

Test Protocol

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CONTENTS

1	Hearing aids	1
1.1	Hardware	1
1.2	Sound source tracking	1
1.3	Noise reduction	3
2	G3	5
2.1	Face detection and tracking	5
2.2	Depth estimation	6
2.3	Eye-tracking	6
2.4	Orientation	7
3	Entire system	8
3.1	Relative orientation	8
3.2	Sound source tracking and amplification	8
4	UI	9
5	Performance tests	10

DOCUMENT HISTORY

Version	Date	Changes made	Sign	Reviewer
0.1	2023-12-04	First draft.	All	ME
1.0	2023-12-05	First version.	EW	ME

1 HEARING AIDS

1.1 Hardware

Test	Description	Pass/Fail	Date	Conclusion	Sign
1	Test if battery gives sufficient voltage over the circuit.	Pass	2023-11-21	Measured with multi meter under circuit load. Shows 1.4 V.	EW
2	Test if diode lits up.	Pass with note	2023-11-21	LED on soundcard lights up as the hearing aids are powered. NOTE: LED only lights up when sound is present. Also soundcard must be connected to computer for LED to be lit.	EW

1.2 Sound source tracking

Test	Description	Pass/Fail	Date	Conclusion	Sign
3	Test the automatic speech recognition (ASR).	Pass	2023-11-29	The ASR got activated after around 1 second when switching from white noise to human speech.	AR, RO
4	Test the localization of the direction and position estimate of a stationary sound source.	Not executed.		Not tested.	
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Test	Description	Pass/Fail	Date	Conclusion	Sign
4A	Test the direction of the arrival to a moving sound source.	Pass	2023-11-30	The direction of arrival to a sound source (human voice) was tested on the angles 0, -30, -60 and -90 degrees. The sound source was in a standstill position in front of the user at 2 meters from the sound source for 30 seconds at each angle. A person that spoke freely acted as the sound source and no noise was present during the test. The person spoke and moved between the test angles during the test. The result of the test can be seen in table 3.	AR, RO
4B	Test the range to a moving sound source.	Pass	2023-11-30	The range to a sound source (human voice) was tested on the ranges 1,2,3,4 and 5 meters in front of the user at 0 degrees. The sound source (human voice) was in a standstill position for 20 seconds at each range. A person that spoke freely acted as the sound source and no noise was present during the test. The person spoke and moved between the test ranges during the test. The result of the test can be seen in table 4.	AR, RO
5	Test the tracking of the direction and position estimate of a moving sound source.	Not executed.		Not tested.	
6	Test 4 and 5 with multiple sound sources simultaneously.	Not executed.		Not tested.	

Direction [degrees]	Mean [degrees]	Standard deviation [degrees]
0	2.1	2.17
-30	1.4	2.99
-60	7.0,	1.76
-90	3.8	5.72

Table 3: Test result of the direction of arrival to a sound source (human voice).

Range [m]	Mean estimation error [m]	Standard deviation [m]
1	0.76	0.41
2	1.33	0.49
3	1.08	0.49
4	0.77	0.05
5	-0.52	0.20

Table 4: Test result of the range to a sound source (human voice).

1.3 Noise reduction

Test	Description	Pass/Fail	Date	Conclusion	Sign
7	Test of monaural beam-former.	Pass with note	2023-12-04	Tested with one hearing aid, beamformer towards signal and white noise in opposite direction. SNR as table Table 6 . Note that the global SNR is the one the test shows is working. The segmented mean SNR is reversed, which is odd.	EW
7A	Test of monaural beam-former interferer.	Pass with note	2023-12-04	Tested with one hearing aid, beamformer towards signal and interferer in opposite direction. SNR as table Table 7 . Note that the global SNR is the one the test shows is working. The segmented mean SNR is reversed, which is odd.	EW
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Test	Description	Pass/Fail	Date	Conclusion	Sign
8	Test of binaural beamformer noise.	Pass	2023-11-30	Tested with white noise at 60 degrees to the left of the signal source. SNR as table Table 8 . The SNR has significantly increased for the left ear especially.	EW
8A	Test of binaural beamformer interferer.	Pass	2023-11-30	Tested with interferer 60 degrees to the left of the signal source. SNR as table Table 9 . The SNR has significantly increased for the left ear especially.	EW
9	Test of amplification difference for two voices.	Pass	2023-11-30	Tested by playing the same signal twice, ones the beamformer pointing to signal, ones pointing straight to the right and calculating SNS (Signal to Signal ratio). Results in Table 10 . Shows clearly how the beamformer pointed away from signal suppresses it greatly.	EW
10	Test of speech recognition in noisy environment.	Pass	2023-11-30	Tested by placing one sound source playing a speech and white noise at the same time. SNR can be seen in Table 11	EW
11	Test of band-pass filter.	Not executed		Not tested	
12	Test of PTA amplification.	Not executed		Not tested	
13	Test of compression filter.	Not executed		Not tested	

