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Effects of Digital Avatar on Perceived Social Presence and Co-Presence in Business Meetings between the Managers and Their Co-Workers

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Abstract. Due to the Covid-19 outbreak, more people in the workforce, especially in the IT industry, started working from home. This brought a set of issues and challenges for both workers and companies across the globe such as losing touch with other co-workers. This could potentially result in decrease of the performance and innovation. This paper investigates effects of using digital avatar robots in virtual meeting environment, specifically, focusing on the perception of social presence and co-presence between workers and their managers. Our experiment results showed that majority of participants felt an improvement in social presence, co-presence and overall virtual meeting experience while using digital avatar for their meetings, especially to those who has a meeting with less familiar persons or persons from the higher corporate hierarchy.

Keywords: Digital Robot Avatars, Video Conference Tools, Social Presence, co-presence, Remote work, Cooperation.

1 Introduction

In January 2020, the Europe saw its first Covid-19 case in France [1] and instantly drastic changes happened. EU countries were forced to impose new measures and strict rules to fight the pandemic and stop transmission of the virus to keep their citizens safe. Covid-19 pandemic was a unique situation for todays' population and a lot of new challenges have arisen. A serious set of economic and financial problems was also coupled with another type of issue [4], which brought greatest sufferings to general population. Many faced to "limitation of direct contact with people, restrictions on movement and travel, necessary changes in activity lifestyle, boredom and monotony and uncertainty about the future" [3]. The financial, economic, and societal problems created unprecedented challenges for industries across the globe and many people in the workplaces had faced challenges that was never seen before.

In technologically advanced countries, Covid-19 made people in the workplaces, especially in the IT sector, change their working location to their private home immediately. During this period, the steep increase was seen in the usage of video conferencing

platforms such as: Zoom, Microsoft Teams, and Slack [2]. Although these applications brought a lot of new features during the pandemic period and currently provide exceptionally rich function with good interface for both business and personal meeting experience, they lack some crucial components of in-person meetings and not manage to provide a touch of social presence.

Since April 2020, 37% of American workforce was working full time from home, compared to only 5% or 3 days per week before the Covid-19 pandemic [3]. Microsoft [3] reported the relationship between the workers stagnated and less interconnected under the pandemic period. This was not a surprise, as interactions with co-workers were normally limited to video conferencing platforms. There are other solutions than well-known video platforms such as using digital robot avatars, which could potentially improve the overall satisfaction and online meeting experience among co-workers. During heavy travel restrictions, digital robot avatars have helped customer relations in a unique way by providing novel solutions for engaging the customers and potential new clients. In addition, virtual meetings with important or potentially new clients could be especially challenging because two parties might not know each other well. Establishing trust and respect is crucial for closing a successful business arrangement [8], but it could be known as exceedingly difficult by using the video conferencing tools.

This paper, by focusing on digital avatar, emerging choice of online conference, research on whether digital avatar can be used to surpass some of the limitations that are noticed in well-known video conferencing platforms. This paper focuses on investigating potentials of digital robot avatar as a substitute of face-to-face meeting in a business context. More specifically, this research is conducted in a partnership with a Copenhagen office in Denmark of one of the biggest IT companies in EU [6]. The company was chosen as it has conducted many initiatives to strengthen the well-being of their workers [7], embraced working from home culture, and managers are often not co-located even before the pandemic. The employee working in the Copenhagen office typically work with their managers located outside of Denmark such as Norway, Ireland, United Stated and Spain. This specific setup creates a unique situation in which both sides were very dependent on the video conferencing platform and cannot be efficient without them under the strict travel restrictions. By aiming at increasing the levels of satisfactions for the online meeting experiences, this research investigates how usage of digital avatar in office environments can help managers manage and cooperate with their workers in different countries, and at the same time what the impact on social presence, co-presence and overall satisfaction is while using such digital avatar in the meetings.

The rest of the paper is organized as follows. First, related literatures and works are introduced. Next, methods and experiments of the research is introduced. Finally, collected data and results are presented with concluding findings.

