Title	Take me to the dancing : dancing with remote friend in your physical space, feeling their presence
Sub Title	
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Publisher	慶應義塾大学大学院メディアデザイン研究科
Publication year	2023
Jtitle	
JaLC DOI	
Abstract	
Notes	修士学位論文. 2023年度メディアデザイン学 第1017号
Genre	Thesis or Dissertation
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=KO40001001-00002023-1017

Master's Thesis
Academic Year 2023

Take Me to the Dancing: Dancing with Remote
Friend in Your Physical Space, Feeling Their
Presence

Keio University
Graduate School of Media Design

Gargi Guchhait

A Master's Thesis
submitted to Keio University Graduate School of Media Design
in partial fulfillment of the requirements for the degree of
Master of Media Design

Gargi Guchhait

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Abstract of Master's Thesis of Academic Year 2023

Take Me to the Dancing: Dancing with Remote Friend in Your Physical Space, Feeling Their Presence

Category: Design

Summary

We, human being are social animal. We can not leave alone. However, due to busy lifestyle we don't get enough opportunity to meet our long distant friends physically. Though the advanced communication technology gives us the pleasure of meeting long distance friends or family on-screen, it doesn't give us the opportunity of doing any activity with them.

Dancing is one of the activity which has the healing power. The platform which are available for remote dancing are screen based or VR based. These platform does not only cause health issues, visual fatigue but also unable to provide one own physical space for dancing.

In this paper, we explore what is the presence of a remote friend for someone, how one wants to connect while dancing remotely and design a prototype which provide the opportunity of remote dancing in our own physical space. The prototype is cost efficient and easy to install in home environment. Here, two person can see each others foot steps on the floor. They will also be able to see the proper movement (for example, whether they are using only toe or not) of our feet in real time. According to the posture of foot the shape will change on the floor. Different type of colour would be used to define if they step on each other feet.

Keywords:

Keio University Graduate School of Media Design

Gargi Guchhait

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Acknowledgements

immense patience and support which have made my life easier in Japan. From collecting data in initial phase of the research to writing final thesis, he has helped me with his resources.

Finally, I would like to express my heartfelt gratitude to my family for their unwavering support, encouragement, and understanding throughout this entire process. My parent's love, patience, and belief in my abilities have been a constant source of motivation and inspiration.They have sacrificed a lot to give me the opportunity to come here to Japan and research. My sister Srijana has always made sure to make my life smooth even from afar back in India. I am grateful to the almighty for these beautiful souls in my life without whom I would not have been able to start this research journey.

Chapter 1
Introduction

1.1. Background

1.1.1 Problem and Research Goal

According to WHO globally 5% of adults are suffering from depression. Loneliness is one of the key reasons behind this illness [1].I have been living far away from my home since 2013 due my studies. In every country, Due to better work opportunities, higher studies people are unable to stay with their friends and family. As a result, they are suffering from loneliness. It is reported that 40% of people in Japan are suffering from loneliness. After Covid, due to social isolation, work from home, online class, the number of people is increasing everywhere who are dealing with loneliness. Loneliness is an epidemic nowadays. It has a direct and severe effect on one's health and mortality [2]. ' Despite having so advanced communication technology, why are so many people suffering from Loneliness?' To answer this question, first we have to understand the difference between physical presence and remote presence of a person. When people share physical space, they do certain activities together. On the other hand, In remote communication people tend to see the person onscreen and talk .This research started with the question, ' What if we can do activity in the same physical space remotely?' It is easier to connect with someone when we do some activities together. I am a dancer and moreover I love to dance with my friends. However, during the quarantine period, I could not dance with my friends. Gradually, I realised that I was dancing less, getting fat and pessimistic about everything day by day. I started to dance with my friends using zoom but It was not enough to feel connected.From workplace to entertainment, using too much of screen is making people feel fatigue all over the world .For this reason we also started to record our video separately and edit

it in one video so we could feel that we are dancing together while watching it. This was my call to explore different ways of remote dancing.

There are lots of people these days who are forced to be in long distance relationships for their career goal. Despite having a partner they often feel lonely because of a lack of communication. To increase the connection, they have online dates where they watch movies together, sing karaoke. However these couples hardly get any opportunities to share physical space. If they could do a slow dance with their remote partner in their own physical space, They would feel more connected.

One of the adverse effects of small nuclear families and dying community culture is that many adolescents and young adults are overly dependent on the friends they make online. Video calls are not always safe. Thus, these people want to do some fun activities together with their friends maintaining their privacy.

The goal of this research is to design a product which enables aforementioned people to dance with their partner remotely in their own physical space feeling the presence of them . They would also be able to control their privacy and the space of their activity .

1.1.2 Why Dancing with partner

Dancing is a complementary activity which can benefit young adults with anxiety, depression and loneliness[3]. It is also often considered as art therapy which helps people to develop social skills. Dancing does not only make people happy but also it enables people to express their emotions. It is a fun activity where people share the same physical space with other people. It is easy to engage in this activity. In every culture, Dance is often related to happiness. It is said that dancing has a positive effect on one;s cognitive function and social skill and mood. Historically. We have seen that dance performance has been a beautiful way to celebrate festival cultural occasions. Till now, we can not think of a happy ceremony without dancing.

Partner dancing is inherently social, fostering connections and building interpersonal relationships. It serves as a means of social interaction, promoting communication, empathy, and cooperation between partners. The non-verbal communication required during dance leads to heightened body awareness and emotional

intelligence. Additionally, participating in dance classes and events offers opportunities for individuals to expand their social networks, build friendships, and foster a sense of community.In Gujrat[1] , people perform 'garba' during their yearly 9 day long festival (AKA Navratri[2]) (Figure 1.1). It is a community dance which is performed by everyone irrespective of age and gender to make the communication strong in a community.

Figure 1.1 Garba Dance

In Japan, During summer festivals, Yosakoi[3] is performed by groups of dancers and school students in Kochi. This not only looks beautiful from outside but also deepens social relationships. In Africa, different indigenous groups have their own style of dance (Figure1.2) which often expresses their social values[4].

From the 17th to 19th Century, several balls used to be organised by wealthy families in Great Britain as a form of social dancing. This is often used as a place for finding life partners. Every Indian tribes have their won dance style. This dance are also social dancing which helps them to enhance the sense of community. Like african dance, these dances also portray the social values of each tribe.

One can not stress enough how much physical movement is necessary for better mental and physical health. Unfortunately, a large number of people are involved

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1   https://en.wikipedia.org/wiki/Gujarat

2   https://en.wikipedia.org/wiki/Navaratri

3   https://ja.wikipedia.org/wiki/YOSAKOI

Figure 1.2 African Dance Dance

in sedentary jobs where they do not get enough time or opportunity to move. Doing exercise can be too tough of a commitment for these people. However, dancing with friends on the other hand not only brings a sense of connection and joy but also improves physical health.It serves as an effective means of physical exercise. It promotes cardiovascular fitness, endurance, and muscular strength. The dynamic movements, such as spins, dips, and lifts, engage various muscle groups, contributing to enhanced flexibility, coordination, and balance. The repetitive nature of partner dancing also aids in developing muscular memory, leading to improved overall body control and posture. In China elderly people often perform 'square Dancing' (Figure 1.3) which is a type of social dancing cherished by elders to stay physically active and stress free. This is a form of exercising and socializing where they perform choreographed dance routines set to music.

Beyond its physical aspects, dancing with partner offers substantial cognitive benefits. Research indicates that dance promotes cognitive functions such as attention, memory, and multitasking abilities. The intricate footwork, synchronization with a partner, and quick decision-making during improvisation stimulate neural pathways and enhance mental agility. Moreover, learning dance routines and patterns can provide mental stimulation, fostering creativity and problem-solving skills.

Dancing with partner or friends offers a myriad of benefits, ranging from physical fitness and cognitive stimulation to social connection and psychological well-being. By engaging in this art form, individuals can improve their overall health,

Figure 1.3 Square dancing

enhance their mental acuity, and foster meaningful relationships.

1.1.3 One's own place

"one's own place" can be defined as a multifaceted construct encompassing various physical, psychological, and socio-cultural dimensions. In its physical dimension, "one's own place" refers to a specific location or environment that an individual possesses, customizes, and identifies as their personal domain. This physical space may range from a residence or living quarters to a designated workspace or retreat. It entails a spatial arrangement that incorporates elements of design, functionality, and personalization, enabling individuals to express their preferences, values, and unique style. "One's own place" becomes a tangible manifestation of individuality, offering a sense of security, comfort, and control over the immediate surroundings."One's own place" provides a psychological refuge, a haven where individuals can seek solitude, engage in introspection, and experience a heightened sense of self-awareness. This psychological attachment facilitates emotional well-being, self-expression, and personal growth, enabling individuals to find solace, recharge, and nurture their mental and emotional states.