	$SNR_{seg,front}$	$SNR_{glob,front}$	$SNR_{seg,back}$	$SNR_{glob,back}$
Before	1.4 dB	2.5 dB	1.2 dB	2.1 dB
After	-0.1 dB	3.3 dB	-0.1 dB	3.3 dB

Table 6: SNR test, monaural, segmented mean and global of noise test for beamformer

	$SNR_{seg,front}$	$SNR_{glob,front}$	$SNR_{seg,back}$	$SNR_{glob,back}$
Before	-3.3 dB	-1.63 dB	-3.6 dB	-2.0 dB
After	-4.5 dB	-0.9 dB	-4.5 dB	-0.9 dB

Table 7: SNR test, monaural, segmented mean and global of interferer test for beamformer

	$SNR_{seg,left}$	$SNR_{glob,left}$	$SNR_{seg,right}$	$SNR_{glob,right}$
Before	1.7 dB	2.8 dB	4.7 dB	7.1 dB
After	2.1 dB	6.9 dB	2.1 dB	6.9 dB

Table 8: SNR test, binaural, segmented mean and global of noise test for beamformer

	$SNR_{seg,left}$	$SNR_{glob,left}$	$SNR_{seg,right}$	$SNR_{glob,right}$
Before	-2.3 dB	-1.3 dB	-0.2 dB	2.3 dB
After	0 dB	5.5 dB	0 dB	5.6 dB

Table 9: SNR test, binaural, segmented mean and global of interferer test for beamformer

	SNS_{left}	SNS_{right}
Before	-1.61 dB	-0.9 dB
After	9.0 dB	9.0 dB

Table 10: SNR test, binaural, pointing the beamformer at or away from signal

	$SNR_{seg,left}$	$SNR_{glob,left}$	$SNR_{seg,right}$	$SNR_{glob,right}$
Before	1.8 dB	2.9 dB	5.1 dB	7.8 dB
After	3.0 dB	9.0 dB	3.0 dB	9.0 dB

Table 11: SNR test, segmented mean and global for speech recognition and noise reduction.

2 G3

2.1 Face detection and tracking

Test	Description	Pass/Fail	Date	Conclusion	Sign
14	Test of face detection and tracking.	Partial pass	2023-12-04	Face detected and tracked correctly. However, due to hardware malfunctioning the test was only performed on one face instead of 3 different faces.	ME
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Test	Description	Pass/Fail	Date	Conclusion	Sign
15	Test of detection of faces.	-	-	The requirement connected to this test was renegotiated. The test was therefore not preformed.	-
16	Test of tracking faces with user orientation change.	-	-	This test was never conducted due to hardware malfunctioning.	-
17	Test of tracking multiple faces.	-	-	This test was never conducted due to time constraints.	-
18	Test of tracking multiple faces.	-	-	This test was never conducted due to time constraints.	-

2.2 Depth estimation

Test	Description	Pass/Fail	Date	Conclusion	Sign
19	Test of depth estimation of a face.	Pass with note	2023-12-04	From the five images the face was estimated with an absolute value of the error to be less than 30 % of ground truth depth making the test successful.	ME
20	Test non-existent.				