2 Related Work

There are some studies related to avatar robot and its perceived social presence and co-presence. In this paper, we touch upon communication, embodiment, and size of avatar robot in relation to perceived social presence and co-presence.

2.1. Communication

Social presence is important for communication and information sharing in the robot conferencing, and studied widely for a decade [9,11]. Not many researches have been conducted in works settings but other domains such as academic conferences, education, and healthcare, social presence of robotics and business meetings have been investigated. It is well-known that interactive communication on VR among academic conference audiences can be easily achieved and provided valuable experience among participants, despite online interactive discussion have been reported as one of the biggest challenges on online academic conferences. Additionally, if the conference is conducted as hybrid conference, it has been reported that the satellite participants (online participants) were often left away from physical participants.

In the context of hybrid learning among university students, Gleason and Greenhow firmly concluded its importance in establishing meaningful bonds among students and professors, which is directly related to both the level of engagement during classes and learning outcomes [5]. The perception of trust in online communications is related important aspect [9] as establishing trust can be extremely hard if the participants do not know each other and if their only interaction and presence happens virtually in a video meeting room. In relation to trust, Jung et al. [10] articulated the importance of embodiment as “trust needs touch” [9]. Also, Brown and Prilla [13] confirmed in their AR consultancy experiment that trust was easier to establish if the avatar was by design like humans and was embodied, compared to abstract avatars. In using robot telepresence systems, many improvements should be implemented in nonverbal communication since human gestures and movements which could not be seen and transmitted in a normal video call. Another level of communication between speaking using avatar communication systems [9] should be considered.

2.2. Embodiment

Jung & Lee [12] studied many interesting concepts regarding the relation of physical embodiment to social presence while using social robots. Social robots are precisely designed for establishing social interactions with humans and can be used in different situations. Applications of social robots can be seen in areas such as education, public health care and especially elderly care and their usage is continuing to increase [12]. Still social robots necessary do not need to be physically embodied since their only task is to interact with humans on social level, unlike robots used in the manufacturing industries which must be physically embodied to move, pick, assemble and build desired products. For example, a couple of studies on robot medicate communication with advanced digital social robots have been conducted [21]. However, the importance of physical embodiment should not be neglected as Kerstin et al. [14] confirms that physically embodied social robots were perceived more attractive by the people, at the same time achieved better results on social presence perception [12].

2.3. Appearance such as Size and Gaze

Size is also a crucial feature for achieving better results in perceived social presence and co-presence while virtually communicating with other participants. In the experiments using virtual avatar using AR platform for online consultations, Brown and Prilla [13] shows the size of online virtual consultant matter. In their research, comparing life-sized and miniature avatars, life-sized virtual avatars achieved higher levels of perceived social presence while miniature avatars were perceived as cute and pleasant. Such a characteristic of miniature avatars brings improved "perceived social presence towards the expert" [13]. This indicates that both miniature and life-sized avatars improved perceived social presence while possibility to gain trust and likeliness in a participant using miniature digital avatar was high. In the robot video conference system experiment, Rae et al. [16] confirmed the importance of size of the robots as well. In their study, as the higher setup of digital robots were, more influential on others compared to the one with lower height. Rae et al. [16] confirmed also on a correlation between possibility of avatar's ability to move and social presence and co-presence: "(T)hey preferred a dynamic avatar over a static of comparable size, 9 participants stated that they liked the more life-like movement of the dynamic avatar" [13]. Spatial awareness also proved to be one of the critical factors defining the quality and overall satisfaction of online communication [17]. Nguyen and Canny [17] researched on spatial and gaze awareness with three different gazes which heavily impacted overall satisfaction of the online meeting sessions.

The presented functionalities such as size and embodiments are all contributing to higher levels of perceived social presence and making the overall conversation make closer to a normal human conversation. Human likeness of robot or digital avatars is its resemblance to a real human being and characteristics that are intricately connected with the appearance of human being [14]. Like the physical embodiment, human-likeness of the digital avatar is also crucial while trying to establish meaningful social connection. Fong et al. [15] showed correlation between human-likeness and higher levels of social affordances, which directly made people trust and like the robot more while communicating or cooperating on certain tasks. However, it is important to note that in using the digital avatar, too much resemblance to real humans can make participants feel strange and unnatural as reached to "Uncanny Valley" effect [17].

