Development of a non-invasive CAPacitive sensor oral MOUSE interface for the disabled elderly (CAPMOUSE)

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D5.2 Report on functional end-user testing, validation and error correction

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D4.3 Evaluation report on performance and usage comfort when using the applications

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1. The aim for the end user tests

The aim for the functional end user testing is to study how first time users are perceive the CapMouse prototype with its functionality. And if they are able to perform basic tasks on the computer with the CapMouse headset, to see if the CapMouse is a hands free full mouse replacement.

The user tests will be analyzed to validate the functionality of the capacitive sensor, and work as input for error correction accordingly.

2. Methodology

Qualitative user studies was performed on May 4th in Ulricehamn and May 15th in Angered with 14 seniors attending a computer class arranged by ABF. The user studies were conducted by test sessions where the participants got to try the CapMouse prototype on a computer to perform various assignments that was documented for later analysis. The participants was at the same time interviewed during the tests and was encouraged to speak out loud how they perceived the CapMouse functionality.

2.1 Qualitative end user studies

For the first session of end user testing Jesper Jonsson from LOTS and Tomas Brusell from Brusell Communications visited ABF in Ulricehamn on Friday 4th of May. The tests were held from 10.00 to 12.30. There were six seniors in the test group, all participants in a computer class arranged by ABF. The second session was held at ABF in Angered, Gothenburg, Tuesday 15th of May, with eight new participants.

The goal of the sessions was to test the usability of the final CapMouse demonstrator headset, with focus on the interaction with the computer interface. The test group is first time users of the CapMouse, with basic knowledge in computers.

Divided into three groups, two persons were tested at the same time. For the test they followed instructions from the instructors (Jesper and Tomas) to perform different commands, and was asked to speak out loud on how they experienced the interaction.

After a small introduction of the CapMouse, and when the headset was adjusted for each user, they got some time to get familiar with the CapMouse sensor. For the test they were asked to move the mouse cursor in designated directions by using the CapMouse sensor. Then trying to combine the movements into the shape of a square and a circle, and to perform a click and a double click. The goal of this part of the test was to see if any of the directions was easier or harder to move the cursor in.

Each task was graded on a scale from 1 to 5 on how easy or hard the test person thought the task was, and how well the cursor's movement corresponded to the users intended movement.

Then the user was asked to perform a common task on the computer. Open a program on the desktop, and then close the program. The task combined cursor movement over a large area, precision movement of the cursor, single clicks and double clicks.

The tests were conducted with the users devided into groups of two.

The test group was also asked to comment on how easy or hard it was to separate the different functions of the sensors, if they experienced any disturbance when talking and if the mouse cursor moved as they intended.

They were also asked to comment on the ergonomics of the prototype. Such as if they know where the sensor is in relation to the cheek, if the headset is stable and if it works well or interfere with glasses and hearing aid. The ergonomics has been covered already in previous tests and the focus of this test session was on the sensor functionality.

3. Test results

The grading system is a subjective evaluation and cannot be used to get a fair average rating over all of the tests. The grading was used as a tool to distinguish if some tasks and steps were easier or more difficult for the individual user.

A form was filled out during each person's tests, for documentation and further analysis of the tests

3.1 Navigation

The first step of the tests was to study the mouse cursor navigation, where we compared how difficult it was to move the mouse cursor in either direction. It was mixed results. Some got it right away and moved the cursor just as easy in any direction. And for many of the users we found that one or two directions were harder than the others. For example if it was easy to move up and right, it was hard to move left and down. Or if right and left were easy, up and down was hard. We didn't find any particular direction being harder och easier, but we can conclude that it's a matter of positioning the sensor head right, so you can reach all the individual directional sensors just as easy. If a user had problems with moving the cursor to the right it was because he or she had a hard time reaching that sensor.

Following was the segment of linking the directions together into a square, and then trying to draw a circle. The ability to draw a square was quite strong connected to the previous step on moving the cursors in individual directions. Once you were able to move the cursor in a desired direction the square was easy. The circle on the other hand was hard. No one was able to draw a complete circle, but some users were able to make a more fluid motion with the cursor.

Over all we could see a vast improvement in the navigation after about 20 minutes of use for most of the users.

3.2 Click

The second part of the test was to test the click function. A single click is performed by solely touching the center sensor for a fragment of a second, and the actual click is executed when the sensor is released. If performed correctly, the software knows that the user's intention is a click, and

not to be confused with a directional motion, since the center sensor is the only one giving a signal. The double click is performed in the same way but by touching the center sensor for about half a second.

Also here it was various results, and there was no direct connection between the results on clicking and the results on navigation. Many experienced that the cursor moved slightly when they tried to perform the click, or that it was hard to separate the click function from the directional move function. Many also expressed that it was hard to find the center sensor and knowing that it was the only one being touched.

