Hot topics in Human-Computer-Interaction

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Abstract. This paper identifies emerging topics in HCI of significant and growing importance. It identifies those focus points to be health, new research methods in HCI and novel ways of interacting with computers. For health research, there was a clear tendency on finding ways to integrate commonly used technologies into daily health struggles as well as defining the role of social media. In the area of finding new research methods in HCI, improvement was sought for studies through their entire life cycle. The field "novel ways of interacting with computers" deals not only with the design of such novel ways and the evaluation thereof, but also all kind of new possibilities appearing through those ways. It focuses on eye-tracking, epidermal devices and virtual reality.
Different types of papers are distinguished and various research techniques identified and analyzed.

Keywords: HCI, Hot-topics, Health, Medicine, Mental Illness, Assistive Technologies, Fitness, Research, Computer-Interaction, Eye-Tracking, Epidermal devices, Virtual Reality

1 Introduction

This work aims to identify hot-topics of today's HCI research. The main focus of HCI research is the improvement of user interaction with any kind of technology. Nowadays technology is integrated into daily activity in every area of our lives. This makes HCI a field that could not be more versatile.

To identify the focus of today's research, I looked at the list of the best papers and honorable mentions of CHI 2019 [1]. The CHI is the leading international conference on human Computer Interaction taking place once a year, held by ACM, the Association for Computing Machinery. With it's international relevance, it was the natural choice to investigate HCI research.

This paper summarizes 26 papers in the areas that were identified as hot topics as an attempt on giving the reader an overview over the topics most relevant in today's research. It draws connections between the different topics, identifying prominent and overarching focal points. It also distinguishes different types of papers and identifies and analyzes various research techniques.

2 Emerging Topics in HCI

2.1 Overview

Figure 1 gives an overview over the many topics represented on the CHI 2019 best paper and honorable mentions list [1]. This word cloud was conducted from reading the abstracts of all 150 papers and in this way making deductions to their content.

Fig. 1. Wordcloud compiled of the Best Papers and Honorable Mentions of CHI 2019.

2.2 Health

As can be see in Fig. 1, the biggest part of today's research focuses on health issues. In the following, this topics is divided into the areas of Medicine, Mental Health, Assistive Technology for Disabilities and Fitness for a better overview of the wide range of topics this field represents.

Medicine

The most well-known area of health management is traditional medicine. Treatment however does not solely take place in clinics or doctor's offices anymore. In the following, two novel ways of diagnosing and dealing with disease are introduced.

Self Management In the year 2020, 157 million people all over the world will be suffering from chronical health conditions [19]. Already today, 50 million people in Europe alone suffer from so called multimorbidity, meaning they suffer from multiple chronical health conditions [9]. With a steadily increasing number of chronically ill people, tools for self-care become increasingly important. Self-care was defined by the World Health organization as "the ability of individuals, families and communities to promote health, prevent disease, maintain health, and to cope with illness and disability with or without the support of a health-care provider" [18]. Tools for self-care are mostly mobile applications that help the patients deal with multiple tasks needed to be carried out every day. Improving on those tools can save a lot of time and effort and thus significantly improve quality of life [9].

While use of such tools has clearly shown health benefits, it has been observed that people affected find it challenging to stick to self-care mechanisms [19]. Raj et al. [19] investigate the role of context in self-management at the example of Diabetes Type-1 patients. Context in this case can be any environment or circumstance, e.g. home/travel, work/school, weekends/working days. They find that these contexts highly influence factors like nutrition, physical activity, mood and, in this special case, insulin. Being aware of those contexts can potentially be used for "providing support at the right time, at the right place, and in the right way" and thus encouraging people, not pressuring them. Data regarding these contexts can easily be taken from the user's smartphones. The challenge here clearly lies in the design of those context-sensitive self-care tools. This includes finding relevant factors as well as solutions on how integrate them best. So-called contextual frames help understanding the same factors in different contexts and thereby can help adjusting and optimizing the support to each individual.

