ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

*(A High Impact Factor, Monthly, Peer Reviewed Journal)*

Vol. 4, Issue 1, January 2016

# How Internet of Things and Autonomous Systems can Contribute to amore Universally Designed Society

Linn Steen-Hansen

Assistant Professor, Department of computer Science, Oslo and Akershus University College of Applied Sciences, Norway

**ABSTRACT:** This article is a reflection on how the Internet of Things and autonomous systems can contribute to a more universally designed society. It presents a review of the seven principles for Universal Design and considers one by one how the coming of the Internet of Things may or may not be beneficial to these principles. It reflects on how the Internet of Things can make life easier and more manageable for everyone, and how this can remove disabilities though technological innovation. Lastly it shows how the Internet of Things affect privacy and security concerns as well as the importance of interoperability and standards, which are all essential for Universal Design. The goal of this paper is a call for more research. The proposed algorithm shows efficient energy utilization and increased network lifetime with total transmission energy metric.

## I. UNIVERSAL DESIGN

Universal design (UD) is designing or accommodating the main solution of a product, service, building or environment so that the everyday operations of an organisation or enterprise works for as many people as possible without the need for special accommodations [1].

**User diversity:**
We live in a heterogeneous society with a diverse population. We speak different languages; have different cultural references, and different bodily abilities. In addition, we get older with the bodily decay that entails. In short, users of society have extremely different needs. That is why we need UD.

**The medical and social model of disability:**
The medical model of disability views disability as a problem only for the disabled individual. In other words, it is not seen to concern anyone other than the affected individual. The social model of disability suggests that it is society that disables people, because everything is designed to meet the needs of people who are not disabled. The social model recognizes that society can do a great deal to reduce, and ultimately remove, some of these disabling barriers. In short it puts the responsibility on society, rather than the disabled person [2].

**The Gap model:**
The medical model and the social model are often viewed as mutually exclusive, but disability should not be viewed as purely medical nor as purely social. We need a balanced approach and have to give appropriate weight to the different aspects of disability [3]. The Gap model (figure 1) illustrates the gap that arises between an individuals' condition and the demands of society. The Gap model uses views from both the medical and the social model to fill the gap. It seeks strengthening the individuals' conditions as well as lowering the demands of society [4].

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

*(A High Impact Factor, Monthly, Peer Reviewed Journal)*

Vol. 4, Issue 1, January 2016


**Figure 1:** The Gap model (Berget and Moseid 2012).

**The seven principles of universal design:**
The seven principles of UD can be used to evaluate existing design and guide design processes. They can also educate both designers and consumers about the characteristics of more usable products and environments. They are described in the following.

**1. Equitable Use:** The design is useful and marketable to people with diverse abilities.
**2. Flexibility in Use:** The design accommodates a wide range of individual preferences and abilities.
**3. Simple and Intuitive Use:** Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
**4. Perceptible Information:** The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
**5. Tolerance for Error:** The design minimizes hazards and the adverse consequences of accidental or unintended actions.
**6. Low Physical Effort:** The design can be used efficiently and comfortably with minimum fatigue.
**7. Size and Space for Approach and Use:** Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility [5].

## II. THE INTERNET OF THINGS

There are many definitions of the Internet of Things (IoT). A 2015 report from The Internet Society states that:
"IoT has become a popular term for describing scenarios in which Internet connectivity and computing capability extend to a variety of objects, devices, sensors, and everyday items. "
Another definition, by Jeff Hagins[6], emphasizes the impact IoT will have on the world. He calls IoT:
"An evolutionary development of the Internet in which software applications can easily make use of connected everyday objects, in order to solve real world problems. The IOT will transform the way which we live and work by making are lives safer, smarter and more productive."
The main IoT has great potential, but there are also some characteristics complicating things. Some important aspects which will be discussed here are privacy, security and interoperability.

**Internet of Things application uses:**
IoT is useful in a great many ways. In the following a few of the main application uses which are relevant in this context is described.

**Wearables:**
Wearables are clothing and accessories incorporating computer and advanced electronic technologies. They are most often used as fitness trackers or for monitoring specific health issues, but can also be used as media devices, for

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

*(A High Impact Factor, Monthly, Peer Reviewed Journal)*

**Vol. 4, Issue 1, January 2016**

navigation, communication and to synchronize data and communication from other gadgets (Wearable technology 2016).

**Building and home automation:**
IoT devices can be used to monitor and control mechanical, electrical and electronic systems within buildings, both public and private to improve convenience, comfort, energy efficiency, and security. There systems are often used to control HVAC systems (heating, ventilation and air condition) as well as lighting, house appliances, entertainment, communication systems and home security devices.