3.3 Sequence

The third step in the test agenda was to link the previous two parts together to test a common sequence in a computer environment. The task was to open an application or folder on the desktop, and then close it. By doing so the user had to navigate to the desired icon, double click, navigate to the small x in the top corner and perform a single click.

The results on the sequence task were more connected to the ability to perform a click then navigation. The navigation worked fine for most of the users, but the click was harder. When closing the application the user had to navigate to a small area, and we noticed that precision movement was an issue in many cases. It was hard to stop the movement at the desired area, and when trying to move it slightly and slowly the cursor sometimes moved fast and the user missed the target. Also when trying to click, if they accidentally touched a directional sensor the cursor moved away from the close-button instead of clicking it.

One user expressed that it was more a matter of luck then skill when he or she succeeded with closing the application.

3.4 Experience

After these three steps we asked some questions regarding the user experience; if they experienced that the computer responded to their actions, if it was easy to separate the different functions of the sensor and if speech interfered with the sensor interaction.

No one experienced any disturbance during speech. The sensor does not register any movement when the user speaks.

The other topics followed the results on the previous steps, naturally. The users that found the navigation and click being easy also thought that the computer responded to their actions, and vice versa.

3.5 Ergonomics

In the last step we asked about the ergonomics of the headset. The headset we tested is a demonstrator to be able to do functional testing of the sensor, and is not considered a final design. The input we gather from this step is important for future development of the ergonomics of the headset.

It was mixed response regarding how comfortable the headset was. Many thought that it applied to hard pressure on the head, but that it was stable. Some liked that, some didn't. Many experienced

that the sensor head changed position over time and that it didn't stay in the same position at all times. You could see some connection between the test results on the ergonomics and the previous test results regarding navigation and clicking. The ones that felt that the sensor stayed in the same place and knew where the sensor was positioned according to the mouth also had quite good results in the test. One user did the test when holding the sensor in a fixed position with her hand, with good results in navigation and clicking. By this we discovered that the sensors position and stability is important for a good user experience.

4. Conclusions

A majority of the test participants responded positively in the tests and managed to execute basic tasks in a computer environment with the CapMouse headset. This proves that the CapMouse works as a hands free, full mouse replacement. The test participants showed good control of navigating the cursor left, right, up and down, and combining the directions to move the cursor to a desired location. Some even managed to do a fluid movement of the cursor, and was close to drawing circle.

Within 10 minutes of using the CapMouse we could observe big progress in moving the cursor and in 20 minutes the results was significantly improved. Many of the users expressed that they thought they would manage the CapMouse perfect after some training, and if they really had a need of a hands free mouse replacement. To control the computer with tongue movement is new to many of us, but we could observe that it takes about 20-30 minutes to get comfortable using the CapMouse. And the ones that had more experience with computers had an even steeper learning curve.

In many cases, one or two directions were a bit harder for the user to move the cursor in. Some expressed that it was too far between the different directions and that they wanted a smaller sensor area. And sometimes the cursor moved much faster in one direction, even if they experienced that the applied the same pressure as on the other directions. This could be corrected with an individual calibration for every time the user puts on the headset, where the user performs designated movements to the sensor that is recorded and used for calibration.

The test users also had some problems with moving the cursor to a smaller area, which required higher precision. One user had had some problems with his motor skills as a result of a previous stroke. This also affected his motor skills in the tongue and made it extra hard for him to move the cursor to a smaller area, and stopping the movement at the desired place.

We observed that many users had issues with performing a mouse click. It requires great precision to perform a mouse click, and the users didn't experience that they got the feedback they wanted that they did it correctly. The click function needs to be more intuitive and needs to work at every time, since it is a key feature in computer interaction. And the user needs to get audio- or visual feedback from the mouse click. Many users also expressed that they wanted to feel where the center sensor is, with some kind of mark on the sensor head. The click functionality can also be enhanced with a calibration step before you use the headset.

Some users preferred to use the tip of the lower lip to interact with the sensor. The results showed that they had quite good control of directional movement and was able to perform mouse clicks. This technique allows for more precision when touching the individual sensors, which shows in straight navigation and successful mouse clicks.

Other users perceived the sensor as a track pad on a lap top computer, and wanted to use the tongue on the inside of the cheek to control the mouse cursor in a more fluid motion. They were able to execute a more mouse-like motion, but had problems with performing mouse clicks. The capacitive sensors in the CapMouse allow for a dynamic movement, and this method of steering the mouse cursor also needs to work well.

The test individuals expressed the opinion that, “for people with muscle disabilities this will be a good instrument for digital control”.