3 Experiment

3.1 Avatar Robot Application: CommU

The tool used throughout the research was a semi-autonomous social CG-avatar room developed by one of the authors and it uses a digital avatar robot to represent participants in the conference meeting. The application allows two basic ways of setting up the video call: (1) CommU-Talk and (2) CommU-Conference. Both Talk and Conference options enable participants to communicate with each other like many other already known video platforms. What makes CommU special is digital avatars that are assigned to each participant in the call. Participants are not showing their own face and

don’t need to use video camera from their computer because they are represented as robotic avatar (See Figure 1). CommU is easy to use, which only requires internet connection and a basic browser, thus, the overall setup of the system was very straightforward and easy to implement.

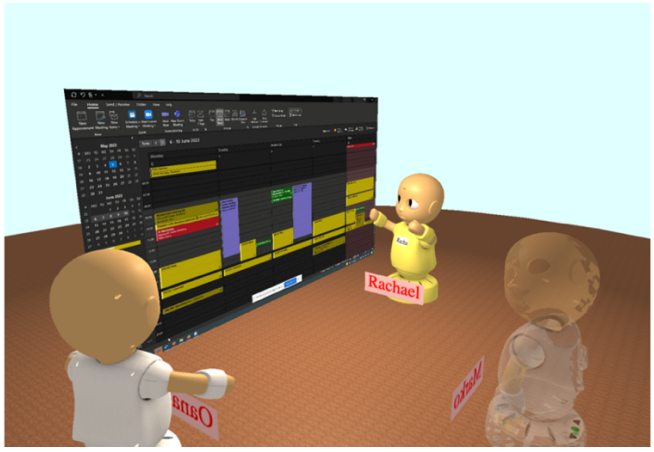

Figure 1: Screenshot of the CommU virtual meeting session during 1-1 participant’s call

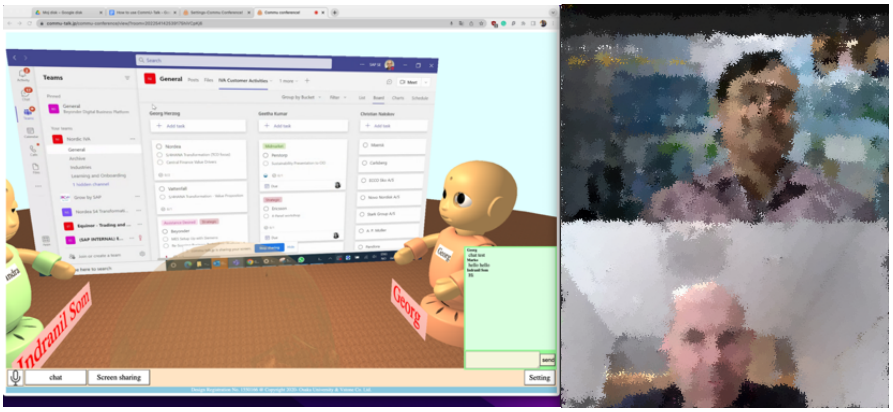

Figure 2: By-side view of CommU Conference with chat and Microsoft Teams application

Digital avatars also implement a set of intelligent features which resemble human interaction while speaking and communication with another person. While on the call with other participants, digital avatar will move hands while speaking to signal that the voice is coming from that exact avatar and, in contrast, avatar will nod its head while listening to others when they are speaking without any users’ manipulation. Also, if more than two participants are in the session, avatar will make head movements in direction of the person which is talking at that exact moment, which is another quite common gesture in human communication. Head movements of the avatar can be also

controlled by clicking the mouse on certain parts of the screen where the participant would like to focus on. Depending where the person clicked with their mouse on the screen, that will be the direction where the digital avatar will turn its head. Participants also have the possibility to use the chat functionality to send and receive messages (See Figure 1).