2.3 Eye-tracking

Test	Description	Pass/Fail	Date	Conclusion	Sign
21	Test of gaze association with video. The user looked at a face moving in the field of view. The 2D gaze was then plotted on the video from the scene camera.	Pass	2023-12-04	The plotted 2D gaze was on the face.	ME
22	Test of 3D gaze estimation. The user was to focus their gaze on a moving face.	Partial pass	2023-12-04	The horizontal and vertical angle was estimated within 10 degrees of the true angle of the face. The depth estimation of the gaze point was extremely bad and was frequently estimated to be more than 10 meters away from the true gaze point.	ME

2.4 Orientation

Test	Description	Pass/Fail	Date	Conclusion	Sign
23	Test of the orientation angles, yaw, pitch and roll. Tested by placing the G3 glasses on the ground in an environment free from materials that could disturb the magnetic field for 10 seconds. Then the glasses were randomly moved for 3 seconds before being returned to their original position.	Pass	2023-12-06	Yaw, pitch and roll angle were all within 20 degree error. Values for the covariance matrix for the magnetometer vary from 1-10 depending on what environment or if the hardware is warm enough.	OR MA
24	Test of the yaw orientation. Tested by holding the pitch and roll constant, rotating the head 90° in the horizontal plane and then standing still for 10 seconds. Iterated three times.	Pass	2023-12-06	Yaw angle were within 20 degree error at every 90° rotation.	OR MA

3 ENTIRE SYSTEM

3.1 Relative orientation

Test	Description	Pass/Fail	Date	Conclusion	Sign
25	Test of sensitivity of the beamforming with eye-tracker for different head shapes.	-	-	This test was never conducted due to time constraints.	-
26	Test of sensitivity of the relative head shape function for different head shapes.	-	-	This test was never conducted due to time constraints.	-

3.2 Sound source tracking and amplification

Test	Description	Pass/Fail	Date	Conclusion	Sign
27	Test for being able to perform sound source tracking with glasses and HA on recorded data.	-	-	This test was never conducted due to hardware malfunctioning.	-
28	Test for being able to perform sound source tracking with glasses and HA on live data.	-	-	This test was never conducted due to hardware malfunctioning.	-
29	Test for static case of beamforming and visually choosing the direction for beamforming.	-	-	This test was never conducted due to hardware malfunctioning.	-
30	Test for static case of beamforming and visually choosing the direction for beamforming with SNR requirement.	-	-	This test was never conducted due to hardware malfunctioning.	-
31	Test for static user and moving sound source of beamforming and constant gaze point.	-	-	This test was never conducted due to hardware malfunctioning.	-
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Test	Description	Pass/Fail	Date	Conclusion	Sign
32	Test for static user and moving sound source of beamforming and visually attending to the sound source.	-	-	This test was never conducted due to hardware malfunctioning.	-
33	Test for moving user and two static sound source of beamforming and visually attending to the sound source.	-	-	This test was never conducted due to hardware malfunctioning.	-
34	Test for moving user and one static sound source of beamforming and visually attending to the sound source.	-	-	This test was never conducted due to hardware malfunctioning.	-
35	Test for user moving head and moving sound source of beamforming and constant gaze point.	-	-	This test was never conducted due to hardware malfunctioning.	-
36	Test of track and camera alignment.	-	-	This test was never conducted due to hardware malfunctioning.	-

4 UI

Test	Description	Pass/Fail	Date	Conclusion	Sign
37	Test functionality of GUI	Pass with note	2023-12-04	No GUI was created, but functionality still exists. <ul style="list-style-type: none"> • Turn on/off amplification, display/change amplification in soundmexpro for DOA, Maya44 soundcard driver for beamformer. • Record sound in code by list for beamformer, soundmexpro for DOA. • Replay saved .wav file 	EW
38	Test recording on G3	Pass	2023-12-04	Recording easily done in UI (G3_terminal) for the glasses.	EW
39	Test the playback of recordings	Pass with note	2023-12-04	Post processing of recording is available for all modules of G3 and hearing aid DOA. NOTE: Not available for beamformer or combination of G3/HA as in real-time	EW

5 PERFORMANCE TESTS

Test	Description	Pass/Fail	Date	Conclusion	Sign
40	Test the delay for the hearing aids	Pass	2023-12-04	Beamformer mean delay 5 ms. + 12 ms for hardware (soundcard, preamps etc.) = 17 ms delay.	EW
41	Test the frequency of hearing aids.	Pass	2023-12-04	44100 Hz without clipping for beamformer.	EW
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Test	Description	Pass/Fail	Date	Conclusion	Sign
42	Test the frequency of G3.	Pass	2023-12-04	Runs in real time which means this test is fulfilled. Camera is at 25 fps, this seems to be the bottleneck during processing.	EW