1.1.4 Dancing in our own physical space

In 2021, We did a survey to understand how people want to be connected with someone while dancing and How they want to experience it.The survey findings

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indicate that people prefer dancing in their own place due to their consciousness. Some, particularly girls have showed their concerns about cyber crime. Dancing in a private space provides a sense of security and reduces the risk of privacy invasion or unauthorized access to personal information.

That survey also revealed that dancing in one's own place facilitates the expression of true emotions. People feel more comfortable and uninhibited when they are in a private setting. The can express their unrestricted emotions through dance movements. The absence of external judgment or scrutiny allows for a greater level of emotional vulnerability, leading to a deeper connection with one's own feelings with his or her partner. Connecting with a partner or friend in one's own place amplifies the experience, fostering a deeper sense of intimacy. The private setting encourages individuals to let their guards down. It often create an environment for authentic connections between partners. Dancing in a personal space enables partners or friends to establish a stronger bond through shared movements, non-verbal communication, and synchronized footsteps, strengthening the overall intimacy of the experience.

1.2. Motivation and purposes

The emergence of social media platform has changed the way people connect and share their emotion these days. One the most used feature in these platform is creating short videos to engage in synchronized dancing. Even video editing technique has been deployed by many to create the illusion of dancing together. There are plethora of work how can people engage remote activity using screen or VR or AR. The combination of AR and screen even enable people to see themselves dancing in real time with other dancers. Using haptic and VR technology, people can dance together in virtual platform , maintaining their privacy. However, remote activity using our own physical space are limited. While VR may seems a tempting platform , it is reported that a significant number of people experience VR sickness AKA cyber sickness. This sparkled my curiosity and motivated me to work on this research. Despite of having myriad of VR, based work, The realm of remote activities in one's own physical space is almost uncharted. To bride this gap and to create real-time interactive remote activity, this research

will contribute.

1.3. Thesis organization

There are five chapter to explain the research in depth. these chapters are the following chapters: (i) Chapter 1: In this chapter, in is explained why I started this research and what is it's goal.The research gap has been determined to direct the research towards obtaining the research goal. The novelty of this research and it's contribution to the society is also stated here.

(ii) Chapter 2: In this chapter, the previous papers and journal which shares same goal as this research, have been reviewed. Different types of work has been reviewed and some technology have been deployed in this research to bridge the identified gap stated in the chapter1.

(iii) Chapter 3: In this Chapter, the inspiration behind the design has been mentions. The concept and detailed designed of the prototype has been explained with diagram . The experiments are also explained here with supporting photos and system engineering.

(iv) Chapter 4: The data obtained form the experiments from experiments explained in the previous chapter has been discussed and evaluated in this chapter.

(v) Chapter 5: As it is the last chapter, the limitation of this research and the future scope of this research has discussed here.

Chapter 2
Literature review

2.1. Remote Dancing

Remote dancing has emerged as a significant leisure and fun activity, particularly in the context of 'work from home'.It presents several unique opportunities, health benefit and challenges. Through online platforms, individuals can participate in workshops or events of partner or social dance remotely fostering a sense of social connectivity and community engagement. This research contributes to understand the dynamic evolution of remote connection and the potential of technology in artistic and entertaining practices. In this research the main challenge we tackle is the presence of a remote individuals in physical space. There are related research that proved the the potential need of remote dancing. Since, this research aim to create the illusion of remote person in physical space, related works about interactive dance and remote communication in real time have been examined. Moreover, this research examine the available platform for remote dancing to understand the gap with the notion to bridge it.

2.1.1 VR Dancing

VR dancing (Figure 2.1) has open a new landscape of dancing recently, specially after Covid-19 Pandemic. By combining immersive technology with haptic technology and motion sensor , VR facilitates an immersive opportunity to experience dancing remotely in a virtual environment. VR has multiple merits on not only in experiencing dancing but also in the field of health, Tourism, Education and so on.Research stated that several mental health problem can be identified and and treated with VR [3]. However, the study has conducted in laboratory environment, it may not have same impact in real life. Also, this paper acknowledges that

the studies are limited it needs more research to understand the full potential of VR in this field.Similar to this study, most of the research using VR environment does not have sufficient amount of sample size [4].

VR chat is a Social platform in virtual reality environment. It enable people to dance and interact with remote partner or friend using their avatar in virtual space [5]. It is found that there is a chance that individuals might get some benefits of dancing by watching dance movement of virtual character without face even if they dance without music [6]. However, this research is not only based on only one VR platform but also it just not address how much the feel the presence of someone through a dancing character.

Figure 2.1 VR dancing in VR Chat

Moreover, although VR Dancing has some tempting features for remote dancing, it comes with some consequences like :

Physical Health Risk:

Enjoying dancing in VR settings can cause various physical health risks. Experiencing VR environment may cause nauseous, dizziness, and motion sickness, also known as "cybersickness" [7]. Though The exact reason triggering Cyber sickness still unknown , researchers often agreed that it is triggered by Visuals of illusory motion in VR environment [8]. As Dancing often involves intense movement, the chances are getting motion sickness pretty high. Researcher also found out VR affect the posture control mechanism which cause unpleasant feeling like motion

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sickness [9].The main goal of VR is the pleasure of immersive experience.But it can be affected VR sickness [10]. One of the main objectives of this research is to allow people have a relax time through dancing which can be affected by VR.

Social isolation:

VR dancing often take place in a solitary setting which has little to no relation with real world. Individuals primarily interact with the avatar or artificial intelligence in a virtual world, which may affect their communication skill in real life. Existing VR dancing platform are gaming platform and this is highly addictive [11]. Excessive addiction to the VR may become a reason for lack of physical presence and emotional connection which can lead to social isolation and loneliness.

Unrealistic Body Standard:

In the virtual realm of VR dancing, individuals can customise their appearance which is too idealistic.It also does not have non-disabled human body which fails to accommodate disabled people [12]. This can affect self esteem of individuals with body image concern and disability. Users may feel pressured to conform to idealistic body image.

Sedentary Lifestyle:

While VR dancing can offer an engaging physical activity, excessive reliance on VR technology may contribute to a sedentary lifestyle. Spending prolonged periods in virtual environments can lead to reduced overall physical activity levels, negatively impacting cardiovascular health, muscular strength, and overall fitness. Moreover, prolonged VR use may lead to an imbalance in physical and sedentary behaviors, potentially promoting a less active lifestyle outside of virtual experiences.

2.1.2 Dancing with screen

Dancing with screen is relatively old way of dancing with someone. Dancing with screens refers to the practice of integrating dance performances or choreography with visual displays, such as projected images or LED screens. This approach combines the physicality and artistry of dance with the visual elements provided

by screens, creating a multimedia experience. Dancing with screens offers a range of creative possibilities and has been employed in various contexts, including live performances, installations, and multimedia productions. In this form of dance, screens can serve different purposes, including:

Visual Enhancement: Screens can be used to enhance the visual impact of a dance performance (Figure 2.2) . Projected images or videos can create dynamic backgrounds, add atmospheric elements, or provide visual storytelling that complements the dance movements.

Figure 2.2 Dance of Love by MIROSLAV BRUISE ZILKA

Interactive Elements: Screens can be utilized to create interactive dance experiences (Figure 2.3) . Through motion sensors or interactive technology, dancers can interact with the screen's content, triggering changes in visuals or responding to movements in real-time, creating a unique fusion of dance and technology.One of the famous screen dance using interactive elements is MIROSLAV BRUISE ZILKA - 2014[1].

Projection Mapping: Projection mapping techniques allow for the projection of visuals onto complex surfaces, such as the human body or three-dimensional

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1   https://www.youtube.com/watch?v=lnX3gQ4sF3E

Figure 2.3 Screen Dancing using interactive element by MIROSLAV BRUISE
ZILKA in 2014

objects (Figure 2.4). This enables dancers to become canvases for moving images,
integrating the projected visuals directly onto their bodies and expanding the
possibilities of visual expression within dance performances.

Figure 2.4 Dancing using projection mapping by Daito Manabe

Digital Backdrops: LED screens or large video walls can serve as digital back-
drops for dance performances. These screens can display various visual elements,
including abstract patterns, landscapes, or even live video feeds, providing an
immersive and visually captivating backdrop for the dancers.

Dancing using screen is not a substitute for live theatrical performances but
rather a separate and equally valid way of creating dance works [13].

2.1.3 Dancing using video call

Dancing using Video call platform became prominent from the time when social gathering was not possible (Figure 2.5). Many dancing schools started to offer class[2] using Zoom[3] or google meet[4].