Concerning the overall physical appearance of the digital avatars, all are in a baby shape format. While setting up the meeting session, each participant can choose between 16 distinct types of avatars ranging from different colors, genders, and professions like: doctor, teacher, secretary, cook, office worker, etc. Depending on the situation and scenario that the participants will use CommU application, different types of avatars can be used in order to suit the environment better. The limitation in CommU-Conference, is that only three avatars with the choice of their shirt colors, compared to CommU-Talk which can chose 16 appearance. Where CommU-Conference excels compared to CommU-Talk is with the screen sharing functionality. Screen sharing is a quite common feature all well-known video conferencing tools use and especially crucial in business meetings to present essential information to other participants. CommU-Conference provides necessary key functions during business meetings. Finally, CommU application allows participants to change the settings and adjust camera angles to have a better view of the shared screen and other avatars join in the session.

3.2 Experimental Design and Participants

In this study, we conducted an experiment to investigate perceived social presence and co-presence. First, participants for this research were both full time and part time workers pf a large IT firm, ranging from student level positions to upper management positions and regional unit leads (See Table. 1). Half of the participants were located in the Copenhagen office and all of those participants had their managers and supervisors located in a different office in another country like United States, Ireland, Spain, and Norway. Overall, five pairs of workers and managers participated in the research accumulating to ten people in total and nine agreed to respond to survey questions after the meeting session. Participants were all adults between the age of 24 and 52, 4 males and 5 females ranging from different nationalities, having different educational backgrounds, and working in different departments at the company ranging from: technology consultants, unit leads, finance and accounting, marketing experts and student workers. Some participants also reported that they had some experience with using digital avatar and knew in general about the importance and potential applications of digital avatars and how they could be beneficial in the future, $M = 3.4$ and $Mdn = 4.0$ *(1 = no experience; 7 = expert user in this field)*. This result was not a surprise since all the participants had extensive experience of working in the IT sector and were mostly for a few or more years in this field.

The research design was following. In the first stage each pair of workers, worker in Copenhagen office and their supervisor or manager outside Denmark would have their routine 1-1 meeting using CommU Conferencing video platform. Usually, 1-1 meetings are held once per week, lasting 30-45 minutes per session and are used for aligning tasks, time schedules and plans for the upcoming week and reporting on all the finished

assignments during the previous week. At the company, all workers have access to a full suite of Microsoft applications and because of that, usually for all video and online meetings the company's workers use Microsoft Teams application. For research and getting relevant results, one meeting session for each pair of participants would be held primarily using CommU Conferencing tool. Before the actual research started, each participant from the Copenhagen office had a short 15-minute introduction call to learn how CommU Application works and to avoid any unnecessary mistakes during the actual meeting session.

Table 1. Age and role of nine participants in the research.

	Age	Role		Age	Role
1	52	Industry value advisor	6	24	Business architect
2	51	Solution specialist	7	31	Business development
3	50	Customer innovation	8	36	Cloud solutions architect
4	47	Industry value advisory manager	9	35	Customer experience solution advisor
5	44	Business architect			

After the introduction phase with the participants from Copenhagen, CommU Conferencing virtual room was created and firstly one of the authors joined the environment in order to test whether everything worked and then other two participants were asked to join the newly created CommU Conferencing session. In total, three participants joined the conference call. Participants were given instructions to wear headphones in order to reduce the unnecessary noise and stop the echoing effect which caused a lot of problems during communication. Also, before the official start of the meeting, brief introduction to the system and functionalities were given to the other participant which did not complete introduction phase to fully understand how the application works and be able to use all the features. After the introduction phase, the official meeting started.