Doyle et al. [9] focus on the special burdens experienced by people with multimorbidity using self-care technology. Additionally, they concentrate on elder people, as the probability for chronic disease grows hand in hand with age. Older people might face additional challenges like a lack of sensory, physical and / or cognitive skills as well as technological affinity when interacting with technology. As a consequence, technology for elder people should be "accessible, easy to use and intuitive, shortening the learning curve for this cohort" [9]. They also found that the daily treatment of multiple illnesses often equals excessive demands on the patient's side. From keeping track of symptoms and taking a potentially vast amount of medication to managing healthcare visits and doctor's appointments, the list of tasks can be overwhelming and sometimes even contradictive. Prioritizing tasks provides a starting point for the patient and supports decisions when having to choose between contradicting assignments. When designing medicinal

care for people with multiple chronic illnesses, it can further be helpful to look at the bigger picture of all their illnesses rather than seeing and treating each one individually. Another benefit can be the co-use of the self-care application by both patient and care-taker, as both possess unique but valuable insight into the patient's condition. The patient has a leading edge on his personal state of health while the care taker can see things from a medicinal perspective.

Online Health Communities Online Health Communities are online forums that allow people with similar diagnosis to connect. They act as a support system and offer advice on illness-related issues [27, 28].

As people seek medical advice to personal health problems, they have to reveal a much greater amount of personal data than e.g. when seeking for help in a tech forum. So-called self-disclosure, "the process by which one person verbally reveals information about himself or herself to another" [27], is important for others to understand the exact terms of the problem and give advice accordingly. This of course makes the author vulnerable. Looking at the big picture of social media, people have shown to be more likely to disclose personal information that might reflect in them negatively in private channels, meaning to a specified audience, rather than in public for everyone to see. Anonymity brings safety. Online Health Communities provide both private and public channels, yet they get used differently: Primarily used are public channels for all matters of support; private channels are merely used for follow-ups. Being a community for a specified group of people already gives a more private feel to the public channels. [27]

Another interesting observation made by Young et al. [26] is the differentiation and the distribution of different social roles amongst members of Online Health Communities. While some people might be focused on sharing illness-related information, others might want to share their personal story or give advice to others. What role a member will fill is mostly depended on their goal, their desire to interact with other members and their expectations from joining the community. Over the course of their in the community, every member will obtain different roles, yet stay equally distributed in the community as a whole.

Young et al. [28] have observed these behaviors and patterns to slightly shift when looking at Online Health Communities for illnesses with unknown cause. At the example of a Facebook support group for Vulvodynia, they found that members primarily used the platform "to collectively make sense of their condition". There was also a significantly larger amount of entries concerning how to self-manage daily life with the illness. Additionally, they discovered potential added benefit of self-tracking devices for diseases with unknown cause. Provided with the resulting pool of first-hand patient data, it might be possible to collectively find a reason for the illness.

Mental Illness

Similar to the online communities discussed in the previous sections, Andalibi's paper [5] focusses on what existing social media networks can do. Sharing mental health issues on identified social networks can be intimidating, since unfortunately, there is still a stigma attached to mental illnesses [5, 11]. Yet it has proven to offer the possibility to form deeper bonds with similar-conditioned people than looking for support on an anonymous website. Victims of mental illnesses sharing them online have shown to turn into role-models for others and thereby experienced health improvement themselves. This mentorship-relationship is however complicated by social media platforms, as they "lack affordances that enable the community, particularly new or occasional users, to effectively find discussions as they become buried below new content" [28]. A new function of labelling oneself as a specific group could help finding people with a shared diagnosis. Integrating an online health community into everyday social media instead of marginalizing them also might benefit the demise of mental health stigmata [5].

This is particularly important as more and more people are affected by this. Studies have shown that especially students are increasingly affected by mental health problems. It is even said that mental health is "the hidden price of education". Not only leading to suicide and a lower life-quality, but a decrease in academic performance too, it is naturally recognized as a problem by Universities and researchers. As a result, digital phenotyping was introduced. Digital Phenotyping is a "health surveillance technology" that monitors digital activity. It is proven to detect signs for stress, mood and even signs for depression and suicidal thoughts. It can be applied to monitor all students to identify those affected by mental problems or just specific people that are known to have those issues. It can also be used to monitor students as a whole to give an overview of the general mental condition on Campus as an additional resource to the many studies that have been conducted on this topic. While this technique might help in identifying students with mental health issues that do not seek for help, it remains unclear what is then supposed to help them. Services of counselling and support are already hopelessly overrun by students with the same problems who do to seek help. The collected data could however be of value when designing methods to help victims of mental health diseases. The HCI challenge here lies in bringing the technology to the people, since most feel uncomfortable being monitored in their daily digital activities. In a study executed by Rooksby et al., participants were most concerned about the violation of privacy. These concerns however often came from not fully understanding what was being recorded. Therefore, a user-friendly design of this approach is crucial. [21]