However, the feeling of co-presence is while dancing with partner is missing. To tackle this challenge a model has been tested where people can see the 3-D form of the partner while dancing. People feel more connected in this way and hence they are able to feel the co-presence of their partner more efficiently [14].
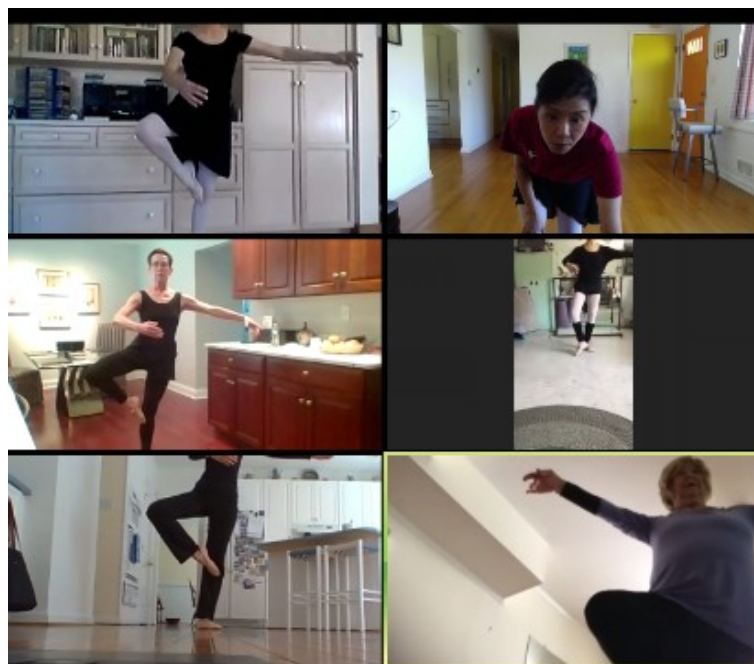

Figure 2.5 Dancing using Zoom(source:Pexel.com)

2.2. Sense of own place

The term "own place" has been referred to the subjective bond and emotional affinity that individuals establish with a particular geographical area in which they reside or possess a significant affiliation. It encompasses a composite notion of affiliation, identity, and familiarity that individuals cultivate with their environment, encompassing various dimensions including the socio-cultural and economic elements intertwined with said location. This profound connection to one's own place profoundly influences individuals' perceptions, experiences, and reactions to alterations in the environment [15].

Dancing is not just somatic, people express their emotion and believe while dancing [16]. Dancing provides opportunities to people to share emotions and express themselves without verbal communication [17], for which people need their own place where they can feel the affiliation.Free dance movement does not only express individual's emotion, the type of this induced emotion also can be successfully recognized [18]. Even the children as young as four years old are able to detect emotion like fear, sadness, happiness, anger through dance movement through some different cues [19].

Therefore to express our emotions we need to be in a place where we feel emotionally secure. 'Emotional security' can be referred as person's feeling of safety, comfort and confidence at their surrounding world .Emotional security plays a significant role is psychology. When individuals find sense of security emotionally within a physical setting,it engenders feelings of acceptance, self-assurance, and affiliation. This security facilitates authenticity, emotional connection and affiliation [20]. Emotional security within a place yields numerous advantages. emotional security does not only enhance general well-being and mental health but also fosters trust and interpersonal bonds. By feeling secure in a particular place, individuals are more inclined to forge deep and meaningful relationships, as they can expose vulnerability and exhibit openness. This sense of connectedness fosters a communal atmosphere and engenders social support, both of which are crucial for emotional and psychological well-being. Furthermore, with the assurance of a secure and supportive environment, individuals are more inclined to venture beyond their comfort zones, pursue personal goals, and embrace personal growth and development. It has also been found out that people with Schizophre-

nia feel safe when they feel they belong and it help them to make and maintain a better supportive social relationship [21].

As we can see from previously referred studies, it is easy to express our-self easily when we are in our physical comfort zone , in this research we have aim to design including our own physical place where we feel safe and confident.

2.3. Using Abstract shape to show presence

The relation between abstract art and cognitive mind has been described in many research. Abstract art often showcase artistic expression instead of depiction of real visual. It focuses on conveying emotion or ideas through various shape and color. Research also suggest that abstract art can stimulate cognitive process and can engage an individual in imagination and creativity [22]. The 'presence' and the abstract depiction may have positive affect of bringing into consciousness [23]. Which leads that a product with abstract visual instead of perfect photograph would be helpful to the user to incorporate the product in their creative world with limitless imagination.

However, It has also been found out when the abstract art has similarities with real object viewers recognize it faster [24].Thus depicting of a certain body part can be easier for people to recognize a person's presence.

2.4. Interactive art to dance with

When two people dance together, it necessitates the synchronization and alignment of individuals' actions which involves the harmonization. One's movement has to be complementing of his or her partner's movements while dancing together [25]. Effective partner or group dancing relies on individuals coordinating their actions, involving actions that match, reverse, or complement each other. Such coordination demands a congruence between visual inputs and motor outputs.Imitation, like dance, involves an observer learning by observing another individual's motor patterns, without receiving direct reinforcement. Consequently, the imitator must establish connections across different sensory modalities to produce a corresponding output. For instance, when an individual observes a dance

move, they translate the visual input into a motor response [26]. This ability of imitating enable human being to dance [25]. Using this phenomena many interactive art has been created to dance which is a new aesthetic in terms of art and science [27]. Dancing with interactive wall is an video installation where the interaction of the viewer and on-screen dancer became an intimate pas-de-deux. When the users go close to the screen the person on the screen seems coming closer to the person while dancing. When the person stops, the person also stops (Figure 2.6) .
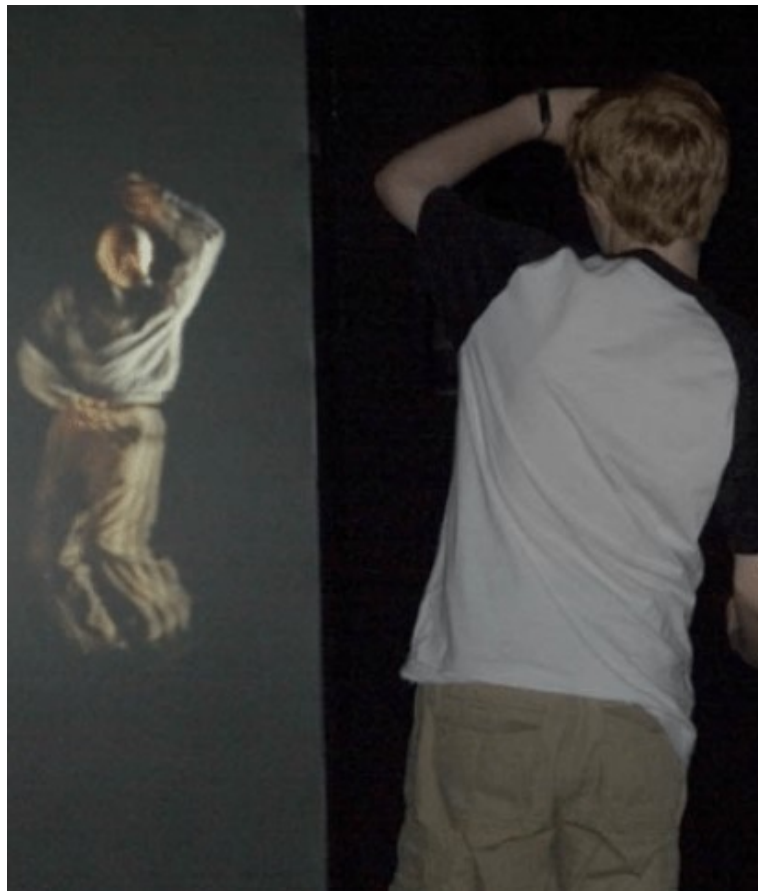
Figure 2.6 Dancing with interactive wall

Chapter 3
Take me to the dancing

3.1. Concept

In this research, I want to design a product to foster remote dancing with someone at their own physical place using same ground where they feel safe and belong from as it help people to express their true emotions. Instead of using any virtual or augmented reality environment, Our own physical environment has been incorporate in the design to the aim of tackling VR sickness and screen fatigue.

3.1.1 Illusion

I wanted to generate a perception of the existence of a distant individual by utilizing our immediate surroundings. The concept of an illusion involves creating a deceptive impression of someone or something (Oxford dictionary).

In this research, we explore innovative methods to evoke a sense of being accompanied or connected to someone who is physically absent. By strategically placing footprints in a particular arrangement, we aim to trigger a cognitive response that convinces the observer of the presence of another individual, despite their physical absence.

Considering the challenges posed by geographical distances, technological constraints, and the unavailability of real-time transportation, our approach offers an alternative means to bridge the gap between people in separate locations.It provides a unique and creative solution to address the limitations of physical presence. By harnessing the potential of illusion, we can create a semblance of connection and enhance the experience of being in the proximity of a remote individual.