The participants were each assigned a robotic avatar and placed in a virtual meeting room. The third participant, who was the author, was just observing the meeting session and taking notes about interesting observations that could be useful for the research. Other two participants, who were worker in Copenhagen and manager outside of Denmark continued with their meeting using all the features that were at that moment available on CommU Conference platform, as they would usually do using Microsoft Teams application. After the 1-1 meeting session was finished, the workers from Copenhagen office stayed for a 20–30-minute interview and discussion about the experience they had using CommU Conferencing platform. Because of the company's policy to flexible working, most of the interview sessions were held remotely using the company's preferred way of online communication – Microsoft Teams platform.

Lastly, after all the interviews were conducted, sessions with participants finished and results from the survey gathered final dataset was created. After the dataset was generated, it gathered all the responses coming from a survey and was later used to present meaningful results in charts and graphs using RStudio. A tool used for gathering the survey responses was Google Online Form creator which also comes with a build-

in feature which generates charts and graphs and offers insights of the data collected by the application. RStudio and R language offer much more options and functionalities. Using the R language and capabilities of RStudio the author was able to present data in a visually pleasant format and at the same time extract meaningful and important calculations to present them in the conclusion. Version of the RStudio used during the research was: *2022.02.2+485 "Prairie Trillium"* and platform used to run operations and use RStudio application was the MacOS platform.

3.3 Data Collection

In total, nine survey responses were collected from the participants in the research process. In addition, individual interview sessions with participants from Copenhagen were collected. Thus, the data of the full online meeting sessions collected for this research originated from three main sources: 1-1 live CommU Conference video sessions with participants and observations noted during the session, individual interviews with the participants from Copenhagen office and participants' answers to a questionnaire after the meeting session and interview process was finished. Images and screen recordings were also saved by capturing the monitor and were also used to examine the recordings in greater detail. Each participant used their own computer to be able to participate in the CommU Conference call and all the participants gave their consent to use and collect data for the purpose of this research.

4 Results

The results from three main sources generated both quantitative and qualitative data. Observations gathered while actively listening to participants' meeting sessions and interviews conducted with participants after the meeting session produced qualitative data, while, in contrast, survey answers collected at the final phase as quantitative results. Nine out of ten participants agreed to answer the questions presented in the survey, which created a small but rather unique data set. It is important to note that our results are not suggested to lead any conclusions and general findings outside the area that this paper specifically discussed since the dataset is small.

Just from briefly glancing over the data it was evident that participants saw potential of the technology, digital avatar. Since participants came, as already mentioned, from the IT industry and had a very frequent occurrence of participating in online video calls, our solutions offered multiple benefits. The results shown that seven participants preferred working either fully from home or hybrid work (combining working from home with occasional visits to the office). Only two participants preferred working full time in the office.

4.1 Awareness and Knowledge about Avatar

Since all the participants were coming from the same company and had overall knowledge about technology and IT industry. They were aware of avatar robots and

what benefits they could bring in the near future. Some of the participants said they already used avatar in different business meetings during Covid-19 pandemic and had excellent feedback from their customers and business partners. From the calculation performed using RStudio, the level of experience participants already had with avatar robots: *M* = 3.4 and *Mdn* = 4.0 *(1 = no experience; 7 = expert user in this field)*.

A few participants with some experience on avatar robots used a Double 3 telepresence robot [17] developed by Double Robotics previously. This was different from CommU since it was a physical robotics machine and offered another set of features. CommU digital robot used for this research was only in virtual format and participants noticed a few benefits as digital robots. In the first place, the virtual solution was free and easy to install in comparison to Double 3 telepresence robot which costs 6000$ [17]. Another reported benefit of virtual solutions is reliability. Participants reported that if errors on physical avatar are found they would need to of course contact the support team to find the issue and even sometimes they would need to send the whole telepresence avatar robot to manufacturer to get repaired. Situations like these could take up to a few months until a solution is found and presented huge issue. On the other hand, software, and virtual solutions like virtual CommU could be fixed in a much shorter period if any issues could occur.

