whatever dynamic button is pushed
    - speed = 120 or 60 [RM – What do these values mean and how are they calculated? It may be easier to schedule a phone call first. KB: speed = 120 deg/s. This will come from the shimmer]
  + An internal timer is started (not to be displayed to the subject; used to track how long it takes subject to do the test)
* Test logic
  + Subject will wear the appropriate Shimmer on the head in a predefined orientation to measure head velocity
  + #1: Program randomly selects one of the C directions from visual acuity level 3 (excel spreadsheet)
    - Trigger to show the C on the screen for the subject = when the net (vector) gyro data is faster than speed selection (120 or 60) for 40ms in the correct direction, the letter becomes visible for 80ms [RM – Speed selection? Gyro comparison to the speed selection? .KB: let’s discuss over phone]
      * Correct direction means
        + For Dynamic UP test: Shimmer y-axis is reading negative value
        + For Dynamic DOWN test: Shimmer y-axis is reading positive value
        + For Dynamic LEFT test: Shimmer x-axis is reading positive value
        + For Dynamic RIGHT test: Shimmer x-axis is reading negative value
      * NOTE SHIMMER READS IN A2D UNITS 🡪 CONVERSIONS MUST BE MADE FROM CALIBRATION FILE [RM – is this conversion file available? KB: we are still working on this, but we will have a calibration file that can be loaded into the program before it is started. Alternatively, once we know these conversion factors, we can work strictly in shimmer A2D units, which may be preferred anyways b/c of the fast latency requirements]
  + #2: Subject enters their guess as to which direction the C is facing by pressing the UP, DOWN, LEFT, or RIGHT button
    - The subject must see letter at least once before they can input an answer (ie the letter must “flash” at least once before a guess can be input) [RM – when to initiate the flash and duration? KB: This is from above—after the subject’s head is moving fast enough (> 120 or 60 deg/s, depending on operator selection) for at least 40ms to insure it’s not just a noise spike. We can go thru this on the phone]
    - The subject can only see letter a maximum of 5 times before they must make a forced choice
  + #3: Write out new row of data to 2 files:
    - big file: every 10ms, write out:
      * current timestamp
      * current visual acuity level
      * current correct orientation
      * current subject response orientation
      * current tablet x, y, z accelerometer data
      * current shimmer data (7 channels: 3-axis accel, 3-axis gyro, shimmer timestamp)
      * + tablet gyro
    - small file: every time subject makes response, write out:
      * timestamp of response
      * visual acuity level
      * correct orientation of letter
      * subject response orientation
      * tablet x, y, z accelerometer data at time of response, averaged over 100ms before response was input
      * shimmer data (7 channels: 3-axis accel, 3-axis gyro, timestamp) at time of PEAK head velocity prior to response
  + #4: Repeat #1- #3 three more times (5 total trials)
    - NOTE: selection of Landolt C directions = sample *with* replacement
  + Repeat steps #1-4 at visual acuity level 2
  + Repeat steps #1-4 at visual acuity level 1
  + End of test: show slide 8
    - Score is computed as: 0.407538 – (# correct @ level 3)\*0.024988 – (# correct @ level 2)\*0.035218 – (# correct @ level 1)\*0.060206

If operator presses “Compute DVA” button (slide 9)

* Slide 10 displayed: 2 windows pop-up with list of static and dynamic filenames, sorted in chronological order starting with most recent test
* default highlight = most recent of each, but operator can select whichever static they want (only one may be selected) and as many dynamic files as they want [RM – how is DVA computed with multiple dynamic files? KB: sorry, I forgot to include the DVA score formula: DVA = dynamic – static. Multiple DVA scores should be able to be computed at the same time using the same static. For example, if the subject is tested in the up, down, left, and right directions dynamically, we can get 4 DVA scores: DVA up = dynamic up – static, DVA down = dynamic down – static, DVA left = dynamic left – static, DVA right = dynamic right – static. The static test is done with the head still, so it only needs to be done once.]
* once operator highlights tests, he clicks “done” button 🡪 results displayed as in Slide 11

Questions:

1. accelerometer data collection duration – static – from start of test until 10 passes completed (5 @ level 2 and 5 @ level 1). Accel and time data collected for each of the 10 discrete tests. 100 Hz sample rate (p). Want an administration panel to set defaults…subject name, date, and the user defined variables. Two different configs such as DVA fast. RM to define the layout screen.
2. minimum head speed to trigger - the presentation of a letter once a dyna test mode is entered? Head gyro triggers the presentation of the Landholt C for 80ms (p). refresh rate on the Asus gyro (running at 100Hz as well) and the sample rate.
3. Slide #6 “start new test” preceeds the presentation of Landolt Cs? Are there defaults for 120/s and shimmer 1 settings? They come from the shimmer? They “appropriate” shimmer? Is the “start new test” modal (e.g. disabled until test settings selected? Shimmer 1 is the default…Shimmer 2 is the backup in case the battery or sensor die. Slide #7 should disable the values not selected.
4. Shimmer 1 & 2 (slide #7) – internal and external? Are there two or only one external shimmers?
5. 120 or 60 deg/s displacement – in any direction (x,y,z)?
6. Gyro data faster than the speed selection?
7. Correction direction and the shimmer readings………pg 3 and slide #1. Using the buttons to filter out head direction not wanted to trigger movement.
8. Is the data post processed with the calibration (or transformation) file or does the app need to perform this (TBD)? Record as raw A/D. Store calibration settings in a header for the file as well.
9. Filename – fully automated ..can not be edited. Non-edited…can append to the filename.
10. Flash of Lindholt – duration, repetition (5x) and (yes) modal buttons? Flash a message “a direction must be selected”?
11. Big file and small file – naming convention for test results. Avg over the previous 100ms (p) just before a selection? Once response is entered, average over prior, programmable period. Big is binary and the small is ASCII. .a is the binary output and is input to matlab. .txt for the small file.
12. accelerometer data - outputs raw DAC measurements over 3 axis (xyz) these values are usually signed 16bit. This coordinate space is specific to OpenGL ES applications. display orientation returned by the Android API’s getOrientation() or getRotation() functions. Both functions return the same values, but the former is a deprecated usage.
13. Shimmer timestamp – sync’d with tablet? Accuracy or frequency of sync. Can this be done? Timestamp the data when it is received by the tablet.
14. Acuity levels – 3 defined, but only 2 used in static and all three used in dynamic
15. “averaged over 100ms before response was input”
16. “peak head velocity” during the period from the start of the test to the response entry? Record the max, but average over +/- 10 mS around that spike after running in through a low pass filter.
17. “three more times (5 total trials)”
18. DVA computation – based on Logmar scores? Does the accel or gyro data factor into the calc? Logmar only is used to compute the DVA score. Store the DVA calcs in a file for later review. Filename is data-timestamp-DVAScore…

Notes:

Accel measures acceleration in three axis in m/sec2

Gyro measures rotation in rad/sec around the devices x,y,z axis