3.1.2 Significance of footprints

Footprints hold significant historical value as they provide tangible evidence of past human activities and behaviours. They offer glimpses into the lives of our ancestors, shedding light on their movements, interactions, and cultural practices.

Footprints in horror movies serve as a powerful visual and symbolic element that contributes to the overall atmosphere and narrative. Footprints, particularly unexplained or unexpected ones, create a sense of mystery and intrigue in horror movies. They signify the presence of an unknown entity, a lurking danger, or an unseen antagonist. They represent an unwelcome presence or an invasion of personal space, highlighting a loss of control and the encroachment of the unknown.Footprints, especially in settings that contrast with the natural order, can enhance the visual impact of horror scenes.

3.2. Design Process

The whole design process the following steps:

Data Collection:

Based on the data collected through a survey done in May 2022, it has been found that individuals exhibit a preference for employing their visual sense as the primary means of establishing a connection with others. Subsequently, the auditory sense is ranked second in terms of desirability for fostering connections, followed by the sense of touch. In this same survey, when we asked users what is important for them while dancing. We found majority of them answered that they want to sense the the presence of their dance partner while watching them (Figure: 3.1).

Literature review:

Two kind of papers have been reviewed before design - papers with the goal of connect people, and papers with entertaining purpose with dancing. Based on literature study The technology has been chosen for this particular design.

What is important to you while dancing
13 responses

- seeing the person while dancing
- sensing the presence of the person
- both

76.9%

7.7%

15.4%
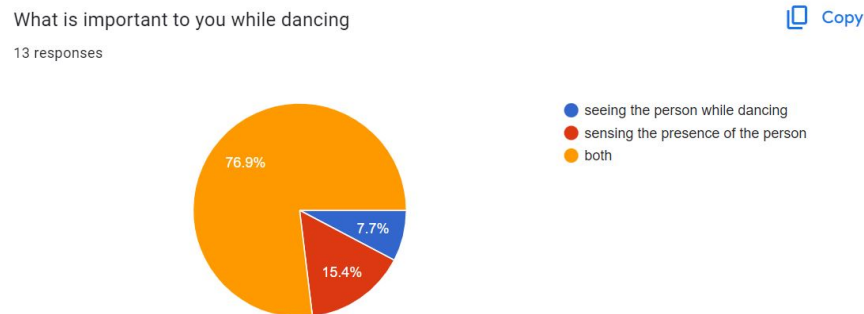
Figure 3.1 What is important while dancing with partner

Ideation:

In this stage, concept sketching and environment creating have been done based on the inspiration.

Prototyping:

In this stage two prototypes has been created towards the direction of this research. Second prototype is the updated version of the first prototype.

Discussion and Evaluation:

in every stages, we have evaluated the result and and collected data from the users for further improvement.

3.3. Ideation

From the survey, we identified that individuals want to feel presence . Therefore, the ideation of the design start with the question 'how can people sense about someone presence while dancing ?' Also, we have noticed in all the related works vertical plane around us has been used.Therefore to answer this aforementioned question we observe an incident, one person crossing another in vertical plane (Figure: 3.2) .
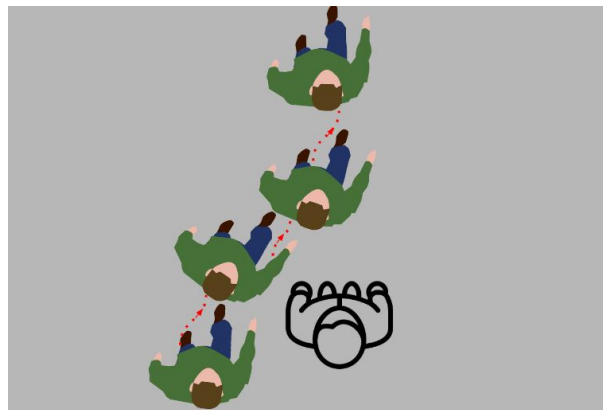
Figure 3.2 scenario observing in plan form

3.3.1 Key elemants

Based on the surveys and literature review, The following key elements have been identified:

Visual: Individuals trust their vision most when it comes to experiencing someone's presence. a mark on people surrounding physical space convey the message of existence easily.

Sound: In the era where it is easy to deploy any image or video, people tend to reassured by the voice of the person. Also, in dancing The choice of music differs. Individual should enable to choose their own music play in the same time at both places. Sound of footstep also foster the illusion of someone's presence.

Privacy: The research consider user's privacy as youth are on social media . Nowadays we are open to make friends and even life partner through communication on SNS. As a woman I do not feel safe enough to share my video with a friend I met online. Therefore, I aim to create the sense of presence without using the face (Figure: 3.4).

3.3.2 Concept sketching

After identifying the needed key features take me to the dancing aim to design a platform where people can identify their remote friend's presence through their mark. At this point the designed has been influenced and inspired by the local culture of the place I belong from (Figure: 3.4). In this culture, We draw foot-
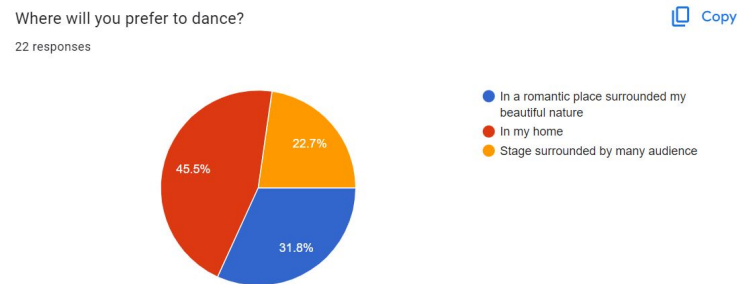
Figure 3.3 survey about place preference for dancing,2021

prints and consider it as god's presence. After marriage also, women enter their new home through red ink and make red footprints while entering to show their presence in the new home. Thus, here we created mark on the ground showing the remote person's position in real time (Figure: 3.5).

Figure 3.4 Inspiration for concept from local culture

3.4. Scenario design

To foster the remote dancing at own physical space, target user, scenario , User case and User flow have been defined. Creating the story with target user will highlight the need of 'take me to the dancing'. The designed scenario will support the technological development of the research. A defined user flow will help to build the prototype.

Figure 3.5 Ideation

3.4.1 Target User

This project primarily aims to foster the connection between two physically long distance friend through a playful artistic solution. In a survey we asked people 'Do you dance?' and we found out 68.2% of people dance under certain circumstance (Figure: 3.6).
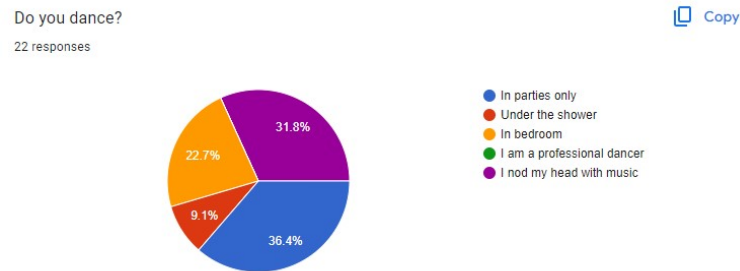
Figure 3.6 Survey to know how many non dancer people dance in May,2021

After talking to these people, We have narrowed down our target users. Individual who are seeking new entertaining platform to connect and to share their personal space with their long distance friend or partner.

Individual who wants to engage in an activity with remote friend but want to decrease their screen time.

Individuals who want to connect with online friend in deeper level securely without exposing too much information about his or her own place.

3.4.2 Scenario

Back ground: Seeking new platform to connect with remote partner decreasing screen time.

The Story: A girl named, Rima from India moved to a city for her job. She stays at her place alone. During Covid she felt lonely and decided to learn a Japanese online. Hence, she open a profile in Language learning application and there she met a Japanese man named, Ryu. Soon after they met, they fell for each other and decided to date. Both of them have job where they spend long hour in-front of screen. They wish if they could feel the opposite person in their own

place. Hence, they decided to use Take me to the dancing. Now insist of having movie date every weekend, they slow dance with each other which not only give them joy but also limit their screen-time. Sometime they move without music also and talk to each other. They are able to feel their partner's presence and they feel deeper connection.

3.4.3 User Case

Take me to the dancing platform enable individual dance with remote partner in real time at own physical space. The user can control whether they want to talk to their partner or not. They can choose the music of their choice as well. When the user first enter into the platform, he or she will she the two mark on the ground which defines the position of their remote partner. The moment their partner will move they will see the movement in those two mark on the ground accordingly. Now he or she can move their feet according to their partner. Here it is shown how the footprints will appear responding the actual movement of feet.A footstep mapping on the ground has been made with respect to a music video where a girl dances in a private place to understand movement of foot durig dancing(figure: 3.7).

3.4.4 User Flow

To understand and simplify the interaction through dance, the user flow has been divided into three steps.

Enter the platform

In this stage the user can only see the position of their partner. what they will do after that is totally their choice.