4.2 Satisfaction during the Virtual CommU Conference Session

The overall satisfaction reported by the participants during the virtual meeting session while using CommU Conference Platform: *M* = 4.556 and *Mdn* = 5.0 *(1 = very bad; 7 extremely good)*. Generally, most of the participants reported they were satisfied with the overall meeting experience while using CommU Conference platform. During one meeting participants experienced an awfully bad echo effect and had to switch from muted to unmuted state while trying to speak one to another. Despite there already was a well-accepted rule of one muting while s/he is not speaking [18], it caused only small problems in conversation. The echo issue seemed to appear only during one meeting session and could also be a result of faulty equipment like headphones and microphones. Simply explained, before participants join the CommU Conference call, they need to be sure their equipment is working without any problems. Participants also reported they appreciated the moving gestures from the CommU virtual avatars although it was almost equivalent benefits to “flashing icon” which indicated very nicely when someone is speaking or every special separate icon for sending a request to speak that other video call platform like Zoom or Microsoft Teams offer.

Furthermore, CommU digital avatars are presented in a baby shape and some participants expressed their unwillingness to use this format for important online consultations, sales or virtual sessions with potential new clients. Despite baby like features of the digital avatars, it was possible to use the system efficiently because the team members already knew each other, and the atmosphere of the call was not strictly formal.

4.3 Frequency of stress during the video meeting sessions

Previously, during Covid-19, all the participants had experienced working fully from home and high usage of video conferencing tools [2], which they had to adapt to the constant communication and collaboration via Zoom, Slack, Microsoft Teams, and similar applications. During the interview discussions with the participants some of them expressed how stressful it can be to turn on the camera for the video call and that sometimes it was not so easy to find a perfect spot at home for video conferencing. Especially for those participants with small children, it was difficult to explain to their children that they should not enter the room during important online video meetings.

Concerning about the stress level, the survey result shows: $M = 3.333$ and $Mdn = 3.0$ *(1 = not stresses at all; 7 very stressed).* This result indicates that participants felt some levels of stress while participating in the normal video calls such as Microsoft Teams. Similar result can be also assumed for other well-known video conferencing platforms like Zoom or Slack. It is hard to make direct comparisons of stress levels experience in well-known video conferencing platform to CommU Conferencing application, however, the following results show that there is a potential for CommU Conferencing application to help participants with anxiety issues to feel less stressed during important online meeting sessions. In our sessions, two participants answered that they directly felt how using CommU Conferencing platform helped them feel lower levels of stress during virtual meeting session, and majority, six participants reported mixed feelings but felt some small different in improvements of their levels of stress. While one participant reported he did not feel any difference in levels of stress, those could easily be those who usually are not experiencing any stressful situations during the video meeting sessions.

The participants also reported to see further potentials in using CommU Conference application. When they don't know other participants, they have a challenging time introducing yourself to a new group of people. Similarly when the situation is stressful, like an important meeting session with senior management about high-priority clients or a deal that needs to be closed, they felt challenged. The seven participants have reported that they would prefer to use CommU Conference application with people they haven't met before, while the rest two participants who would prefer to use CommU with already known participants.

4.4 Perception of Social Presence while Using CommU Conference

The participants reported both in the interview and the survey that using CommU conference application made some difference in perception of the social presence of other participants who joined the meeting session. In the analysis of the responses gathered from the survey, the results were as follows: $M = 3.889$ and $Mdn = 4.0$ *(1 = no difference at all; 7 huge difference).*

The results indicated there was not a drastic change, but overall, some improvements regarding the perception of social presence for the participants. This result was supported by the interview. A few participants mentioned they appreciated gestures produced by the digital avatars, which drastically improved communication in online

environment. Another participant commented that the head movements of the digital avatar and avatars' ability to focus the attention on the participant who is speaking at that exact moment proved extremely beneficial to all the participants. Hand movement of the digital avatar was also reported beneficial as compatible with "flashing icon" functionality which is available in well-known video conferencing applications.