Smartphones take quite powerful roles in our everyday life. It seems only natural to include them in the design of new ways to ensure mental health. Doherty at al. [8] explore the possibilities of the mental health screening of antenatal woman through self-reporting. An alarming 50 percent of pregnant women suffering from prenatal depression remain undiagnosed. While there are examinations of this illness, those are primarily performed face to face. Women have reported to feel

uncomfortable in those situations, unsure of expectations and afraid of stigmata. The leading cause for maternal mortality in the UK is suicide, and not only the mothers are at risk, but the children too. In the study run by Doherty at al., pregnant women were provided with an app on their mobile devices where they could self-report on their mood. This data was then stored encrypted and only when showing risk to a participant's health shared with a doctor to instantly make help available to the patient. Of the women that were diagnosed with prenatal depression through this app, two-thirds weren't detected by conventional methods.

Mental Illness being an increasing field of interest was already recognized by Sanches et al. [22]. They too found the biggest focus of research in this field to be on self-tracking technology and automated diagnosis. In their paper, they evaluate existing research on affective disorders such as depression, bipolarism and anxiety and suggest improvements to today's research. They recognize the main goal of HCI research in this area to be the "positioning ... as an important component of therapies, prevention strategies or self-management for people dealing with affective disorders, as well as their peers, caregivers or clinical staff". Most fitting for this would be full-cycle studies: gathering information, translating that data into design and after that evaluating, e.g. through clinical trials, and thus getting feedback on their effectiveness. Yet they observed a tendency to overreach on data collection and underplay on translating that data into novel technologies. Another point was the collaboration of both technology and therapy. One informing the other, they can improve best when working closely together. Involvement of in-clinic patients in technology design was also found to be beneficial, as they have valuable input to contribute. Considering that research subjects in this case are people suffering from affective disorders, there is a need for encouraging taking precautions to not affect those people, often more unstable and vulnerable, in a negative way. Lastly, they found that novel technologies were in no way utilized on the scale they could be. As seen in one case of virtual reality exposure therapy, this could potentially hold great possibilities and improvements.

Assistive Technologies for Disabilities

Assistive Technologies for People with Visual Impairments With technologies like Alexa and Siri HomePod, Voice User Interfaces increasingly become more present. Not only are they capable of making daily life at home more comfortable, they could also be highly beneficial in other environments. One example is supporting people with visual impairments, as for them, speech seems to be the simplest and most intuitive way of interacting with technology.

Metatla et al. [15] explore this at the defined example of visually impaired students in mainstream schools. It was found that while more and more students with visual impairments are send to mainstream schools and educated together with sighted students, there still seems to be a social barrier between the both groups. Visually impaired students have a harder time participating in class

and are often socially isolated. One explanation for this might be that assistive learning techniques are usually designed for single person use and therefore, complicate interactive study techniques like group work projects used in class. The elimination of this example could be easily achieved by a technology aware of its surroundings and context: during group work, the technology would be used on a speaker, enabling interactions all students, visually impaired and sighted. Switching from group work to individual studies could then be easily achieved by plugging in headphones. Another observation made was that visually impaired students in mainstream schools preferred to use assistive technology on their tablets or smartphones. Technology that was developed especially for this purpose, e. g. ear pieces, were perceived as socially awkward, embarrassing and isolating the user in a "technology-bubble".

There are however challenges visually impaired people have to face when interacting with smartphones. Not only touch input can often be more troubling, as visually impaired people tend to only have one hand available with the other hand holding on to a cane, a guide-dog or an accompanying person. Speech output in public raises a number of issues as well, starting with the compromising of output through environmental noise. Privacy concerns have to be considered. Again, there was unease about social salience and awkwardness. These struggles were motivation to Wang et al. [25] for designing their new technology EarTouch. In their approach, interaction with the phone takes place thorough tap and draw gestures of the ear. Holding the smartphone against the ear is a common position, e.g. when taking a phone call or listening to an audio message. It enables confidential speech output and does not stand out in any ostracizing way. Especially challenging was not only the natural condition of the ear, which made it harder to track gestures. The ergonomics too were reversed to what is known from finger interaction, as not the ear, but the device is moved. Ultimately, a user study found their design to be a success, describing it as "easy, fast and fun to use".

