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Master's Thesis
Academic Year 2018

# Wearable Aura: Interactive Personal Projection to Bring People Closer

Keio University
Graduate School of Media Design

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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

Laura Lugaresi

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Abstract of Master's Thesis of Academic Year 2018

# Wearable Aura: Interactive Personal Projection to Bring People Closer

Category: Design

## Summary

Loneliness is increasing, and people spend more and more time glued to their smart-phones, looking for interactions on-line. It seems we are forgetting that the world around us is full of individuals to whom communicate. Wearable Aura aims to take advantage of technology to encourage and stimulate communication between strangers in real-world scenarios.

Wearable Aura is a wearable device able to project a personalized animation onto ones Personal Distance zone. This projection, as a spiritual pet is aware of the environment and responds to the users activity. Above all, it reacts to the people in close proximity to the user, taking the burden of making the first move.

This research explores a new way to connect people, offering an unexpected experience and a playful activity to do together. The goal is to bypass the mediation of a screen but encourage spontaneous face-to-face communications.

## Keywords:

Interaction Design, Wearable Device, Social Interaction, Loneliness, Projection, Proxemics

Keio University Graduate School of Media Design

Laura Lugaresi

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# Chapter 1
# Introduction

Through the Internet, it has become increasingly easier to connect with new people. But how can we encourage and stimulate spontaneous interactions between strangers in the real world?

The goal of this research is to investigate how technology may support verbal and non-verbal communication in off-line scenarios. It is proposed Wearable Aura, a wearable device that projects a personalized and interactive animation onto the floor, into ones Personal Distance[1] zone. This projection behaves as a spiritual pet: it is aware of the environment and it is reactive to the user's activity. In addition, in its core, it interacts with the people in the close proximity to the user, functioning as an ice-breaker for social encounters.

## 1.1 Connected but Alone

Nowadays more than ever, we talk about communications, connections, networking. At the same time, loneliness is a growing issue. Ironically, in our over-connected society, people feel alone as never before.

Individuals choose to live in a big city, hoping to get more contacts and friends, believing they will avoid loneliness. However, the truth is that especially in a big metropolis, it is extremely common to feel lonely and isolated. In fact, the city's crowded environment tends to make it hard for people to connect with others. The need for privacy increases people's attitude to isolation, both personal and towards the others. Moreover, the distrust and fear of strangers, typical in urban environments, contributes to the difficulty of building new relationships (Pirone and Mazzonna 2005).

The stress of being alone and companion-less in a new environment, due to relocation or community and family crisis, is emerging every day more. At the same time, the trend of being independent and move out from home often results

in loneliness too[2].

When individuals feel lonely, they do desire connections with others and look for means to answer the need of socialization and belonging. As an evidence, the Internet is crowded every day more with innumerable services and applications for meeting new people, that generally require an on-line interaction before having an actual face-to-face encounter. From this point of view, on-line platforms might offer an opportunity to connect strangers in new and exciting ways, enlarging one's social network. On the other hand, these connections are mostly virtual and hardily translate into a real-life relationship. In this context, several studies support that the new technologies are making people even more lonely, giving them only the feeling of being connected, but actually leaving them even more disconnected in the real-life (Drago 2015). Moreover, the growing replacement of the physical by the digital is changing drastically everyday experiences, contributing to reduce the opportunities to connect with others off-line. It is preferred to send a mail instead of having a face-to-face update or to make a call instead of a meeting. Finally, also the increment of exchanges with artificial intelligence, only superficially meaningful, raises concerns regarding the consequent decay of genuine social interactions. Precisely, the psychologist Sherry Turkle blames technological development, and in particular, the inconsiderate and unhealthy adoption of new media, for the sense of alienation between people, which she demonstrates that is increasing every year (Turkle 2017).