Music or talk

In this stage user can choose whether they want to talk to their partner or they can choose to play a music(which will be played in same time at two places) directly.

Figure 3.7 Footstep mapping from a dance video recorded indoor

observation

After playing the music, they will observe the movement of their partner in order to understand their partner position.This stage is crucial specially when user choose to not to talk at all.

Dancing

After understanding their partner's position, two user can finally enjoy dancing together at their own place.

End Dancing

When anyone of them wish to end dancing they can let the other person know after turning on their mic. And they can exit from the partner.

3.5. Concept Summery

To sum up the initial concept, Take me to the dancing is a platform that facilitates communication through dancing with remote friend in real time. the main features of this platforms are-

Foot Steps on physical horizontal plan The appearance of the footstep marks in physical space translates the position of the remote friend in real life. It makes individual believe the presence of someone in their own space.

Assurance with voice Though the footsteps make user believe of someone's presence, it lacks to assure them about specific person. Voice of the other person give the assurance that they are dancing with the partner they choose to.

Privacy As users are unable to see any thing but the foot step in their space. the privacy of the user gets being protected.

3.6. Concept based System architecture

System overview

The following components have been decided for the designed system:

Sensor or camera that can be used to record movement

Projection on the floor

To connect with sound , communication technology will be used.

Chapter 4
Evaluation

Take me to the dancing is a unique platform to experience dancing with remote friends. The main purpose of the research is to integrate surrounding physical space and to feel the presence of a remote entity. The challenges which have been taken considered are Dance as a language, Using Floor, minimizing screen-time , Remote communication.

The previous chapter has explained the Ideation, concept design, scenario of 'Take me to the Dancing'. During Concept design, surveys have been done in order to understand what is remote presence of someone to individuals and how they want to perceive it while dancing. In this chapter prototype design and it's development in different phases according to the user test will be discussed.

4.1. Methodology

Since this research is aiming to facilitate real time remote dancing using own physical space, it is important to validate the concept design through experiments using prototypes.

This research has been evaluated based on the main features of 'Take me to the dancing', degree of feeling the presence of a remote person while dancing.

The type of data that has been measured in the experiment is qualitative data. Through user test, videos study, survey, interviews and discussion , the data has been collected.

4.2. Prototype 1

4.2.1 Aim

The aim of my first prototype was to test whether people are able to sense of someone's presence through my proposed design.Although the previous study in this research verified the validation of conceptual design of 'Take me to the dancing', we are digging deeper to understand if impression of footprints on floor delivers the feeling of a remote entity's presence. We wanted to know if it is possible for individuals to communicate through footprints and dance in their physical environment. Moreover, we wanted to validate the usage of technical implementation in this research.

In this prototype, instead of using real time human interaction through dancing, we create an illusion of a remote entity on the floor. It has been designed to observe the degree of engagement of participants.

4.2.2 Prototype design

Using commuter language programming and projection mapping the first prototype has been created (Figure: 4.1). In this prototype, the presence of a remote person has been tackled manually using mobile phone using fingers. Instead of foot's position of a remote person , The position of my fingers on the phone has been projected on floor using projector[1].

As the remote footprints were manually controlled by me, I designed the movement pattern for the prototype in correspond to the motion direction of the users (Figure: 4.2) (Figure: 4.3).

When I touch my finger on the phone, two white dot appears on the floor (Figure: 4.4). When the participate starts to move with music, I move my finger according to designed motion. The participate can see two dot on the floor is moving with their foot movement.

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1   https://en.wikipedia.org/wiki/Projector

Figure 4.1 Concept sketch for first prototype

4.2.3 User test

The participates are told that the dots on the floor are the footprints of a remote friend (Figure: 4.5). First, they are asked to dance freely with the dots . Music for slow dance has been played as background song. Then they are given a questionnaire to fill up in order to record their response after they tried the prototype.

4.2.4 Findings

This prototype has been showcased in KMD Forum,2022 and 35 people have taken part in this user taste.Through interview with the users and the questionnaire filled by them, we came to know the followings:

Engaging:

Users reported that they are able to engage with the foot mark on the floor easily. In the videos also it has been seen users are having fun dancing with the illusion of foot steps.

Music:

As the background music was slow ball dance music, 20 users has reported that they would like more hyped up music instead of slow music.
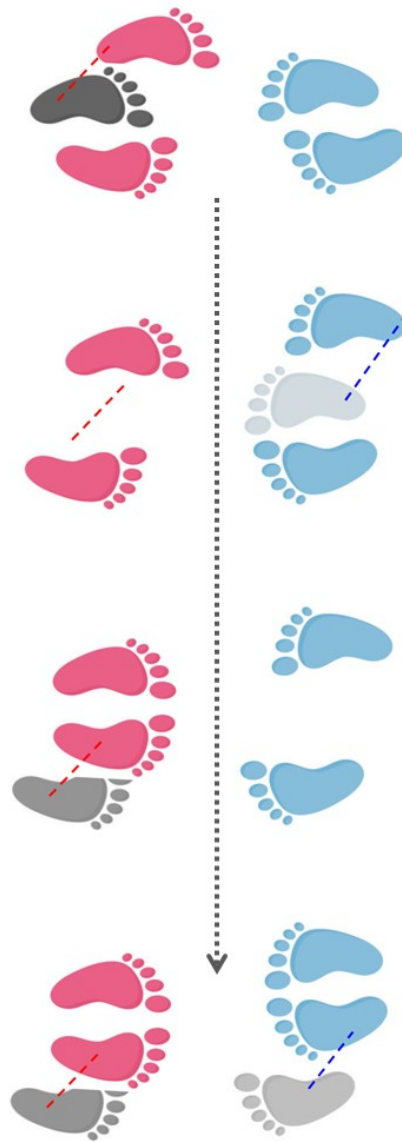
Figure 4.2 Pattern design corresponding to users foot movement 1
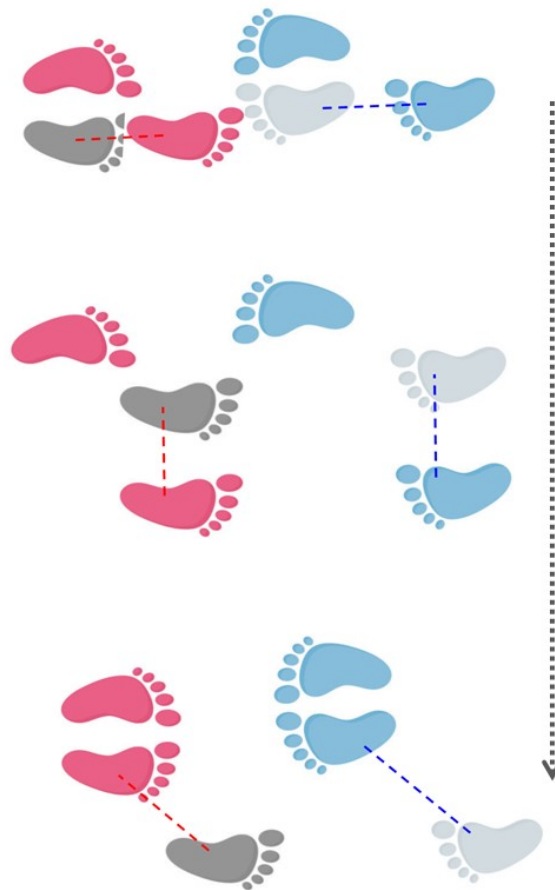
Figure 4.3 Pattern design corresponding to users foot movement 2
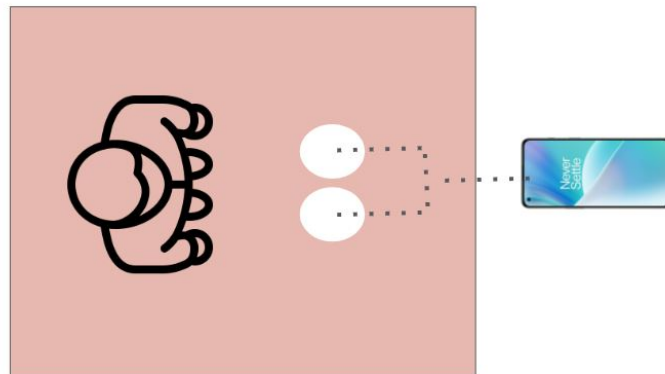
Figure 4.4 Ideation of Prototype:1

Voice:

As the only way to communicate was the footprints, users reported that it would be more communicating if they can hear their partners voice while dancing. Mel Mings in her early thirties told, ' I would like to talk to my partner while dancing. It would be great if I can hear his breathing while doing slow dance'.

Realistic moving pattern:

As the pattern of footprints were manually created by me, it was unpredictable and not same all the time unlike AI. Users found this feature realistic presence of a remote person.