Another troubling matter for visually impaired people is the input of text using a smartphone keyboard. When editing text on a smartphone keyboard, most sighted people rely heavily on auto-correcting techniques. These algorithms however cannot simply be copied to screen-reader keyboards for visually impaired people, as their typing mechanisms are significantly different. They enter text letter by letter, not progressing to the next one until the current one is validated. Those factors slow down text input enormously. This lead Shi et al. [23] to develop "VIPBoard", a smart screen-reader keyboard with an adapted auto-correction algorithm. During text input, their algorithm calculates the probability for each letter to come next, considering preceding text as well as touch input position. The letter with the overall highest probability is then read. Additionally, keyboard-layout and scale of specific keys are adapted whenever the user's touch input does not equal the desired letter. A user study showed a decreased touch error rate of 63 percent and a speed increasement of roughly 13 percent.

Assistive Technologies for Socializing and Personality-Development Socializing and interacting with other people is essential to happiness and health. Especially for a child's development, it is essential they play with their peers. Playing helps you develop social skills as well as self-esteem and a personality. Children with disabilities however often have trouble interacting with other children, as they might be perceived as strange or different. If they have a disability like autism, it might also be uncomfortable for them interacting with others directly. For these children, online communities and social media can act as more comfortable way of socializing. Ringland [20] examines the online community Autcraft, a Minecraft online server adapted especially for autistic children. It is mounted with special plug-ins that prevent any form of bullying like the destruction of someone else's buildings. Surrounded by children with similar conditions, it creates a safe environment. It allows the children to make friends, feel safe and confident about themselves and just play.

Another marginalized group that easily gets excluded from socializing processes are people with dementia in care homes. Especially when the illness is more advanced, they are often labeled as incapable of meaningful social interaction and left by themselves. Foley et al. [12] developed a technology called Printer Pals to encourage social interaction in such care homes. It is a small, receipt-based printer providing the user with short riddles and questions while playing music. Its main purpose is to spark interaction between multiple users. In a user study, elders with dementia seemed very interested in and fond of the novel technology and found it easy to use.

Creativity is one more aspect of self-development and mental well-being. Being creative allows people to relax and be at ease with themselves. This too is sometimes complicated by disorders. Neate et al. [16] introduce "MakeWrite", a prototype app that helps people affected by Aphasia with the process of creative writing. Aphasia is an illness that complicates the process of comprehending and formulating language. The app provides you with a pre-written short story, that is than reduced on the number of words. This can happen both randomly or user-chosen. When less 10 percent of the original text is left, the user can rearrange the words in an order of their liking and randomly create new words to fill gaps. MakeWrite can essentially be used not only for people with Aphasia but everyone experiencing difficulties with creativity, in this case creative writing.

Fitness

Exercise plays a crucial role in physical as well as mental health. Yet more than 1/4 of the world population does not exercise regularly Aladwan et al. [3] recognize mobile fitness apps as the way to popularize exercising. With most people nowadays having a smartphone and access to internet, mobile fitness apps are a good way to make exercise more approachable.

2.3 Methods of HCI Research

One thing that naturally seems to come to mind when researching and improving in the field of HCI is improving the research techniques themselves.

As taking surveys and interviews is the gold standard for research in HCI, understanding the participants right is essential for quality outcome. Surveys with young children hold specific challenges. Nowadays, children naturally are a part of the technological world. They have valuable insight into modern technology that is crucial for creating new technologies and evaluating existing ones. Being pre-literate, research methods need to include information transfer by direct speech. This however often leads to flawed results: Not only do they have a harder time answering interview questions in the desired way. It has also shown that adults, even if they might be parents or teachers, perform poorly on understanding and collecting such data. This paper introduces Anchored Audio Sampling, a new way of collecting survey data. It is a program that can be embedded into any android software. Using a microphone, it records participants during their interaction with a technological device during so called anchor moments. These are researcher-chosen pre-selected moments of interest, e.g. the press of a button. It then presents these audio snippets together with the pre- and succeeding audio sequence to provide context. This provides researchers with a less cluttered, valuable data set [14].