## 1.2 The Importance of Face to Face

Humans are fundamentally social beings. Even if today's life seems to reduce people capacity for human-contact, there is clear evidence of the benefits that people can gain from social ties. Indeed, it is proven that feeling a sense of connectedness to people in proximity is psychologically beneficial (Seeman 1996). Moreover casual and informal connections, identified by the American sociologist Mark Granovetter as "weak ties", among the other effects, help information sharing across different groups, opening new and unexpected possibilities (Granovetter 1977). After all, our dearest friends were once completely strangers.

On the other hand, the increasing use of digital media to interact with others is blamed to be the cause of a loss in humanity. It is known as a fact that on-line communication does not benefit from the non-verbal language support. Therefore, in Internet-mediated interactions, it is easy to misunderstand the tone of voice

and consequently the meaning of the message. In this sense, S. Turkle argues that replacing face-to-face communication with smart-phones is diminishing peoples capacity for empathy (Turkle 2012).

In-person communication, more than everything, can improve people's sociability and help to connect with others in a meaningful way. However, it can be hard to approach non-familiar individuals and to initiate a conversation, due to perceived social norms or individual personality. Therefore, commonly, it is easier to escape into virtual third places rather than facing the real-world context. However, people are still seeking personal relationships in a tangible form, and they aim to feel actively part of a physical community in everyday life. In this perspective, technology may be the way to push users towards off-line social interaction and stimulate new encounters.

## 1.3 Contribution

The final goal of this research is to foster communication between strangers in real-world situations. More and more people are experiencing loneliness, suffering from the detachment of physical presence or experiencing hurdles in feeling part of a community. Currently, new technologies are already looking to solve this issue through match-making services and promoting meet-ups.

However, we still believe in the importance of spontaneous face-to-face interactions. Therefore, instead of using technology to replace companionship and absent people's presence, the ambition of this work is to envision technology as a possible way to sparkle real connections in the outside world.

How can we take advantage of technology to encourage genuine encounters completely off-line? And, can communication between people overcome language and culture barrier, allowing individuals to interact in a unique, unambiguous and entertaining way?

This work aims to analyze these questions and to give an answer through Wearable Aura, in the hope of reducing social alienation and empowering the sense of belonging.

This research won the award as best project of Acm CHI'18 Student Design Competition (Lugaresi et al. 2018), in April 2018 in Montreal, Canada and it was presented at UbiComp'17 (Zheng et al. 2017), in September 2017, in Hawaii.

## 1.4 Thesis Organization

This thesis consists of five chapters.

- In Chapter 1, above, is discussed background, current state-of-the-art and the contribution of this research.
- Chapter 2 mentions the three main foundations of this research: proxemics, pets, and ice-breakers. Several related works are also illustrated.
- Chapter 3 describes the concept of Wearable Aura and the design process followed from ideation to the finalized prototype. Two user tests are mentioned in this chapter.
- Chapter 4 validates the proposed design, through an experiment in-the-wild.
- Lastly, Chapter 5 analyses and outlines the future development of this research.

# Notes

1 See reference at proxemics (Hall 1966)

2 What It's Like to Be Young and Extremely Lonely in a Big City, Vice, 2018`https://www.vice.com/en_uk/article/3k5meb/what-its-like-to-be-young-and-extremely-lonely-in-a-big-city`

# Chapter 2
# Literature Review

In proposing a solution to promote communication, this research examines the moment in which people initiate any interpersonal interaction. From this perspective, non-verbal communication plays a big role: non-verbal cues are crucial for the onset of human-to-human communication. Indeed, this research is rooted in proxemics, a segment of non-verbal communication related to human use of space, which delves into how social interaction affects reciprocal-distance. Besides, are examined the beneficial effects of walking a pet as an example of a social bridge in public spaces. Hence it is discussed how and why companion animals facilitate interpersonal connections. Lastly, the research looks into the spectrum of ice-breakers and tools to overcome initial shyness. As a result of the literature and related-works review, the three main requirements to determine an awkwardness-free communication emerged.

## 2.1 Proxemics

### Distance is communication

This research is related to the interpersonal interactions occurring in real-life situations, therefore in physical space. In these scenarios, contrary to the online environment, many factors are involved, like eye contact, body language, and posture. As proved, 93% of all communication is nonverbal.

