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Smart Home Techniques for Young People with Functional Disabilities

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Regarding the presenter

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Topics of research interest

- Education, especially for project based courses
- Active learning
- How people learn- develop learning activities based on cognitive processes
- Incorporating FN sustainability goals in student activities
- Possibilities with Brain Computer Interface and Machine Learning

Motivation

- The expression ‘Leave no one behind’ is a cornerstone of United Nation’s Agenda 2030, so that even the most vulnerable people are guaranteed an acceptable level of quality of life.
- The *disability* aspect is elaborated on through several of the Agenda 2030’s Sustainable Development Goals, their targets, and indicators
- For instance, target 4.5 relates to appropriate access to education, 10.2 relates to reduced inequalities with respect to income, and 16.7 relates to societal inclusiveness, all with perspective in the situations of disabled people.

Background

- This contribution will cover IT-based techniques experimented on prototype systems.
- Such systems and techniques especially address assistance in the daily living of young people with functional disabilities, and, thus, should contribute to the quality and the sustainability aspects of life for those people.
- *Riksgymnasiet* is a secondary school in Sweden for students at ages from about 16 to 19 that have different kinds of functional disabilities.
- Experiments in this contribution have been done on the basis of meetings with- and need of students of that school.

Background studies

- In 2012, a study was performed by researchers at Computer Science at Kristianstad University (CS@HKR), at Riksgymnasiet at Kristianstad, with the purpose of investigating possible IT-based support systems to be used by students, in their living at that school.
- In parallel with that study, a prototype system was developed, where the students were able to turn on and off the light of lamps from apps developed for smart phones in their rooms.
- The studies showed that the end users (as well as support staff at Riksgymnasiet), were satisfied with the prototype system, and that they also had further desires from such a system.

Observations

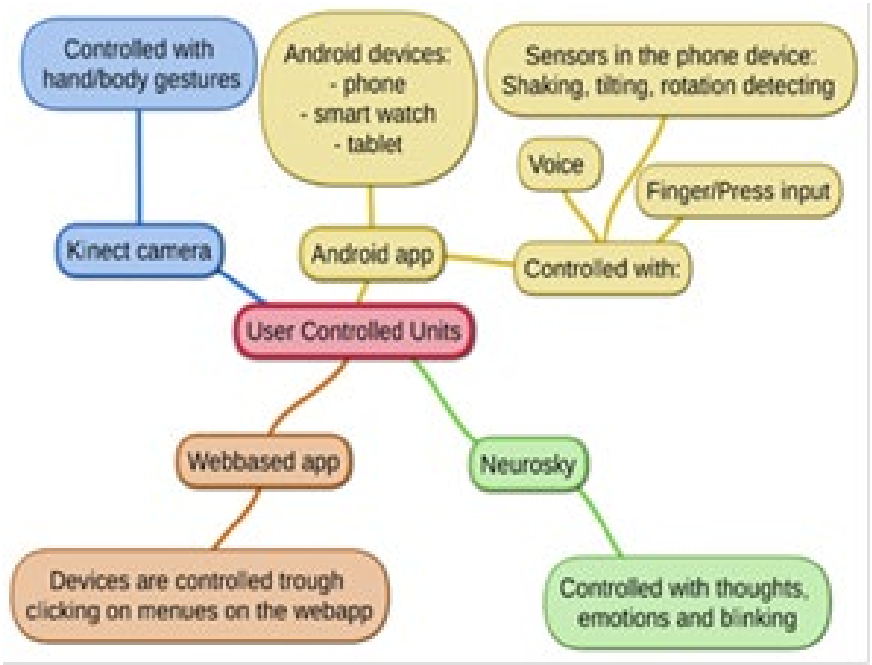
- Among other things, researchers at CS@HKR observed that it was impossible for the students to pull down blinds and put on fans by themselves to protect themselves from the sunshine and heat in their rooms.
- Furthermore, the air quality was questionable and would gain from being controlled.
- Apps, as well as other user units, needed be developed to control devices in the homes.
- While several solutions exist today for Smart Home-techniques for use by the common public, it should be noticed that it is also especially important to regard the diversity of the end users' needs.

A generalized system view

- While early initiatives were taken to understand the living situation of the young students at Riksgymnasiet, later experiments were mainly done at the lab at CS@HKR.
- Development processes have here typically been prototype based, which is an efficient way of testing out ideas, reject ideas, and build new solutions upon previous successful experimentations

USER CONTROLLED UNITS

- Different kinds of user units have been developed to be able to control the system



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Smart Phone Apps

- Apps for Smart Phones have been especially developed based on Google's Android platform. The apps have been developed to control Smart Home-devices through pushing buttons on common user interfaces
- In use at Riksgymnasiet, as shown at experiments done there, it was regarded as quite 'cool' by end users.
- To open up for further possibilities, voice recognition has furthermore been introduced. For instance, the spoken command '*Turn on the light'*, implies an answer from the Smart Home, '*I heard you said turn on light*', where after the light is turned on.

