Technologies Disability and Inclusion

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Abstract
This paper is going to explain how a technical invention in the dental clinic evolved to become a hands free digital input device for everyone with his or her hands occupied with other things. As a natural consequence the invention thus will enhance the possibilities, also for people with disabilities, to use computers and remote controls.
There will be descriptions of the scientific process, leading to the product development and design and there will be provided explanations how the technology works and there will be descriptions of future applications where the inclusion of disabled is in focus.
The future "vision" will be a combination of science and art, where the story line depicts how the physical invention meets the reality of the "The Silver Economy" market where innovation is needed, more than ever and old people want to be included, for longer time, in the action of innovation.

Keywords: hands free, technology, disability, inclusion.

Background

As modern technology permeates every corner of life, there are ignited more and more hopes among the disabled to be compensated for the loss of mobility and as a consequence participation in normal life. With Information

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and Communication Technologies (ICT), Exoskeleton Technologies and truly hands free technologies, like Human Machine Interfaces (HMI), it's possible for the disabled to be included in the social and pedagogic spheres, especially via computers and smartphones with social media apps and digital instruments for Augmented Reality (AR).

The idea to free the hands from computing had its beginning in the dental clinic.

From an odontological point of view there was something still missing when the digitalisation of the dental clinic was fulfilled in the end of the first millennium. Voice Recognition newer was accepted as an input device and nothing else was offered. If you needed your computer during clinical work you had to ask your assistant to act as an input device or remove your gloves and do it yourself.

Due to the bio safety restrictions a clinical operator cannot touch the keyboard or the computer mouse, not even touch the screen on a smartphone, and then turn to the clinical instrumentation again.

As a dentist I didn´t feel comfortable in this situation and tried to conceive of a device, a method to be able to control the digital environment in a hands free and mobile way.

What about the tongue and the other oral muscles – covered by the face mask?

As a clinically active dentist I did analyse the precise and endurable muscles, already in use among disabled in many ways; blow-suck devices, joysticks etc. and tried to see if they were possible to use in a more advanced way.

Project

We initiated research and development (R&D), using ultra sound sensors to monitor the position of the tongue, and made a prototype together with Sintef[2] and a group of students from Trondheim Technical University[3] and testing was made at the St Olav Hospital in Trondheim, Norway. In the process we decided to switch to capacitive sensors, which was a much more simple technology, and focused on extra oral placement of the sensors, due to my dental experiences and knowledge of the corrosive powers in the oral cavity. This new path to utilize the untamed oral muscles for computer control lead to us, via the Norwegian Research Council to the Ambient Assisted Living, Joint Program and we initiated a second R&D project, composed a consortium of partners,

[2] www.sintef.no/en/.
[3] www.ntnu.edu/.

partially funded by AAL JP[4] and was able to build a headset with a capacitive sensor array close to the lower lip, possible to touch, like a touch screen and thus command the smartphone and PC-screens surrounding you in the geriatric environment as well as in the clinic.

The Result of the AAL PJ CapMouse Project was refined and tested, redesigned and tested in several phases.

With this device I was able to switch clinical programs, scroll my x-rays and still be on the right side of the hygiene barrier, in no violation of bio safety and *lege artis* regulations.

The testing programs has shown that the LipIt input device, also will enhance the possibilities for High End Injured and other disabled individuals to be included in the work force, in everyday life of the modern world and in a new way be able to participate in the social media communications. We organised one testing program together with Telenor Open Mind[5], with disabled employees at Telenor, Oslo and we continued testing in the AAL JP with geriatric end users, members of the project partners PRO[6].

At the same time a team of dentists, in Sweden and Norway, made tests, some for longer, and others for shorter periods according to standard academic protocols. There were a large majority endorsing the functionality of the prototype and input, for the final design phase, was collected.

The technical development and miniaturisation, generally, during the LipIt development phase has been staggering and the LipIt Product 1A contains software and digital Bluetooth hardware making the sensor more sensible than ever, small size/low weight and now a high end microphone is added. Due to its placement close to the mouth, noise pollution can be avoided and conversation can be held at very low decibel levels.

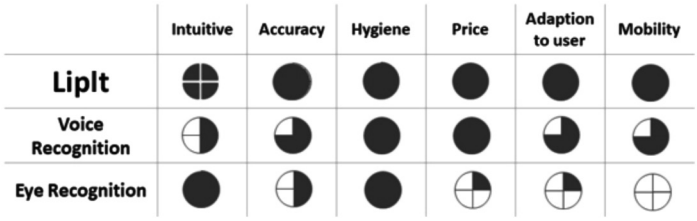
With the LipIt headset mounted, disabled persons can work with telephone support, marketing and all the computer based work stations can be accessible for even the High End Injured and as long as you can eat and breathe, you are able to use the LipIt input device for computer control.