In this context, thought-provoking was the study of proxemics (Hall 1966), on which relies this work. The cultural anthropologist Edward Hall, in his book "The Hidden Dimensions", suggests that humans set the space between them according to the social and affective relationships they have. On top of that, he defines the social spaces into 4 main distance zones:

- **Intimate Distance**: between 0 and 50 cm, is the distance people usually

occupy only in a close relationship since it includes the realm of physical contact and private conversations.

- **Personal Distance**: between 50 and 120 cm, is the distance people have when interacting with family members or friends. Generally, if a stranger invades this area, an individual may step backward to readjust the spatial relation, or even get angry at the other.

- **Social Distance**: between 120 and 350 cm, is the distance of impersonal interaction, socially acceptable space between customer and employee or at a social gathering.

- **Public Distance**: over 350 cm, the distance for mass speaking or one-to-many interactions, as in the case of teachers, clergy, stage people.

The exact size of each zone varies from person to person because it is influenced by numerous factors as the culture of reference: a Japanese individual needs more distance from others than an Argentinian; gender: people of the same sex tend to stay closer than two people of different sex; individual characteristics: attitude and character, are also factors in determining the preferred spatial positioning; environment: in a louder situation people tend to get closer to communicate. However, individuals tend to keep a similar distance with the interlocutor according to the intimacy level they have. In others words, there is a tight correlation between physical distance and social distance. Moreover, people are inclined to move closer to the people they know and like (Marquardt and Greenberg 2012).

The design of Wearable Aura encourages individuals to enter respective Personal Distance, smoothing or avoiding the awkwardness effect that could happen when two strangers move closer. Personal Distance is taken into account because, as discussed before, this is the area of familiar interlocutors. Furthermore, allowing people in this range proves congeniality and mutual sympathy.

## Applying Proxemics to Reshape People's Interactions

Previous studies already investigated how proxemics zones may be manipulated, and the reaction of people to the reduction or enlargement of the proxemics distances. The study of Katrin Wolf et al. (Wolf et al. 2016) about proxemics zones of exhibits, is a clear example of how humans' spatial behavior can be modified manipulating proxemics zones. The researcher utilities interactive floor projections

to dynamically change the size of an exhibit forbidden areas, artificially increasing or reducing the distance that visitors keep from the exhibited subject. In Wolf's work, it is proved how floor projection is an effective approach to influence people spatial relationships. Moreover, it is shown how people react faster to animated floor projections rather than to static ones.

Another approach to manipulating artificially proxemics in order to modify people's behavior is the one of The Nescafé Hello Bench [1].The peculiar bench was presented at Milan Fuorisalone 2017 as a marketing and social campaign from the agency Publicis Italy for the coffee brand Nescafé. As a matter of fact, The Hello Bench looks like an ordinary red bench placed in public space, but, when two people sit on it, its length starts diminishing. Two sensors activate the bench, bringing the two strangers unexpectedly closer. The shorter distance between them in addition to the surprise-effect lead to an interaction, giving a motivation to break the ice as well as a starting point for a conversation. The brand challenge and goal through this project is to help people building new relationships in a crowded but disconnected city-environment, "shortening the distances to spark a real connection".

Figure 2.1: The Hello Bench from Nescafé[2]

.

On the other hand, experimental designer Anouk Wipprecht conceives a garment that avoid people to violate proxemics zones, guaranteeing a proper spatial

behavior of people around the user. In her work Smart Spider Dress[3], powered by Intel and presented at CES 2015 in Las Vegas, the dutch designer combines fashion, wearable technology and robotics to ensure that the users Personal Space area is respected and maintained. The 3-D printed dress is equipped with proximity and biometric sensors, interfering when someone overcome the comfort boundary of Personal Distance. The robotic spider legs, attached in the dress, shoot forward rejecting whoever is too close, and re-establishing the acceptable distance space for the user. The interaction is autonomous, but it is adapted to the user's data. In this perspective, the dress allows the users to express their emotions and at the same time to protect their Personal Space as they perceive it. In Wipprecht words "the Spider Dress acts as the interface between the body and the external world".