**Medical and Healthcare systems:**
IoT devices are also used forremote health monitoring andemergency notification systems, e.g. blood pressure and heart rate monitors. It can also be more advanced devices capable of monitoring specialized implants, e.g. pacemakers. It is possible to install specialized sensors within living spaces to monitor the health and well-being of senior citizens. This can be used to ensure that proper treatment is being administered, make sure they are moving around as normal and not lying somewhere injured.
There has been a rise of end-to-end health monitoring IoT platforms for antenatal and chronic patients. These platforms can help manage health vitals and recurring medication requirements. Advantages to this include cost-effectiveness and personalization for chronic patients. Doctors can monitor their patients' health on smartphones long after the patient is discharged from the hospital. In addition to these useful devises, many devices have been pushed to the marked which may encourage healthy living, e.g. connected scales or wearable activity trackers.

**Transportation:**
IoT application extends to all aspects of transportation systems, i.e. the vehicle, the infrastructure as well as the driver or user. Dynamic interaction between these components of a transport system enables vehicular communication both within one vehicle and between vehicles. It also offers possibilities ofsmart traffic control, smart parking,electronic toll collection systems,logistic andfleetmanagement,vehicle control, as well as safety and road assistance.
There are many other IoT application uses likeenvironmental monitoring, energy management infrastructure management and manufacturing. However, these areas may have less relevance in this context (The Internet of Things 2016).

**Autonomous systems:**
Many IoT-solutions rely on autonomy. To achieve autonomy a system has to work well under considerable uncertainty in the system and surrounding environment for extended periods of time. They should be able to sense the environment around them, execute and perform tasks and duties and compensate for significant system errors without human intervention, i. e. perform self-maintenance. They should also be able to navigate around the environment if needed. Manyautonomous systems use techniques from AI to achieve this degree of self-governance [7].

## III. THE INTERNET OF THINGS AND THE SEVEN PRINCIPLES FOR UNIVERSAL DESIGNWORK

The following is a discussion of how basic principles for the Internet of Things and autonomous systems can contribute to uphold The seven principles for Universal Design.

**Equitable Use:**
The design shall be useful and marketable to people with diverse abilities. The basic idea of the Internet of Things is that all things should be connected. This is also one of the biggest challenges because it means all kinds of differentdevices needs to be able to connect to communication protocols and to each other. It is also important that software works on all these different kinds of devices [8]. This is a great benefit for Universal Design, because device independences in software means it will be easier to use systems with all kinds of devices, including assistive technology (AT) like screen-readers, braille keyboard and voice control. In short, designing for the heterogeneity in IoT-devices benefits UD.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

*(A High Impact Factor, Monthly, Peer Reviewed Journal)*

**Vol. 4, Issue 1, January 2016**

**Flexibility in Use:**
The design shall accommodate a wide range of individual preferences and abilities. The arguments for how designing for IoT helps designing for UD made in the paragraph above, also apply the principle of flexibility. One cannot think one device or one way of using a device anymore. With the coming of IoT the different compositions of devices and uses has exploded, and this has to be catered for. This will in all likeliness benefit user diversity.

**Simple and Intuitive Use:**
The design should be easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level. In this regard IoT becomes a double-edged sword. On the one hand machine to machine communication minimalizes the need for human interaction – and the easiest interface is the one you do not have to operate. On the other hand, the complexity of all the different devices could make it more overwhelming to become a part of the digital society, perhaps especially for older people or people from cultures where digital information and services are not such an integrated part as in western society.

**Perceptible Information:**
The design shall communicate necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities. When It comes to this principle the IoT may be an advantage. A lot of different devices offers many new way of communicating with users, for example through haptic input, voiceover or blinking lights. Another advantage may be that with the increasing machine to machine communication more and more information may not even need to reach the user in order to be useful. The less information the user needs to take in, the smaller is the risk that the information is not perceptible.

**Tolerance for Error:**
The design minimizes hazards and the adverse consequences of accidental or unintended actions. One of the criteria for autonomous systems is their ability to tolerate and even fix system errors without human intervention. That means that an autonomous system, in theory, should be able to fix a human caused problem as well as other system failure. In that regard, theoretically, the user could make errors without ever being aware of it because the system identified and fixed the error before it created a problem.

**Low Physical Effort:**
The design can be used efficiently and comfortably with minimum fatigue. When imagining all the different types of devices possible with the IoT it seems unreasonable to think there should be devises for anyone out there meeting this criterion. Many IoT-devices is designed to make life more comfortable and convenient, e.g. light and heat that switches on and off by itself, a vacuum cleaner or lawnmower robots you can control remotely or program once and not have to worry about again or a fridge which reminds you to buy milk without you having to do anything. It seems remote control and machine to machine communication can go a long way to achieve this goal. In addition, many IoT devices may help this criterion in the interface of society as it makes life in the real world more convenient and practical for all users.