Another aspect is of course the design of such experiments in the first place. When coming up with an experiment, researchers often find themselves between saving costs and resources and wanting a high-end quality product. Finding a trade-off between the two while also taking external influences into account is a difficult task. Touchstone2 is a tool designed to help with that. It visualizes correlations between single parameters and also offers interaction with them, thus enabling the user to compare alternate experiment design approaches. It is able to predict statistical significance and estimate the number of research subjects needed to achieve a certain value [10].

Once the data has been collected, it of course needs to be evaluated to find utilization, e.g. in founding design solutions. This is the field of Translational Science: developing scientific knowledge into practice. The major issue in this field is the loss of knowledge during the translation. To decrease this loss and improve translation quality, it is important to understand what obstacles hinder knowledge from progressing from one state to another. The research-practice gap metaphor describes the phenomenon of the two worlds of research and practice seemingly being completely separated. There might even be obstacles like terminology standing in the way of a smooth translation. In contrast to that stands a bidirectional development as a new approach. It proposes the close cooperation of the research and design communities when translating knowledge [7].

2.4 Interaction with Computers in New Ways

Eye-Tracking Eye-tracking increasingly becomes field of interest as a natural way of interacting with technology. It may in fact soon be built into most of our

every-day devices [24]. This offers great opportunities for novel technologies and designs in multiple fields of HCI.

Sindhwani et al. [24] explore the possibilities of eye-tracking in text editing with the development of their program "ReType". They discovered that when editing text at a computer, having a hand leave the keyboard for mouse interaction to relocate the cursor takes up a considerable amount of time and interrupts writing flow. ReType is a text-editing program that uses eye gaze tracking to enable navigation through the text, e.g. to correct a spelling mistake. While it seems only natural to use eye gaze for a task like pointing at a specific area, there are a few challenges that need to be taken into consideration. The Midas Touch metaphor describes the problem of distinguishing between intentional eye movement, meant to trigger an action, and natural, unintentional one. It is also quite challenging to pinpoint the gaze to an exact spot as text on a screen is quite small and closely together. In ReType, these issues are managed through a process called patching. When looking at the typo the user wants to correct, not only do they type in the corrected version, but a preceding and subsequent sequence. This provides the program with context that then can be used as context to the eye-movement tracked. This process is also based on how one would naturally talk about editing a text. A user study found ReType to be the same and even above speed as working with a mouse and an overall improved user experience regardless of typing skills.

Berkovsky et al. [6] take a different direction: they explore the use of eye-tracking in the area of psychology, personality detection to be precise. Personality "refers to a set of individual patterns of behaviors, cognitions, and emotions that predict a human's interactions with their environment" [6]. From personality detection can thus be drawn important conclusions to character traits. This holds potential for novel ways of e.g. recruitment and personnel assessment. It also offers potential for improving HCI designs. Investigating one's personality however is a process prone to faults, as it is mostly conducted through psychological questionnaires or face-to-face interviewing. Obstacles like people not fully understanding questions or feeling uncomfortable answering them makes results biased and flaky. A new approach of making personality detection more objective and fail-safe is the exposure of humans to external stimuli and simultaneous capturing of their external response. In this case, the subject is provided with an image and / or video. Their responding eye movement is captured and fed to a machine-learning algorithm that deduces a number of different personality traits. A high accuracy to predicting personality traits was shown by a user study.

Epidermal Devices .

As epidermal devices become increasingly popular, Nittala et al. [17] investigate the effect of these skin-worn technologies on the tactile perception. More precisely, they looked at three specific factors: tactile sensitivity, spacial acuity and perceived roughness. As sensoring epidermal techniques, they used PDMS,

Fig. 2. Example for epidermal devices [13].

consisting of thin films of poly, and tattoo-paper. While PDMS has 100 times the stiffness of tattoo paper, they both had similar results. They found there to be a connection between the natural sensitivity of the skin and inaccuracy of the technology-covered same spot. The higher the original sensitivity, the more perception will decrease. For example, spacial acuity increased by 50 percent on skin-areas more sensitive and stayed roughly the same everywhere else. On tactile sensitivity and roughness perception, the devices had a much larger effect, with tactile sensitivity threshold increased by 390 percent and the roughness threshold by 490 percent on the most sensitive areas. Overall, they found there to be not a large effect on tactile perception in increasing the stiffness of the device, yet it was found to be better liked by users, as it seemed more sturdy and re-usable.