Shape and color:

45% of Users do not care about shape or prefer the shape of the footprints as circle as it gives them the place to imagine. On the other hand 55% of users want to see the shape as footprints. As the numbers are too close we decided to make it clear in second phase of the prototype.

Figure 4.5 User test in Prototype:1

Privacy:

In this user test we provided semi-privacy where three sides are closed and only one side is open. Through interview we found out that people who think of the footprints as their partner's , felt romantic connection and they prefer privacy.

4.3. prototype 2

After considering the positive and negative feedback from the previous prototype, Some alteration has been done in prototype 2. In this stage, the system architecture has been also changed with the up-gradation of mechanical part of the design.

4.3.1 Aim

From the past user test we found out that the design is working to feel the presence of a remote person in surrounded physical environment. However, the previous test was based on an illusion manually created.

In this prototype, the aim was to design a system where the footprints on the floor created based on one's foot movement , instead of manually finger movement. Before, Creating the final prototype, we wanted to make sure that the designed technical implementation will work to achieve expected goal.Moreover we wanted to know users' preference about the shape of footprints.

4.3.2 Prototype Design

Motion sensor and projection mapping have been used to design this prototype. We have used one Microsoft Azure kinect[2] to capture the motion of one person's foot movement. We used Touch Designer to read this data in x and Y plane and to create footstep impression on X-Y plane. This impression was projected on floor using projector. In this prototype also, one person dance with the the footprints projection on the floor. this foot prints were my foot movement. the kinect was

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2   https://azure.microsoft.com/en-us/products/kinect-dk

capturing my foot movement and with the help of touch designer and projector it was projected on floor. I was in L position with the user and moving according to the users' footprint as it was visible from my position.

4.3.3 User test

The participants are told to dance freely with the footstep on the floor thinking those are their remote friends' footstep. They are told to dance in two scenario. In first scenario, they could only see the round shape as their partner's footprint (Figure: 4.6). In the second scenario, they could see two footstep as their remotes friend's footstep (Figure: 4.7). After dancing they are interviewed .
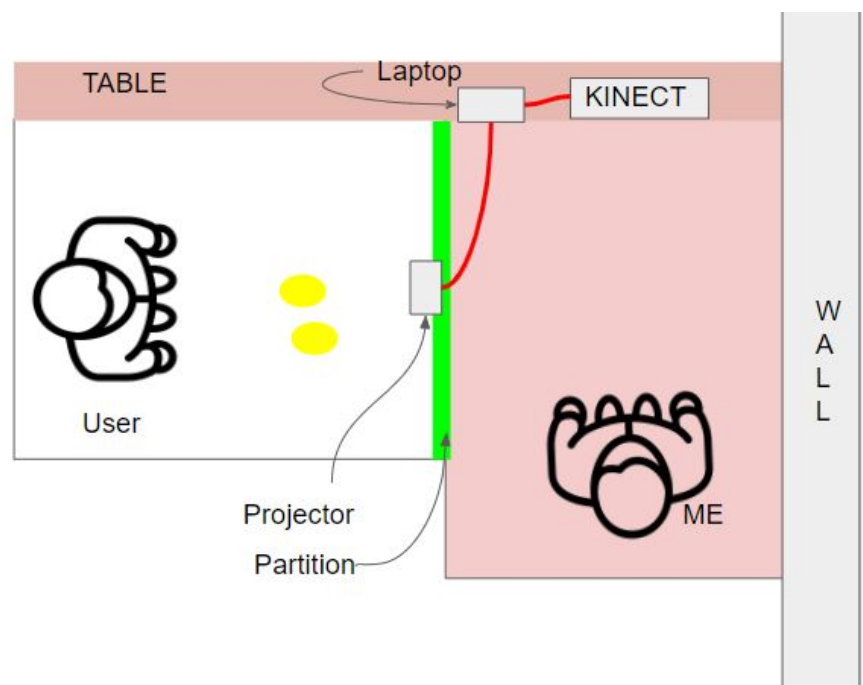
Figure 4.6 Prototype 2: user test in first scenario

4.3.4 Findings

10 participants had participated in this user test. They were asked which shape do they prefer. All of them showed their preference footstep shape. They were also
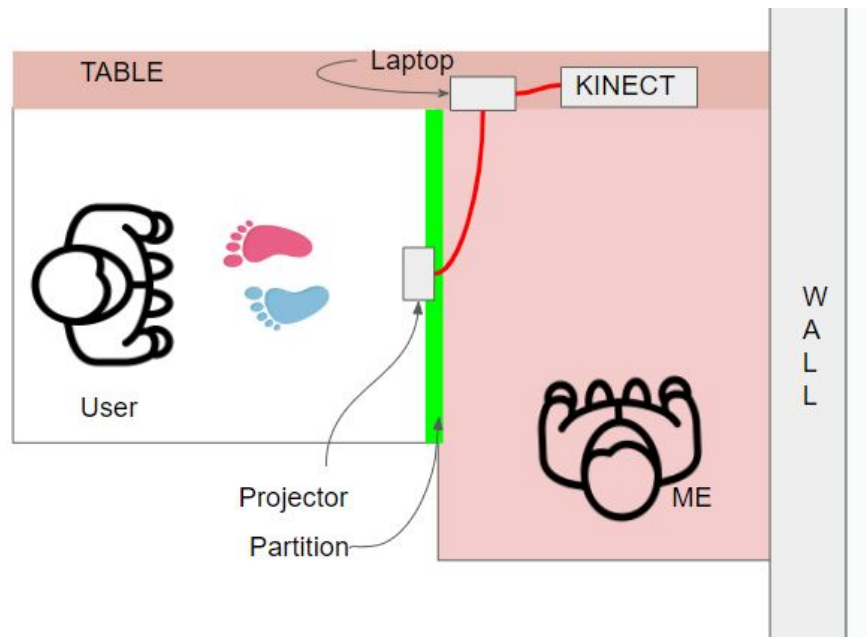
Figure 4.7 Prototype 2: user test in second scenario

asked about their experience of dancing with their remote friends. It is reported that participants found it engaging and felt of presence of a remote person.

It has been also noticed that many participants denied to dance saying they are are shy as the user test took place at a open room in KMD Project showcase April 2023.

It has been noticed that users are getting confused about the stage and starting to dance far from the edge of projected place. A demarcation of the stage area is necessary in the next prototype so that users don't feel lost.

Three people also reported that they are too conscious to dance. The moving footstep are encouraging them to dance. They think they can use it to learn basic dance step in their home without revealing their identity in future.

4.4. Final Prototype

After evaluating the data found in previous user tests, the final prototype for this research has been designed. In this stage, we have updated the technical implementation adopted in previous Prototype. The real time communication

through dancing between two different physical place has been designed here. It is a synergy between design and technology.

4.4.1 Aim

The final prototype has been meticulously designed with the primary goal of evaluating whether the proposed design successfully elicits the sensation of dancing with a remote friend. This final user test not only evaluate the necessity of the research but also provide provide valuable insights for shaping its future direction.

During the prototyping and user testing phase, the main objective is to ascertain the level of engagement and connectivity experienced between two dance partners situated in different locations. Given that one of the primary aims is to foster a feeling of presence with a remote person, the users' behaviors and interviews will be carefully analyzed to gauge their ability to perceive the existence of their distant friend. By closely observing user interactions and collecting their subjective feedback, it will be possible to determine whether the design effectively facilitates the sense of dancing with a remote companion.

Furthermore, an evaluation will be conducted to determine whether this innovative design enhances the enjoyment and engagement of remote dancing, ultimately contributing to its potential for adding social value. By examining the users' responses and reactions, valuable insights will be gleaned regarding the effectiveness and impact of the prototype in reality. The findings from this evaluation will not only validate the efficacy of the current design but also address the future iterations and improvements to meet user needs and preferences efficiently.

The results obtained from the user testing of the final prototype will serve as a significant contribution to shed light on the feasibility and desirability of dancing with a remote friend. These insights will help substantiate the importance of the research, demonstrating the value it holds for creating meaningful social connections despite physical distance through dancing.

4.4.2 Prototype design

Basic technical design from prototype 2 has been implemented in final prototype. In this phase we designed a product to dance in real time from two adjacent

rooms.

The hardware which has been used in this prototypes are:

2 Microsoft azure kinect, 2 Windows laptop with high graphics, 2 projectors, 2 stand, 2 tabs, 2 50m. long HDMI cable, 2 USB extender, One pair of speaker.

Two 2.5m x 2.5m black tents have to create two different physical private place in one hall room.