**Size and Space for Approach and Use:**
Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility. Again, the IoT offers many different devices and it should be possible to find one that are suitable for ones needs in any situation. As with the previous principle, the IoT may also help this criterion in the interface of society as it can make life in the real world less demanding, e.g. helping someone with back problems with their house work or making it easier to drive with semi-autonomous cars.

## IV. HOW INTERNET OF THINGS CONCERNS BENEFIT UNIVERSAL DESIGN

The following describes how working with three of the most prominent IoT concerns, privacy, security and interoperability, can benefit UD.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

*(A High Impact Factor, Monthly, Peer Reviewed Journal)*

**Vol. 4, Issue 1, January 2016**

**Privacy:**
Privacy has become immensely important in the digital world and even more so with the rise of IoT. Wearable technology, like smart wristbands and smart clocks, gather for example health and activity information about their users. A smart house might gather information about daily habits and routines. Where these data are stored, who has access and how they are used are important questions which may raise privacy concerns.
The focus on privacy is a benefit for us all. However, the work towards ensuring privacy is even more important for people who are entirely dependent on these new technologies, e.g. smart devices in the house for more independent living or health monitoring. To these people, privacy would be extremely important.

**Security:**
With the IoT, security concerns become, if possible, even more important than they are in today's digital world. We need to be able to trust the Internet. With an autonomous car, it is essential to know it is impossible to hack it and make us crash. We also need to know our smart houses or even our connected pacemaker can resist attacks, so we don't have a heart attack or let intruders in because of some flaw in the system.
As we connect more and more devices to the Internet, the opportunities to exploit potential security vulnerabilities grow. IoT devices which are poorly secured could serve as entry points for cyberattack. Thus malicious individuals could re-program a device or cause it to malfunction. There is also a risk that poor security can expose user data to theft by leaving data streams inadequately protected.
Devices that fail or malfunction can also create security vulnerabilities. These problems are the same for small, cheap, and ubiquitous smart devices in the Internet of Things as they have traditionally been for computers (The Internet Society, 2015).
Even more effort has to be put into securing devices. This means people depending on new technology to live independently will be safer. It also opens for more possibilities in society like digital voting, which have had several security issues in the past.

## V. INTEROPERABILITY AND THE IMPORTANCE OF STANDARDS

Interoperability is a large concern when it comes to IoT, and there are tugs of war between open source and proprietary solutions. There are many different types of devices which use different software, and the different "software families" does not necessarily communicate well. There are communication architectural models designed to deal with these problems [8].
Compatibility is also essential when it comes to universal design. Assistive technology for people with disabilities like screen readers, voice control and braille keyboards is always going to lag behind commercial technologies. It is therefore very important that newer and older technologies as well as different technology "families" are compatible [9]. The use of standards is an important part of the solutions to these issues. The fact that interoperability and standards is a common objective for IoT and UD brings hope of a more compatible, open and standardized technology in the future.

## VI. CONCLUSION

This has just been a quick scratch the surface of the possibilities, and also the challenges, the IoT offers for a more universally designed society. We have seen that there are many ways the IoT can contribute, both directly with many of the principles for UD, and indirectly by setting focus to privacy, security and last but not least, interoperability and theneed for standards. It is a subject that deserves more research as IoT and UD are two areas within technology that have had an uprise the last few years and in many ways are intertwined.

## REFERENCES

1. Lovomforbud mot diskrimineringpågrunnavnedsattfunksjonsevneDiskriminerings- ogtilgjengelighetsloven (2013). 61
2. C Bingham, et al. Towards a social model approach? British and Dutch disability policies in the health sector compared. Personnel Review. (2013) 42: 613-637.
3. WHO; World report on disabilities. (2011)

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

*(A High Impact Factor, Monthly, Peer Reviewed Journal)*

**Vol. 4, Issue 1, January 2016**

4. G Berget and T Moseid, Mind the Gap: Mellomoppsøkendebibliotektjenesterogdetuniverseltutformedebibliotek. I: R. Audunson (Red.). Krysspeilinger: Perspektiverpåbibliotekoginformasjonsvitenskap. Oslo: ABM-Media. (2012) 185-204.
5. FE Sandnes, Universellutformingav IKT-systemer: Brukergrensesnitt for alle. (2011).
6. Ted Talks. adding value to people's lives.(2013)
7. PJ Antsaklis, et al. An introduction to autonomous control systems. Control Systems IEEE. (1991) 11:5-13.
8. The Internet Society.The Internet of Things - an overview: Understanding the issues and challenges of a more connected world. (2015)
9. L Steen-Hansen, Building accessible Rich Internet Applications (2015).
10. Internet of Things .In Wikipedia. Retrieved February 3rd from Internet of Things.
11. Wearable Technology.In Wikipedia. Retrieved February 3rd from (2016).