The technology is simple – the sensor is based on capacitive sensors, basically sensible to water, measuring the density in the working field, and the software registering the proximity of the lip is also registering the movements of the lip – the touch of the lip creates signals indicating the user's commands – combining digital and analogue signals; a touch of left quadrant – cursor to the left, etc. The sensor is circular with a 2 cm diameter active surface, extending out on the headset boom, for additional commands, click and right click – swipe and scroll.

[4] www.aal-europe.eu/projects/capmouse/.
[5] http://www2.telenor.no/openmind/nyheter/.
[6] www.pro.se/Om-pro/Sprak/Engelska/.

The programming of computer software is a scientific endeavour and will include device software, possible to personalize with the user friendly LipIt App. The LipIt patents are issued in EU and US [7]and a proof of the uniqueness of the technology.

A survey of the high end hands free input devices includes "eye recognition" by *Tobii*[8] and "speech-to-text" by *Google Cloud*[9], there are elaborations on the "sip and puff" devices from *Origin Instruments*[10]. All these input devices are examples of technologies complementary to the LipIt technology



The product name LipIt was chosen replacing the project names "Oral Mouse" and "Cap Mouse". The appeal to LipIt is also the description of the actual physical input method.

Vision

For Smart City inclusion, as in all other social environments, the LipIt input device will make it possible for disabled to control transport vehicles, technologies at school, order at shops, restaurants and service stations.

In the future Smart City the disabled community will interact with the abled with the same accessibility to digital air (the internet), to the sustainable energy grid and with HMI (As LipIt) the disabled community will seamlessly be integrated with the abled.

Exoskeletons and drone technology will revolutionize mobility. The transport apparatus will be 100% safe with the beehive technology of IoT (Internet of Things); all vehicles know about all other vehicles, always automatically keeping the optimal distance to avoid collisions. Which means also blind people will be able to commute, individually, in ordinary traffic.

[7] US 20110032126 A1, EP22335606.
[8] www.tobii.com/.
[9] https://cloud.google.com/speech-to-text/.
[10] www.orin.com/access/sip_puff/.

All heavy work, construction of real estate, bridges, tunnels, roads and maintenance of the recycling process will be done by machines and driverless vehicles, and drones will take care of dangerously boring stereotype work. The digitalization of the transport sector will change the way humans interact and the most obvious effect will be the beneficial effects for the elderly and disabled.

Artificial Intelligence (AI) will enhance the quality of life in the future smart city and with full control of the smart phone, the disabled will be able to move and participate all over the sociological spectrum from entertainment to education, from work to leisure.

The development of the Smart City is accelerated and in Saudi Arabia, together with Jordan and Egypt, the NEOM project[11] is designed as a huge human enterprise, in the Gulf of Aqaba, with solar power, wind power and geological power parks, with robots taking care of all manual work.

The Ecological awareness is emphasised in architectural aesthetics, in the construction of infrastructure, in balance with the Desert Mountains and wide coastal areas.

The smart farming surrounding the Smart City will be based on desalination plants, also powered by solar and wind. The crops will be grown as much vertically as horizontal. Production of protein and other nutrients will adapt to ecologically sound scientific methods giving back to nature more than what's taken out.

Ocean farming will be based on understanding of the ecologies of the Sea and a regeneration of the reefs will begin, with human intelligence and construction knowhow. Smart Oceanography will establish deconstruction of the fishing fleets and rehabilitation of endangered gene pools of fish and crustaceans. All these developments are possible due to the manifestation of digital air and the evolution of cybernetics and the LipIt HMI fit the bill in the Smart City future.

Telemedicine and prophylaxis will be operative – based on AI networks and ICT – and health care will reach a new level with smart watches, bracelets for medication and sensors collecting medical data, storing them in the cloud, all the time.