Figure 2.2: Smart Spider Dress from Anouk Wipprecht[4]

.

## 2.2 Pets

### A social bridge in public environments

Pets are considered social bridge in public environment, facilitating social interactions and overcoming loneliness. In fact, pets, especially dogs, are identified as

social companions. Furthermore, it is proved how dogs can provide even more companionship for humans than merely their own company: they play a role in socialization in public spaces. In this context, several studies have shown how dog walkers are more likely to experience social contact and kick off a conversation with strangers, rather than people walking alone. An Australian study on social capital by L. Wood and al. proves how non-pet owners find it hard to get to know people in the public spaces as streets, parks, or squares. Instead, 90% of who owns a pet confirm that walking their companion-animal made them have a talk with people in their suburb that they did not previously know. (Wood et al. 2005)

It can be said that dogs are a catalyst for social connections and reduce inhibitions regarding social contact between strangers. Therefore they are recognized as facilitators for social interaction and promoters of community-belonging sense among both: who own dogs and who does not.

The extensive research of (Johnson et al. 2199) about the benefits of walking dogs, explains why dogs are able to facilitate human-to-human contact. The reasons why dogs can be called social bridge are summed up in the following 4 points:

- **Ice-breaker**: dogs give an excuse and a topic to start a neutral conversation.
- **Attention catalysts**: prevent the awkwardness effect that happen when a stranger invade ones personal distance space
- **Antidote for anonymity**: they are a tool of self-expression, help people show their character and attitude. Have to walk a dog make people feel part of the city
- **Trust-agent**: valuing the behavior of liking and being liked by an animal, is reflected in spontaneously assigning positive attributes to a pet owner

## Recreating Pets Impact Through Digital Artifacts

In this perspective, Wearable Aura aims to recreate the same mechanism of genuine interactions of walking a dog, and achieve a similar spontaneity in social interactions between strangers or unfamiliar people. In a similar mindset, Leung et al. (Leung et al. 2011) investigate how to trigger interpersonal interactions utilizing technology to enhance self-expression. The design consists in a personal projection in the ceiling, just above users head, representing one's on-line social

identity . The visualization is supposed to bridge the on-line and the off-line presence of the user, to stimulate communication in real life situation by giving a tool for breaking the ice and start a conversation. The design generated curiosity and interest, and above all it was an effective breaking-the-ice tool. However, during user test people felt uncomfortable and unsafe due to privacy issues related to the personal data shown indiscriminately.

An other example of a similar approach is the research [5] conducted in 2015 by Kosuke Maekawa at Keio University Graduate School of Media Design. His work, Social Mascot, consist of a companion object that supports inter-human communications. Able to interact with other Mascots independently from its owner, the device is designed to facilitate social relationship. In fact, Mascots have a proper interactions when they meet in the real world. When they are in close proximity they start communicating with gestures and physical movement, surprising and entertaining the respective owners. The uncontrolled an spontaneous interactions of Mascots aim to kick off a conversation, breaking the ice between familiar strangers, similarly to how it would happens when walking a dog.

## 2.3 Ice-breakers

### Assisted Activities to Build Social Bonds

According to the dictionary definition, an ice-breaker is something that someone says or does in order to make it easier for people who have never met before to start talking to each other (Hanks 1986). Usually employed to start a workshop, a class or any sort of organized session, it is an activity that facilitates the introduction of people to each other, making them feel more comfortable and relaxed together. As discussed before (see Chapter 1), it could be difficult for someone to start a conversation with others, especially if they do not know each other, or are not used to gather together. In fact, the "ice" to be broken, refers to the matters that limit or inhibit spontaneous interpersonal interactions.

Usually, ice-breakers are advantageous when entities within a group struggle to engage. Several signals make it clear, such as little or no conversation, lack of eye contact and unwillingness to have physical interactions. Ice-breaking activities also help to overcome single person isolation within a group, absence of initiative and poor trust among people. In those contexts, typically due to short-time constrains combined with the necessity of communication and fruitful comfort

level between participants, ice-breakers are used to artificially provoke a group interaction, stimulating people to overcome shyness and social reserve.