4.5 Trust establishment while using CommU Conference

The analysis of the survey results shows that participants performed an exceptionally low impact on the trust establishment. This is not surprising as trust establishment is a very complex process and much longer and frequent sessions should have been organized to get meaningful results. Although trust establishment could be a very important aspect for further research in similar areas, it was not a principal area for this research. Results were as follows: $M = 2.222$ and $Mdn = 2.0$ *(1 = no difference at all; 7 huge difference).*

5 Discussion

The main purpose for this research was to investigate whether new conference systems like CommU platform and similar digital avatar robotic solutions can make any significant impact on the perception of social presence and co-presence for participants and bring overall improvements during video meetings in the virtual environments. The pandemic showed how the global situation could easily shift and completely change the working environment for millions of workers in many different industries, thus, the importance of remote work and virtual meeting session should not be neglected.

The data presented in the previous section indicate the participants saw a potential in using such technological platforms and can see several benefits. Primarily, our analysis indicates that CommU Conferencing platform would be beneficial in virtual meetings for those people who are experiencing higher levels of stress and have harder times in presenting important topics to people positioned in the upper management hierarchy and people they have not met previously. There would be a couple of reasons why the participants considered improved perceived social presence and co-presence.

First, the participants achieved improved perceived social presence and co-presence as all participants could situate at the same stage as equal appearance as digital avatar. Different from the typical conference system, the participants at CommU could recognize themselves visually as a part of the meeting participants in the virtual CommU meeting room, where all participants present and visible each other. While digital conference sessions with ordinary online conference systems such as Zoom and Teams, sometimes participants neglect each other by accident or forget some participants as the system hid away from the screen. It was not within our research scope, but the context of hybrid meetings would be more complexed as participants in satellite location can easily fall away from the discussion among the co-located participants.

Second, our results indicate that digital video conferencing systems could be especially beneficial to young age group and unexperienced workers during job interviews

or for important meeting sessions with senior management. This was also evident especially comments from interviews such as “feeling safe under the condition, which requires no need to show faces”. Younger workers and the novice workers could have important benefits during virtual meeting sessions since they would not be perceived by their looks as young and unexperienced. Those biased opinions could sometimes be formed by senior managers and more experienced workers in the company. It can be easily imagined that by not forming those biased opinions during the initial video calls and introduction sessions, more important tasks and challenges could be given also to a younger employee. Age could be just one aspect of varied biased opinions, and this could be applied to many other areas in the work settings such as: gender, race, nationality, and others. Additionally, by using CommU, digital avatar for video meeting sessions, the participants are all perceived the same and have the same physical shape in the virtual environment. In this situation, all participants in meeting sessions, will be primary focused on the matter of the issue and on the main topic of the conversation. This can result in overall better and more efficient meeting experience and at the same time limit the formation of biased opinions which could create an unpleasant meeting atmosphere.

Participants did not experience any major difference in trust establishment, but they expressed that social presence was perceived better while comparing it to well-known video conferencing platforms. There was no difference in the age groups about the acceptance of such technologies, and all the participants were aware of the potential benefits we could have in the future by using such virtual teleconferencing systems.

6 Conclusion

In this study, in order to understand effects of digital avatar on perceived social presence and co-presence in business meetings between the managers and their co-workers, we conducted a preliminary experiment. Our analysis showed that participants experienced improvements in perception of social presence and co-presence in virtual meetings. Our results suggest that participants appreciated having digital avatars and saw benefits of implementing human gestures to the digital avatar for improved communication in distance. It is important to mention that embodiment of the digital avatar might matter to the use contexts, such as business or casual meetings. The baby shape format was a nice option to have for casual and relaxed meetings, such as weekly meetings between manager and worker like our case.

The participants are fond of using the digital avatars and did not experience any negative sides while having one to one meeting sessions. Most of the participants reported that they felt some improvements in perception of social presence than their usual virtual meetings. Minor technical problems occurred for some participants but those were resolved by changing the headset or the microphone and in general all participants were positively impressed with CommU Conference platform. All in all, participants felt such conferencing solutions could easily become a primary way of virtual communication in the future and could forecast virtual meeting experiences could be drastically improved by using digital avatar systems. One of the most unexpected

indications of this research is that such digital avatar conferencing systems can reduce formation of biased opinions towards other participants that we have never met and encountered before. By using avatar in meeting contexts, all the participants can primarily focus on the content of the meeting session and have a better and more fair understanding of the issues discussed during the meeting session.

