Ubiquitous Computing In Accessibility

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I. Introduction / Summary

It is a great delight that the timeline for ubiquitous computing has made a series of incremental innovations to enhance accessibility and inclusivity for People with Disability (PWD). Mid-2000s can be a general pinpoint for ubiquitous computing in accessibility as it involves the convergence of various technologies and appreciative research efforts from the decades previously. Early research endeavors focused on the integration of sensors into wheelchairs to enable intelligent navigation for individuals with mobility impairments. In the 1980s, advancements in wireless communication technologies further fueled the possibilities in telecommunications, laying the groundwork for seamless connectivity between wheelchairs and external systems like for example motors and joystick controllers. The imperative for this kind of propagation prompted a shift in our perspective, guiding us to venture into a new domain where the demand for ubiquitous computing infrastructure was more of a necessity: addressing the accessibility requirements of wheelchair users [4]. Before that era and our leap in unifying access for the disabled community, support often manifested in forms of sympathy and volunteer work. Individuals with mobility impairments relied heavily on the goodwill of others, often receiving support through empathetic gestures and volunteer assistance, which at the time was "fair enough" simply because of inadequate tools and technologies specifically for this sector. Fortunately, we have come to a new paradigm where accessibility is not just a sympathetic endeavor but a dynamic and inclusive journey supported by a multitude of global cooperation efforts [1].

II. Literature Review

There are many critiques in the realm of ubiquitous computing for accessibility given it is a delicate investment that directly impacts individuals' lives. Collectively, over the years, wearable technologies in this subject area have garnered renewed attention and expanded outreach, successfully addressing earlier critiques by efficiently catering to the diverse needs of individuals with disabilities.

After a near fatal injury or a blow to the body, the limbs are commonly affected. This type of trauma to the body can severely affect the chances of complete restoration and would require a resort to wearable assistive robotics. [5] beautifully describes how ubiquitous computing for accessibility can be seamlessly integrated into the biological body itself. These technologies use sensors or actuators and can be shaped into the form of prosthetics, exoskeleton, orthotics mimicking the functionality of natural human limbs, sometimes even enhancing the original strength. The HandeXos-Beta device enables swift responses to operator movement intentions by utilizing machine learning algorithms and data from inertial measurement unit (IMU), electromyographic (EMG), and torque sensors [10]. The rigid engineered structure of these devices affect portability when being equipped with them. In [7] testimony, the cost of these products is substantial, yet their utilization requires an initial level of effort after which the user easily adapts to the technology. An analogous experience is akin to the initial discomfort of getting orthodontic braces: a brief inconvenience for a long-term benefit.

This trend extends beyond the yard scale and even offers its way into Ubiquitous Internet of Things (UIoT) to amplify accessibility for the elderly. UIoT is in essence a ubiquitous network in which electronic devices have access to the spatial surrounding, ultimately encompassing into the broader scope at the Internet level. A primary example of this is in the Georgia Tech Aware Home Research Initiative which houses a smart bathroom for senior citizens who are self-capable but experience a degree of physical impairments in the upper or lower body [3]. The capabilities of this eloquent piece of technology is treasured with a smart toilet seat which monitors weight displacement during seated postures, smart grab bar detects grasp strength and positioning, and an underlying floor discerning the foot positioning and vertical forces from weight.

Furthermore, weaved into home and clinical settings in this study by Jones et. al. is another sleek system to automatically measure gait speed on a 13-feet course, invented to gather information about tiredness or collapse of individuals aging with disability (or surgery) from the home environment [3]. The use of these sensors in an accessibility perspective has definitely proven its potential to facilitate independent living for some of the disability community.

Another way ubiquitous computing has witnessed state-of-art transformation in accessibility was through the integration of Augmented Reality (AR). AR was essentially used to teach science topics to students with physical disability such as congenital muscular dystrophy. A research performed by UCF used VR/AR technology to create a virtual science laboratory accessible to students with physical disabilities through assistive tools like joysticks [12]. This ecstatic vision helped the students in practically applying the scientific method and exploring scientific concepts by actually conducting experiments, overcoming physical limitations.

III. Challenges

As challenges arise when ubiquitous computing is used in an accessibility perspective, new critiques are again formed, solutions are engineered, and the cycle repeats. The topic is too pressing to have a stand-still when faced with adversaries. Collectively, I pinpoint three challenges.

One main issue that Chaves et. al. have addressed is the need of additional safety measures for wheelchair users, apart from the vanilla seatbelt and restraint, which are simply not enough. [11] addresses going beyond traditional safety measures by incorporating smart sensors (MGY-BMI160) and real-time crash detection and notification systems (with RP2040) to enhance the overall safety and security of wheelchair users.

With current inflation, there is an inevitable challenge in the cost of ubiquitous accessibility technology and its outreach [9]. Remote areas of the world are deprived of having proper ubiquitous accessibility tools, not to mention the price tags that follow it too.

Despite its significance, only 10% of individuals in need of assistance, according to [13], have access to this technology. In light of these challenges, Ubicomp continues to evolve providing continuous improvement in accessibility and safety for individuals with disabilities.

IV. Reflection

Ubicomp in accessibility has actually been quite keen on its privacy measures, which is why I did not list it in the challenges section. Top level researchers tend to have kept privacy and safety on the top bucket which have never missed the eyes of a critique [8]. Additionally, I have been quite astonished by the interests of geopolitics to have attention in this sector. Promoting accessibility has definitely been a shared societal objective. I wish this were the case in some parts of rural India, where let alone having a disability was considered a bad omen. Providing technological access to those people could at least shine light on Diya Foundation, India's organization for accessibility and inclusion in Bangalore [6].

V. Conclusion

Accessibility before the introduction to Ubicomp and after are now two different distinct contrasts. From smart prosthetics to smart homes, Ubicomp has shined light in accessibility for individuals with various impairments. Leveling the ground in terms of access to accessibility tools, however, should be the current focus. Personally, it has been a pleasure thus far working for its cause in many projects. Soon we shall see exponential demographics for this sector as the cycle of accessibility innovation continues to grow.

VI. References

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