When it comes to skin-feedback, most is based on vibrational interaction and little attention has been given to more natural options like applying pressure or stretching. Devices developed in this area are often bulky and therefore impractical, disrupting movement and not universally applicable to each body area. Additionally, development so far was always limited to one technique per technology, no one combined several interaction methods on one design. This motivated Hamdan et al. [13] to develop their shape memory alloy spring based mechanotactile interfaces “Springlets”. Shape memory alloy springs are a type of spring that is especially slim and flexible. Placed in ergonomic stickers, they are movement resistant and can easily be applied to every area of the body like arms or near the head. When a current is applied, they contract similar to human muscle. As can be seen in Fig. 3, there are two different types of actuators. For skin actuators, the interaction takes place at the two ends of the spring where it is attached to the skin. Examples are pinching and directional stretching. End-effector actuators support interactions like pressing, pulling, dragging and expanding by having an additional object added to the spring that is then manipulated by contractions. Even combining two springs or changing the current applied for a different effect is possible. Not only do Springlets offer a wide range of novel ways to interact with skin that are completely silent, they are also easy and cheap to produce and very compact. This could be highly beneficial in many areas like in health and fitness, navigation and Virtual Reality.

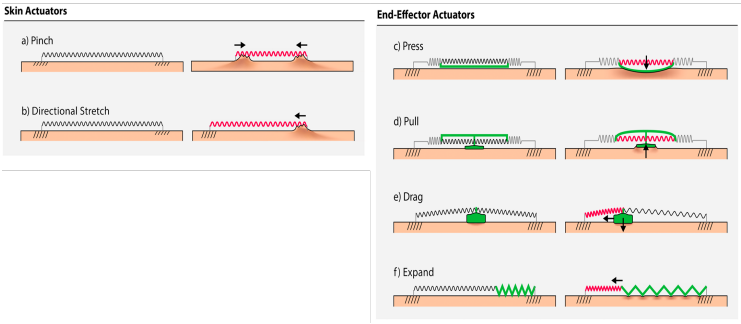

Fig. 3. The two different types of Springlets developed: skin actuators and end-effector actuators [13].

Virtual Reality The goal of virtual reality technologies is "to replicate the sensation of the physical environment by mimicking people's perceptions and experience of being elsewhere"[4]. With tools like controllers being used for interaction in a virtual environment, a natural design of these too should be a priority. Often interaction with objects is where the illusion of being in a realistic, alternative world breaks [2, 4].

Alzayat et al. [4] developed the Locus-of-Attention Index to provide a measurement on how different tools affect the virtual experience. The Locus-of-Attention Index is based on measuring the so-called embodiment of VR tools. Whether interaction is executed by a body part or external tool can highly influence how the brain processes movement. Embodiment describes the phenomenon of having a tool feel like an extent of your own body. It was measured by Alzayat et al. through a user experiment. They put subjects in a virtual reality setting where they had to complete small tasks and puzzles for a short period of time. Simultaneously, there were color-changing dots projected onto the task board as well as the interaction tool . Participants were instructed to count the changes of color on the task board and the controller separately. The Locus-of-Attention Index was then calculated from a ratio of the dots counted on the task board and the ones counted on the tool. The idea behind this was that the more embodied an interaction tool would be, the less attention users would pay to it. For reference, they conducted the same study with using hands instead of tools, validating this theory.

Not only interaction tools are needed to make a virtual experience seem realistic. So-called encountered objects offer a physical surface for the user to directly touch and manipulate. Traditionally used are robot arms. Those are however highly limited in the range they can move in. Even robots that are on wheels are limited in the height they can reach. Abtahi et al. [2] explore the possibility of a quadrocopter as an alternative, for them having a much wider range and also being more affordable. While there has been work on quadrocopters giving force feedback in virtual reality before, other haptic interactions are possible after

overcoming a few obstacles. An example is covering the quadrocopter and its propellers in a mesh cage so it would be safe to touch. The new possibilities were demonstrated by constructing a virtual shopping experience. The quadrocopter was equipped with a piece of cloth and a hanger, enabling users feel clothes and take them from shelves by their hangers (Fig. 4: left and middle). Quadrocopters could also be shut down completely and then lifted by a user, imitating a show box (Fig. 4: right).