6.1 Limitations and Future Work

There are a couple of limitations in this research. The biggest limitation is the size of the participants and the duration of the experiment. The participants are small with five pairs in total, and the field experiment period was short with a few sessions in three months. Originally, the research was planned not as lab experiments but as real-world field experiments at the real work environment as a preliminary investigation. It is a great advantage to conduct experiments under non-fictious setting as we can investigate genuine impacts of digital avatar on remote work by running longitudinal experiments. This article reported only the preliminary part of the experiment, however, we are currently planning to conduct more meeting sessions and follow-up meeting sessions with the participants to observe changes of participants' mindset.

Another potential limitations of this research could be the location where the research was carried out. Denmark, together with other Nordics region in general are overall one of the most developed and digitalized regions in the world [20]. All the participants of our study easily accepted the usage of such an innovative technology and were really interested in learning more about it. This is an incredibly unique situation and could potentially result in accumulating optimistic data and should be interpreted with caution. In other regions, which are not as technically developed, it would be interesting to see the effects of such technologies and whether the workforce would accept new technology such as virtual avatar.

The same caution should be paid regarding the industry. The workers in the IT industry, in which the research conducted, understand the technology and its potential needs to get their job done. Some participants had experience with avatar robots. Further research should be conducted with participants coming from other industries and from countries with a lower level of digitalization.

There are some potentials of future works. From observations gathered during the virtual meeting sessions with participants, it was evident that participants were not fully immersed in the virtual experience. They were not immediately aware of the benefits and differences CommU Conferencing platform can bring and the primary advantages of using such platforms. Thus, it would be highly suggested to further improve and advance CommU Conferencing platform to use virtual reality as its main interface. Using CommU Conferencing platform with web browser on a laptop or desktop computer was functional and participants got overall understanding of the benefits. However, huge improvements could be generated if the entire system was available on a VR platform. By implementing such a solution on a VR platform, participants would be fully immersed in the virtual meeting environment, and it would be much easier to understand the benefits and potential that can be unlocked. Something similar can be seen by the development of Metaverse – a virtual reality environment where in the future people

will be able to work, socialize and in general do everything we are doing currently in our real lives. Using technological development, such technologies will be possible soon if we, human beings, accept such technologies and a way of living. Today, we are not ready and there are a lot of thought given on whether such technologies are needed and what kind of benefits they could bring, but concepts like Metaverse are increasingly being mentioned and a lot of giant IT corporations are starting to develop solutions to support such technologies in the future.

Digital avatar robots like CommU and other similar avatar robotic solutions will be used increasingly as the time goes by and as the people get used to the existence and potential benefits of such robotic systems. Currently, most people coming from technology industries are perceived to have some benefits from using such robotics systems because of flexibility in their work. They are also the workers who understand its crucial role in transforming the global workforce and the way to work in the future. Todays' workforce is heavily influenced and dependent on global economic, political, and financial decisions and without effective usage of technology, it would be extremely hard to stay productive and deliver better results. Because of that, every industry and every job should be aware of the benefits that can be achieved by understanding technology and whose technological advancements can help run a better business.

The digital technology mentioned in this research is still being developed and still very new to a substantial number of people. At the same time, it could potentially be something to make drastic changes in overall meeting experience and also in the perceived perception of social presence and co-presence of other participants. Still, we are witnessed how such avatar robotic systems are being also used in other industries and their application constantly grows. As seen from the effects of the Covid-19 pandemic, we are very depended on the technology and technological advancements and today's modern workforce would not be able to be as productive as it currently is if the benefits of modern technologies are not being used to its full potential. From the analysis of the results, it was evident how such digital avatar robotic solutions could improve perception of social presence, co-presence and improve overall meeting experiences. However, still a lot of research should be done with this technology to completely understand its benefits in varied situations and environments.

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