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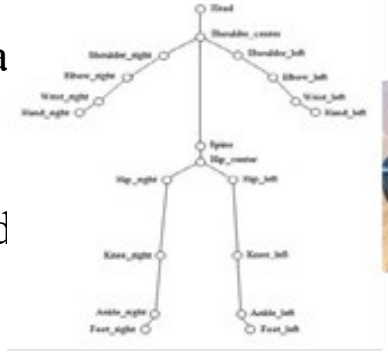
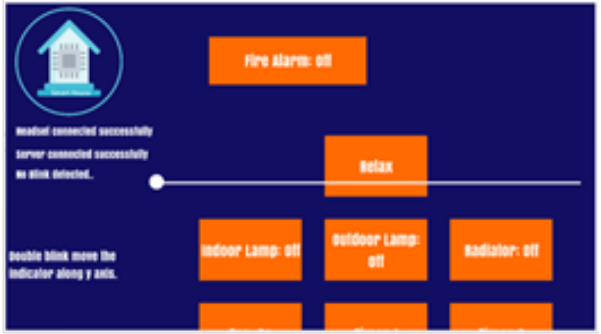
Guesture based communication

- Experiments have been made in the order to provide a variety of forms of communication, based on a diversity of needs. Yet another example is based on the use of sensors of a Smart Phone when shaking and rotating it.
- Gesture based communication has also been developed at a basis of camera techniques, with possibiliteis for a customized gesture language



The NeuroSky brainwave interface

- To meet even harder grades of disabilities, experiments have been introduced with NeuroSky brainwave headsets
- Control of home devices are here triggered by thoughts, emotions and blinking.
- One experiment was done with different combinations of specifically chosen thoughts to form commands that can be used to control the window curtain.
- The result was showing that a combination of two specific thought tasks could be used to form two commands with 97% accuracy performance, and that three specific thought tasks could form three commands with 92% accuracy performance



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HOME DEVICES

- Devices include, for instance lamps, fans, and blinds.
- Adapters have here been used to convert from high- to low level voltages. Furthermore, blinds have been fitted with a machinery to be able to be lifted up and down remotely
- Furthermore, sensors have been used for detection of quality of air, based on humidity, temperature, and carbon dioxide.
- Moreover, sensors based on ultrasonic sound have been experimented on to catch the number of entrance and exit in and out from a room.

Simulated device

- For experimentation reasons, a small scaled model of a house has been used by students
- From a point of view of techniques for a Smart Home, this house still has a wide range of functionalities that in several cases may be scaled up into real life contexts.

	Functionality	Description
1	Automatic fire alarm	This signal is simulated with a switch
2	Housebreaking alarm	This input is realized by using a magnetic switch mounted at the house door
3	Water leakage alarm	This signal is simulated with a switch
4	Temperature indoors	This signal is realized using an analog temperature sensor mounted inside the house (on the first and the second floor
5	Temperature outdoors	This signal is realized using a digital temperature sensor mounted outside the house
6	Stove On	This signal is simulated with a switch on the front panel
7	Window open	This signal is simulated with a switch
8	2 Timers	This output signal is simulated with an LED lamp on the front panel
9	Lighting indoors	This function is realized with a lamp mounted inside the house
10	Lighting outdoors	This function is realized with a lamp mounted outside the house
11	Power cut	This input is realized by controlling the presence of supply voltage
12	Electricity consumption	This input is realized by measuring the supply voltage deliver to the house (an analog signal)
13	Twillight automatic system	This input is realized by Light-to-Voltage sensor (outdoors)
14	Fan	This function is realized with a fan mounted on the house's loft
15	Radiator	Four power resistors are connected in series to realize the heating of the house. The resistors are mounted in pairs, two at each long side wall

FURTHER INVESTIGATIONS

- The core purpose of the techniques presented in this contribution has a focus on the independence of the living of the end users.
- Although use of the mentioned techniques show promising results so far, they need to be critically examined from several perspectives.
- With a diversity of disabilities, supporting techniques certainly must be customized.
- Moreover, grades of independence a system contributes with, must be examined, e.g., a fan may be controlled from a distance through an app, and therefore provide a significant grade of value, while controlling a washing machine from an app may bring less value, since it still must be loaded with clothes.
- Concepts should here relate to the grade of independence, and the grade of external assistance that is still needed even with the support of the developed system.

Final discussions

- For the sake of sustainability in use, an iterative process involving end users, and support organizations for collaboration and participation must be further initiated.
- Initiatives for further collaboration between researchers at CS@HKR and the Riksgymnasiet have been taken, and a mutual interest in future collaborations has been shown.
- A form for such collaborations should also emphasize a conceptualization of grades of independence that technical support may provide.
- Solutions should be useful for purposes of independence in the daily living, not only motivated by the functionality of the technique itself.

Thanks ☺