Fig. 4. Possibilities of haptic interactions in Virtual Reality using a quadcopter [2].

3 Best Practices

3.1 Types of Papers

When talking about scientific papers, there are two different types of papers that need to be distinguished.

A paper might be introducing a novel technique. In this case, the authors have developed software like a computer program or an app [10, 16, 23, 25] or even a completely new technology like the small, receipt-based printer "Printer Pals"developed by Foley et al. [12]. They could use the platform of a scientific paper to introduce it, talk about design and conducted user studies.

A paper can also be analyzing. The focus here lies on research. It could be conducting interviews or simply summarizing other scientists findings. Conclusions might even be drawn solely based on already existing research. While they might develop prototypes for research purposes, the main difference is that the outcome is not a finished ready-to-use product. Analysis papers solely provide theoretical conclusions like design guidelines.

An aspect worth mentioning is co-design / co-development. It is a method of involving directly affected people into the process of developing and designing. E.g. in developing a voice interface for education of visually impaired students in mixed schools, Metatla et al. [15] involved a group of both sighted and visually impaired students.

Figure 5 shows the distribution amongst both all papers from the CHI 2019 Best Paper Award and Honorable Mentions List [1] and those covered in this paper.

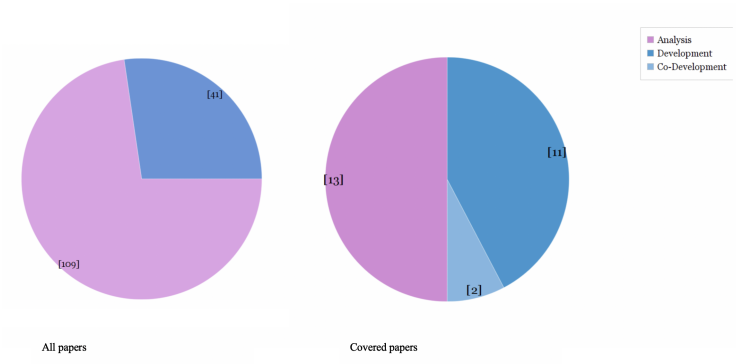

Fig. 5. Categorizing papers into Analysis and Development. Left: All papers from the CHI 2019 Best Paper Award and Honorable Mentions List [1] Right: Papers covered in this paper.

3.2 Research Techniques

When designing or developing in the field of HCI, data is needed to develop and base theories on. This data can come from reading other scientific papers concerning the same or a similar topic. This however does not always cover it. When researching in a fairly new and unattended field or wanting assessment on a technology you developed, new data needs to be aquired directly from the source. HCI offers a range of pre-defined methods for this purpose:

Observation describes the process of compiling data without direct interaction with people. It can be drawn from user online reviews [3] or through observing the behavioral patterns in an online community [26–28].

User Studies are a popular method in HCI, when searching for feedback on newly developed technologies. The basic principle is setting volunteers up with the technology and drawing conclusions from their interaction. This interaction can be free-use or instructed, giving the participants actions to perform and tasks to complete. It might be set for a time span of about hour in a laboratory [6], but could also be the use and evaluation of a mobile application over several months [8, 14, 19]. The number of participants can range from as little as four to 245. Often mentioned is the study of an entire online community, and even though this is hard to pinpoint to a specific number, it can be estimated even higher than 245. User Studies are often followed by interviewing the participants to get a deeper understanding of their experiences during the study. In fact about fifty percent of the user studies conducted by researches covered in this paper were followed by interviews.

In interviews, participants get asked specific questions of interest to the researchers. This might be directed at a specific group of people, e.g. about an online community they're a member of [20, 26–28] or an illness they're dealing with [15]. It could also be a follow-up after a user study [9, 25]. A typical interview lasts between thirty minutes [10] up to 90 minutes [5]. The number of participants is highly similar to the number used in user studies.

Data can also be gathered through giving a workshop. A group of ten to thirty people, potentially specifically educated in this field, meets up for what can be a day or a week and together collects their thoughts and experiences on the area.