2 computer were kept in the middle of two tents on a table. Each tent has one projector,one speaker, one tab, one kinect using stand inside them. tent-1 has the projector connected with the kinect in tent-2 through one laptop which is deciphering the data from kinect and creating visuals of footprints. Tent-2 similarly has a projector connected with the kinect in tent -1 (Figure: 4.8). Two tabs in two tents are connected to each other using google meet.
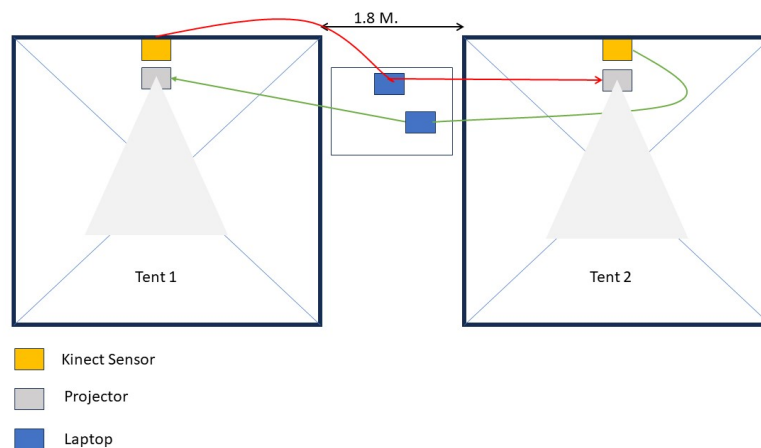
Figure 4.8 Schematic diagram of Final Prototype

Based on the the findings from previous prototype user test and the literature study, the shape of the visuals has been designed as footprints of someone wearing shoes. One stage area also has been demarcated in the tent's floor using projection. The whole software technology ; from receiving motion data to creating footprints visual has been completed using Touchdesigner[3] (Figure: 4.9) (Figure:

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3   https://derivative.ca/

4.10) (Figure: 4.11).

Figure 4.9 Prototype 2: Final user test setting from outside

4.4.3 User Test

The participants are asked to dance in pair remotely from two tents in three different scenarios. Both the participate were able to hear the same music at same time.

Following their interaction with the prototype, each participant was interviewed and asked to feel a questionnaire to gather their subjective impressions, emotions, and overall experience. These interviews served as valuable qualitative data, shedding light on the participants' perceptions of dancing with a remote friend and their level of engagement during the session. The interviews provided an opportunity for participants to share their thoughts on the design, technology, and the overall effectiveness of the prototype in creating a sense of presence and connection.

To supplement the interviews,participants' dance sessions were video recorded and photographed with their permission. These recordings enabled a more detailed analysis of their physical interactions and gestures during the remote dance

Figure 4.10 Prototype 2: Final user test setting (laptops creating visuals)

Figure 4.11 Prototype 2: Final user test setting (inside the tent)

experience. By examining the recorded data, we will gain insights into the synchronicity,imitation coordination, and overall quality of the participants' movements while dancing with their remote partners.

Participants

In order to gather comprehensive feedback and insights, the final user test was conducted with a diverse group of 28 participants, paired up into 14 pairs. From these participants 27 were non dancers and aged 20-55years. Only one user was 4years old. Each pair had the opportunity to experience the final prototype and engage in a remote dancing session together.

Among these 14 pairs, 4 pairs were unknown to each other and 10 pairs were either friends or family or partners.

The scenarios

In the first scenario, participants are asked to dance with the footprints of their partner , projected on the floor in real time.

In the second scenario, paired are asked to dance with the footprints of their partner projected on the floor in real time while they were also able to see and talk to the partner using google meet[4] on tab.

The third scenario was using exiting communication application (google meet) only. Here we stop the projection and ask user to dance with each other remotely using google meet.It was make sure that they were able to see each other clearly and they were audible to each other.

4.4.4 Findings

Assessing from the questionnaire

During Interview, The users have been asked to feel up an questionnaire (anonymously) which helped us to find their engagement in the process, the difficulties they face and the benefit they gained in terms of connectedness.

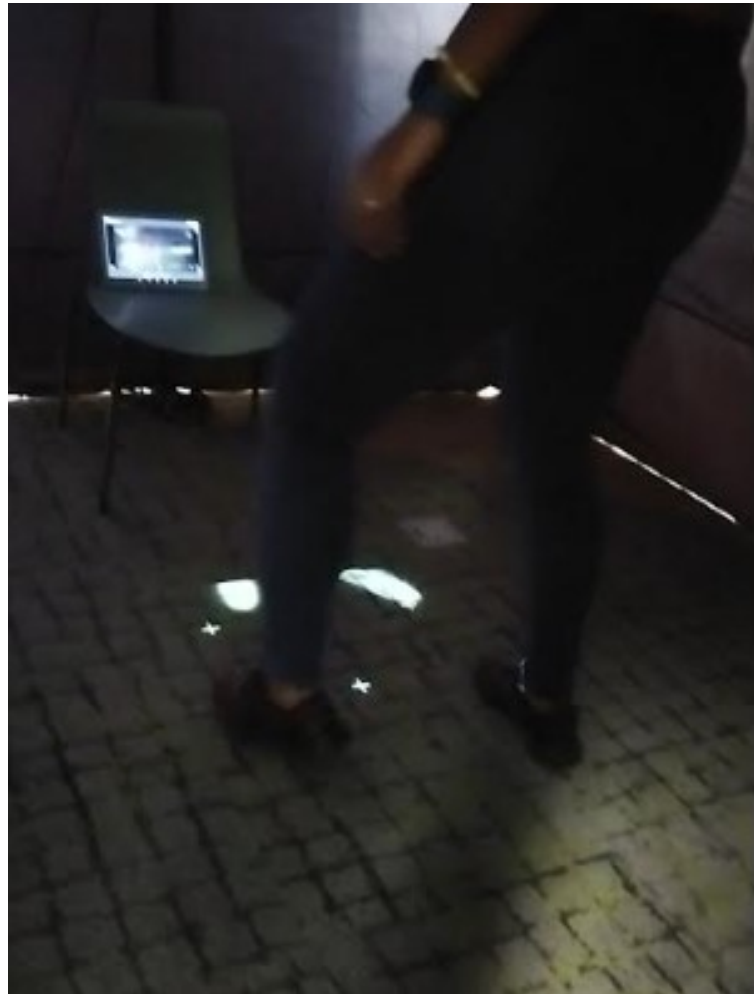4   https://meet.google.com/

Figure 4.12 Prototype 2: Dancing with Footprints while video call in on

Figure 4.13 Prototype 2: Dancing with footprints only

Participant were asked to rate their experience in the session out of 10. From the data we can conclude that 'Take me to the dancing' was rated 8 in average out of 10. This result clearly shows the design in this research has achieved one objective which is proving the user immense fun in an immersive environment.

Assessing from the interview

From the data we have collected through the interview we can also conclude that the participants felt the co presence of their partner in the session as participants reported that they felt guilty of stepping on the projected footstep and suggested that it would be better if the stage could be little bigger . As the pairs got chance to dance in three different scenario, following the session they were asked which experience did they prefer most.The discussion is following:

- Scenario only with video call:

80% participants has showed their dissatisfaction within 20 seconds. One participate commented ' There is nothing new and when I am dancing I like to rotate, I don't like to see my partner in one place.' Although we have already discussed in literature review how people are failing to feel the co presence while dancing using the screen, this research foster that previously commented statement. Thus,it shows how the novelty of this research can contribute .

- Scenario using projection and Video call:

While 30% of the participants reported that they felt more connected and co presence of their partner in session through the video and voice of their partner 70% of the participants reported that they did not even watch the video while dancing, they dance with the projection only (Figure: 4.12). However,65% of this 70% participants has agreed that despite of not watching the video, the take the advantage of the sound. One participate mentioned ' It is hectic to dance while watching a person on screen but the voice of my partner make me feel her presence'. another participant told, 'The voice help us to collaborate each other smoothly. When to start, when to stop and which music should we play - to understand these the voice helped us. In the session, A mom was participated

with her daughter. She reported ' As I care for my daughter safety, I like to dance with her where I can see her.'

- Scenario with only Projection:

35% participants commented that they prefer to dance without any voice (Figure: 4.13). One participant quoted, 'the anonymity was more fun'. Another participant told that 'I liked it with out sound because it's more intuitive'.

Pair who did not know each other:

These participants have shown their biasness with the scenario without sound and video. One participate at his 20s reported that 'I like the footprint without video because I think it's a bit awkward to dance in front of camera but without camera I feel more comfortable.'

Pair who knew each other:

Except one pair, all the pair who known each other danced readily.this pair has shown the difficulties with communication while dancing though they were talking. It has been observed that they were standing still until they were asked to move their leg. After that also, there were no coordination. One of them reported 'It would have been fun if the other person could lead me and I could just imitate.My brother and I both do not have any idea how to start dancing'

Summery

It can be concluded from the aforementioned discussion that Participants were able to feel the co-presence with the footprints and the feeling amplified with the voice of their partners. It provides specific information about their partner foster their believe of someone's presence in their own space.