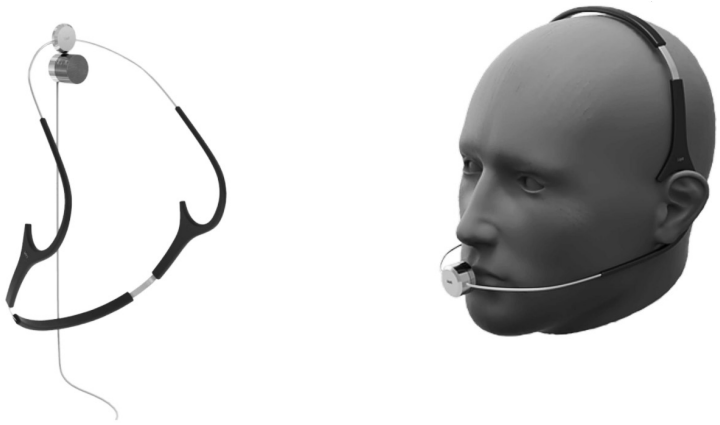
Smart homes will be developed in the Smart City and will be inclusive for all levels of disability and make the new technologies accessible for all, and with LipIt, as a complement to existing HMI, the access is made with a touch of the lip – intuitive and effortless – on the move.

In combination with voice to text software (like Siri, Bixby, Cortana and Alexa) the LipIt HMI will make it possible to manoeuvre the smart

[11] www.discoverneom.com/.

environment and communicate with both the assistive (robot) technology and near and dear, friends and partners of flesh and blood.

Figure 1-2 – The LipIt headset, design Hareide Design[12]



Truly hands free input, on the move will make future interactions with assistive technology as effective and instrumental as if the user were not disabled at all.

With a user friendly and intuitive instruction manual the learning curve will be steep and one will be able to control the smartphone, tablet or PC within a few hours of training.

Most disabled individuals are using microphone and the LipIt device offers, in addition to a microphone, full mouse control and/or replacement of the touch screen, for the index finger.

That's a step further into the next Digital Holon in human machine interaction and since we still are in the digital infancy it's important to understand that the future digital air will contain every possibility for professional development, physical movement and communication. With HMI technologies, like the LipIt input device, all these technological advancements will be accessible for all, disabled and abled alike, and thus be key for the development of the ultimate inclusive technology.

Last, but not least, LipIt is an affordable technology, it is simple and will forever change the concept of microphone technology, taking functionality to the next level of complexity – hands free, voice free and mobile digital control.

[12] www.lipit.net.

The LipIt idea has evolved for almost thirty years, almost as long as the PC itself. Today the first LipIt headset device is ready and functioning and the development of the open source LipIt App can begin, with endless possibilities for personalisation, software combinations and areas of digital use, including wheel chair control, exoskeleton control and control of the smart environment in the 5G digital air.

All disabled of all ages are invited to participate in the development of useful Apps while at home, at school, at work or on the move.

References

Adams L. *et al*. (2006). Individual Planning: An Exploration of Link Between Quality Plan and Quality of Life. *British Journal of Learning Disabilities*, 34: 68-76.

Booth T., Ainscow M. (2002). *Index for inclusion: Developing Learning and Participation in Schools*. Bristol: CSIE.

Di Cucchianico G., Kercher P.F. (2017). *Advances in Design for Inclusion, Proceedings of the AHFE 2017 International Conference on Design for Inclusion*. Springer.

Dustdar S., Nastic S., Ścekic O. (2017). *Smart Cities: The Internet of Things, People and Systems*. Springer.

Elshabrawy E., Hassanein A. (2014). *Inclusion, Disability and Culture*. Sense Publishers.

Hassan M.M., Song B., Huh E.N. (2009). *A Framework of sensor-cloud integration opportunities and challenges*. In: ICUIMC.

Law C.K., Wong Y.C., Fung J.Y.C. (2012), *HUSITA 7 – the 7th International Conference of Human Services Information Technology Applications: Digital Inclusion – Building a Digital Inclusive Society*. Routledge.

Marlier E. (2009). *The EU and Social Inclusion: Facing the challenges*, Policy Press.

Meijer C.J.W. (2003). *Inclusive Education and Effective Classroom Practices, European Agency for Development in Special Needs Education*. Middelfart.

Miesenberger K., Bühler C., Penaz P. (2016). *Computers Helping People with Special Needs*. Springer.

Mittler P. (2000). *Working Towards Inclusive Education: Social Contexts*. London: David Fulton.

Pao E. (2017). *Reset: My Fight for Inclusion and Lasting Change*. Random House.

Roulstone A. (2016). *Disability & Technology – An Interdisciplinary and International Approach*, Macmillan Publishers.

Smart J. (2015). Disability, Society and the Individual. Pro Ed. Williams R. (2008). *A Study of Inclusion of Students with Disabilities*, VDM Verlag.