As for an overview of which studies were used in the papers discussed above, Fig. 6 considers the different types and their representation.

For a closer look as to how many participants were typically used, Fig. 7 offers a relation between a range of numbers of participants and how many studies of the covered papers fall into that range.

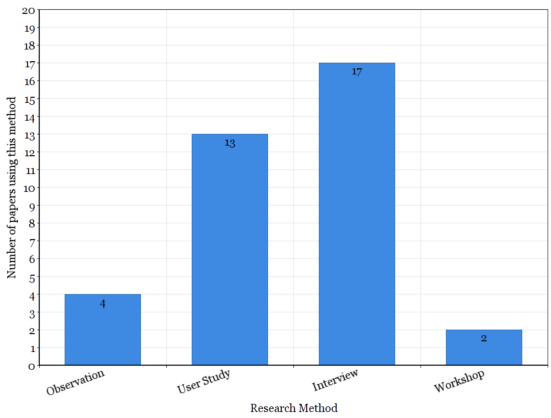

Fig. 6. This diagram shows how often each of the different research methods was used in the pool of papers covered in this paper.

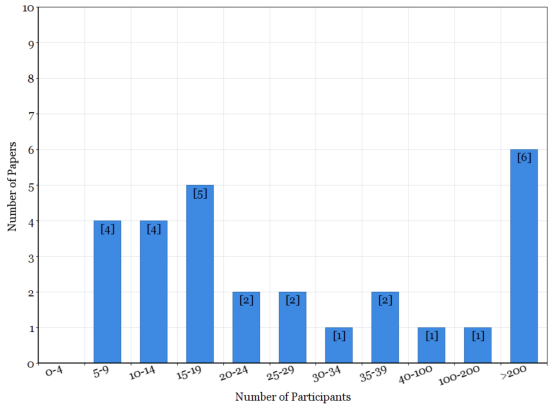

Fig. 7. Diagram showing the number of participants used in the covered papers. The bars represent the amount of papers using as many participants as indicated in the span below.

4 Conclusion

Looking at the list of the Best Papers and Honorable Mentions List of the CHI 2019 [1], three hot topics of research were identified: heath, new research methods in HCI and novel ways of interacting with computers.
Health being a versatile field, the topic was divided into the areas of Medicine, Mental Health, Assistive Technology for Disabilities and Fitness for a better overview. Overall there was a tendency of finding ways to integrate commonly used technologies into daily health struggles. Smartphones hold new possibilities for self-management of disease [9, 19], while voice user interfaces can highly benefit visually impaired people [15]. Another aspect covered by multiple papers was the role social media can play in illness management, e.g. through supportive online health communities [5, 26–28].
Methods in HCI research focused on the three aspects of conducting a study. Starting at designing the study in the first place, evaluating qualtiy and costs [10], to handling challenging research subjects [14] up to best utilizing findings [7], the life cycle of a study was covered.
For new ways of interacting with computers, eye-gaze tracking offers new possibilities in all kind of different fields [6, 24], while epidermal device work is still more centered around improving techniques [13] and researching in the way existing ones influences human perception [17]. While both areas are a big part of virtual reality, there is more to it. The greatest problem with the virtual experience at the moment is interaction with tools and objects, for this is often where the illusion of being in a realistic, alternative world breaks [2, 4]. A measurement for the ability of a tool to feel ëmbodiedäs well as new possibilities for interaction objects are discussed.

There were two significantly different types of papers: analyzing papers and developing papers. While analyzing papers mostly relied on interviews and / or findings of other researches, work shops and especially user studies were highly popular in developing papers. With a variety of techniques used, it is hard to define gold standard. It seems that developing a new technique comes hand in hand with a user study of perception and assessment of this technique. Combining a user study with interviews is a concept proven concept. There were also notably more development papers than analysis papers in the best paper section of the CHI 2019 best paper section [1], while overall there was a clear lead in analysis papers.

Future work in HCI is likely to continue in a similar direction. As long as there is illness, health is a field that will always remain relevant to humanity. Equally can be said that as long as there is technology, there will be research on new ways to interact with it. Virtual reality is one area that is just on the rise and definitely holds a lot of potential. As to developing new and improved methods of research, improvement might not have the direct visual effect like health or VR, it is however essential for the background of not only those, but every field of research and should therefore always be reinvented and improved.

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