Figure 2.3: Ice-breaking activity at KMD crash course. Credits: Sam Furukawa, 2016

Ice-breaking activities are countless, and they could be shaped in different ways. Indeed, they turn out to be especially effective when carefully customized for the specific audience, and taking into account the goal to achieve and the typology of the gathering. Ice-breakers can be used in a wide variety of situations and social settings, within a small or large group. Also the focus may differ. For example it could be to stimulate strangers to work together as a team, among students to start socialize and know each other, or at a party to introduce guests one to another and entertain them. Therefore the range of possibilities is wide, it could be a game, a challenge, a presentation or even direct questions.

However, even if different kinds of ice-breaker exist, they have some commonalities and a general pattern can be outlined in 4 key points:

- **Facilitator**: to be successful an ice-breaker needs a facilitator that leads and controls the activity. It is necessary that someone, outside the group, gives clear instructions and directs the progress of the activity. Generally, the ability of the facilitator to foster collaboration and relationship building, is crucial to determine the success of the ice-breaker.

- **Topic**: an ice-breaker should cover areas of commonality and shared interests among participants, and needs to be designed to result inclusive and sensitive to cultural differences.
- **Simplicity**: it is crucial that the activity is simple and easy to understand, fun and highly interactive. If people are entertained and focus on the task, they can easily loosen up and behave spontaneously in the activity.
- **Task**: with a goal, and everybody in the same situation it is easier to start a conversation and overcome social barriers. Having a goal in common, something to share or to solve together, makes people closer and surely increases the the initial level of warmth within the room.

## Ice-breakers in Everyday Contexts

Thought Wearable Aura, the intent is to provide to people an ice-breaking tool. Differently from traditional ones, the facilitator is not present but instead Aura works according to users' own pace. In other words, Aura present to people an unusual and unexpected activity to do together, when and where they prefer.

In this prospective, Free Hug Campaign[6] can be seen as a peculiar ice-breaker. The goal of the campaign is to reestablish and reinforce a human-to-human contact, progressively lacking due to the increase of social-disconnection. Though the act of the hug, the huggers intend to break the invisible social barrier between strangers. Usually, a Free Hug Campaign consist in one or more people, standing in a crowded area holding a sign asking for a hug. In this case, the facilitator of the interaction is the owner of the sign, and at the same time he or she is also an active participant in the ice-breaking activity.

The impact of this gesture is disruptive, making two completely strangers feel connected, even if they do not exchange a single word, but just have a physical interaction. However, taking in account the natural need of keeping a certain distance from stranger, also the intimacy of a physical contact, this kind of interaction could result problematic or uncomfortable to someone, especially in countries like Japan[8], where this research is conducted.

On the contrary, it could be said that on the Internet is drastically easier to break-the-ice and to get in touch with strangers. Trough social networks, chatrooms, blogs, etc. people have a space, and usually also a topic, to start talking and get to know each other. Bearing in mind that the goal of this research


Figure 2.4: Free Hug Campaign in Shibuya, Tokyo.[7]

is to enhance communication in real-life scenarios, the analysis of the tools or application to encourage on-line interactions is out of the scope. However, several Internet services are aiming to facilitate off-line encounters. Moreover, the physical location of the user influences the usability of the application, blurring the barrier between real and virtual. A clear example is Tinder [9], the location-based match-making on-line App that allows users to like or dislike the other users nearby. The vicinity plays a crucial role to support the goal of an off-line meeting, and the App works as the facilitator for the encounter. In the context of enhancing real life encounters through Internet, the Happn[10] App goes a step beyond Tinder. Indeed, the users are allowed to visualize each other profiles only if they have been in direct proximity, giving to them a second chance, when they miss the first encounter in real life. However, again, even if the final goal is similar to the one of this research, the process of utilizing an App, and the mediation through the self-phone screen, wipe out all the spontaneity and the temporality of the encounter, explored in Wearable Aura.