We can also conclude that the feature of anonymity can be more helpful for the friends or partners who met online or relatively distant.

This research does have some back draws as well which will be discussed in next chapter.

Chapter 5
Conclusion

Dancing has it's enormous benefit what we have discussed in previous chapter.Dancing with someone does not only comes with health benefit, it also provide us a happy fun experience. In this technically advanced era, physical distance should not be a barrier for dancing with someone. As a result, we can see an expanding market for remote dancing system. However, this can be challenging for people who experience VR sickness or screen fatigue. Besides, these systems have failed to incorporate our our physical surroundings.

'Take me to the Dancing' proposes an unique and entertained way to facilitate remote dancing in our own physical space,while decreasing the screen time. The way to facilitate this remote dancing is enabling users to interact with the real time movement of their remote partner's footsteps through dancing. User can see the footsteps movement on the same ground they are standing.

The concept design of 'Take me to the Dancing' has been evaluated several times through user testing and gathering data. The goal of the experiment was to validate it's novelty and values in remote dancing with someone while sharing same physical space. Though we have already discussed about it's success to achieve the aforementioned goal, there are some limitations which leaves a room for future improvement.

5.1. Limitation

According the data we found after user test and the observation during user test, We have seen 'Take me to the dancing' has shown it's potential in solving the challenge of feeling the the presence of remote person at our physical space and sharing the same space with them while dancing and maintaining certain

privacy.However, there are still limitations which is needed to address for future improvement.

The first limitation is that the whole prototype was built connecting two place with wire. It was only possible because the distance between two places was only 1.8 meter.

The second limitation of this project is that it is still not able to show the complex dance movement or the how they are moving feet as the z-direction has not been considered here.

The third limitation is that as it was not tried by any couple for more than 2-3 minutes, it is in unclear what demerits 'Take me to the dancing' may have for longer time usage.

5.2. Future Work

The qualitative data found after user test demands future work in this project technically. Some users have been reported that for then it is easier to follow the movement if two foot have different color. Also , they reported that it would be easier to dance if the quality of the visual become clearer as the visuals sometimes had glitch and the floor has a pattern. In this context, technological betterment is necessary.

Also, participant were not able to control the darkness of the room or volume of music as it was fixed. Therefore, some participant struggle to hear their partner's voice. In future it also can be fixed with better technology.

5.2.1 Broaden the Context

The previous user test has shown that 'Take me to the Dancing' foster the idea of sharing same physical space in remote dancing. The research made a conclusion that foot prints on someone's physical space has certain values to feel the presence of someone and to connect with them in shared physical space.

Based on the discussion with the users we can conclude that this research has potential of many possibilities. According to some non dancer user's statement, it can help them learn dancing with maintaining their privacy as they feel too shy to attend a dance school or dance in front of anyone. We also found out through

discussion with couple that it is suitable for intimate communication using action instead of words.

Therefore, we conclude that this research has potential to open new doors not only to foster relationship but also it can be used in education purpose.

References

[1]

[2] Jussi Tanskanen. A prospective study of social isolation, loneliness, and mortality in finland. *American journal of public health*, 2016.

[3] D. Freeman, S. Reeve, A. Robinson, A. Ehlers, D. Clark, B. Spanlang, and M. Slater. Virtual reality in the assessment, understanding, and treatment of mental health disorders. *Psychological medicine*, 47, 2017.

[4] Lynsey Gregg and Nicholas Tarrier. Virtual reality in mental health. a review of the literature. *Social Psychiatry and Psychiatric Epidemiology*, 42, 2007.

[5] Mairi Therese Deighan, Amid Ayobi, and Aisling Ann O'Kane. Social virtual reality as a mental health tool: How people use vrchat to support social connectedness and wellbeing. In *Conference on Human Factors in Computing Systems - Proceedings*, 2023.

[6] Jon Cedric Roxas, Deborah Richards, Ayse Bilgin, and Nader Hanna. Exploring the influence of a human-like dancing virtual character on the evocation of human emotion. *Behaviour & information technology*, 37(1):1–15, 2018.

[7] Maria Gallagher and Elisa Raffaella Ferrè. Cybersickness: a multisensory integration perspective. *Multisensory research*, 2018(7):645–674, 2018.

[8] Lisa Rebenitsch and Charles Owen. Review on cybersickness in applications and visual displays. *Virtual reality : the journal of the Virtual Reality Society*, 20(2):101–125, 2016.

[9] Y. Takahashi and A. Murata. Change of equilibrium under the influence of vr experience. In *Proceedings - IEEE International Workshop on Robot and Human Interactive Communication*, pages 642–647. IEEE, 2001.

[10] Andrej Somrak, Iztok Humar, M. Shamim Hossain, Mohammed F. Alhamid, M. Anwar Hossain, and Jože Guna. Estimating vr sickness and user experience using different hmd technologies: An evaluation study. *Future generation computer systems*, 94:302–316, 2019.

[11] Xuesong Zhai, Minjuan Wang, Rongting Zhou, Muhammad Azfar Anwar, Saba Saneinia, Intikhab Ahmad, Man Li, and Fahad Asmi. The nexus between vr affordability, cognition, and vr addiction: A gaming perspective. In *2020 6th International Conference of the Immersive Learning Research Network (iLRN)*, pages 116–124. Immersive Learning Research Network, 2020.

[12] Kathrin Gerling and Katta Spiel. A critical examination of virtual reality technology in the context of the minority body. In *Conference on Human Factors in Computing Systems - Proceedings*, 2021.

[13] Douglas Rosenberg. Video space: A site for choreography. *Leonardo (Oxford)*, 33(4):275–280, 2000.

[14] Zhenyu Yang, Bin Yu, Wanmin Wu, Ross Diankov, and Ruzena Bajscy. Collaborative dancing in tele-immersive environment. In *International Multimedia Conference: Proceedings of the 14th annual ACM international conference on Multimedia; 23-27 Oct. 2006*, MM '06, pages 723–726. ACM, 2006.

[15] DAVID BURLEY, PAM JENKINS, SHIRLEY LASKA, and TRABER DAVIS. Place attachment and environmental change in coastal louisiana. *Organization & environment*, 20(3):347–366, 2007.

[16] Deidre Sklar. Ii. on dance ethnography. *Dance research journal*, 23(1):6–10, 1991.

[17] Ilhan Adilogullari. The examining the effects of 12-week latin dance exercise on social physique anxiety: The effects of 12-week latin dance. *Anthropologist (New Delhi, India : 1999)*, 18(2):421–425, 2014.

[18] Edith Van Dyck, Pieter Vansteenkiste, Matthieu Lenoir, Micheline Lesaffre, and Marc Leman. Recognizing induced emotions of happiness and sadness from dance movement. *PloS one*, 9(2):e89773–e89773, 2014.

[19] R. Thomas Boone and Joseph G Cunningham. Children's decoding of emotion in expressive body movement: The development of cue attunement. *Developmental psychology*, 34(5):1007–1016, 1998.

[20] Olga Zotova. Emotional security of people. *Journal of Siberian Federal University. Humanities & Social Sciences*, 8(9):1816–1833, 2015.

[21] Graeme Browne and Mary Courtney. Housing, social support and people with schizophrenia: A grounded theory study. *Issues in mental health nursing*, 26(3):311–326, 2005.

[22] Vered Aviv. What does the brain tell us about abstract art? *Frontiers in human neuroscience*, 8(1):85–85, 2014.

[23] John Halverson. Paleolithic art and cognition. *The journal of psychology*, 126(3):221–236, 1992.

[24] Scott L. Fairhall and Alumit Ishai. Neural correlates of object indeterminacy in art compositions. *Consciousness and cognition*, 17(3):923–932, 2008.

[25] Kevin Laland, Clive Wilkins, and Nicky Clayton. The evolution of dance. *Current biology*, 26(1):R5–R9, 2016.

[26] Marcel Brass and Cecilia Heyes. Imitation: is cognitive neuroscience solving the correspondence problem? *Trends in cognitive sciences*, 9(10):489–495, 2005.

[27] Joonsung Yoon and Jaehwa Kim. The interactive artwork as the aesthetic object: Aesthetic technology converging technological applications and aesthetic discourses. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, volume 4326 of *Lecture Notes in Computer Science*, pages 116–126, Berlin, Heidelberg, 2006. Springer Berlin Heidelberg.

Appendices

A. Questionnaire for Final Prototype

How much did you feel the presence of the person dancing with you from the different tent:

Unhappy   Happy

1 2 3 4 5   6 7 8 9 10

Did you like the experience?

Unhappy   Happy

1 2 3 4 5   6 7 8 9 10

What was the difficult in that experiment?

Please write some words about your experience? Why did you like or dislike the experiment?

Figure A.1

B. Question for interview in Final User test

Which scenario you found best for remote dancing with your friend and why?