On the other hand, The coMotion Bench (Grönvall et al. 2014), from E. Grnvall et al., is a representative example of how also a simple object can work as an ice-breaker to facilitate encounters between strangers. The research assesses how the unexpected experience generated curiosity and led to a conversation. As

for the ice-breaking activities, the shared situation and the goal of investigating the peculiarity of the bench, united the people and pushed them to have an interaction. In this case the absence of a human facilitator, do not assure people to respond positively to the trigger and to bond together. However, the simplicity of the action and the common topic alone, supported, for most of the cases, the social contact.

## 2.4 Summary

The goal of this research is to create a trigger to foster an encounter and to achieve a casual and spontaneous interaction between strangers, as they walk through each other. The connection doesn‘t necessitate to involve a verbal exchange, as far as it generates a sense of connection, as it happens during Free Hugs campaigns. In this perspective, this research proposes a new way to interact with others, not necessarily verbally or physically, but through a third-party: the Aura.

During ice-breaking activity, people are pushed to communicate by completing together an assigned task. In the same way, Wearable Aura generates an animation, as the tool for stimulating the interaction. In other words, Aura is the touch point to initiate the communication. The interactive feature of the animation makes it reactive to both: actions of the user and movements of other people. Consequently, Aura has to be visible with bare eye, without the use of additional interfaces, to reduce the physical barrier and encourage the face-to-face communication. Removing any device is important to make the experience direct and more personal. In fact, the distance and the gestures play a crucial role during any interaction.

Lastly, from the ice-breaker and pets-effect review, it emerged clearly that the surprise effect and the focus on something that catalyzes the attention, reduce the stress of initiating an interaction. Aura needs to be reactive, as a dog, to keep surprised both the user and the people around.

To sum up, 3 key points, (illustrated in figure2.5)that ensure awkwardness-free verbal and non-verbal interactions, emerged from the literature and related work analysis: Distance, Topic, and Self-expression.

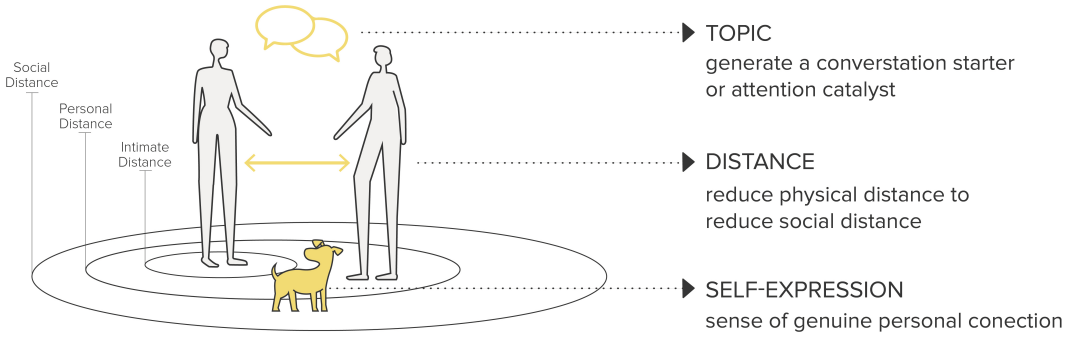


Figure 2.5: Key points

# Notes

1 The Hello Bench. Agency Network: Publicis. Published: 04/2017 `https://www.adsoftheworld.com/media/ambient/nescafe_the_hello_bench`

2 Credits: https://www.youtube.com/watch?v=Wf09HIBX8XU

3 Robotic Spider Dress Powered By Intel Smart Wearable Technology `https://iq.intel.com/smart-spider-dress-by-dutch-designer-anouk-wipprecht/`

4 Credits: https://iq.intel.com/smart-spider-dress-by-dutch-designer-anouk-wipprecht/

5 Social Mascot: Design of Social Things for Human Communication, Kohsuke Maekawa, 2015 ( 2015)

6 https://www.freehugscampaign.org/

7 Credits: https://hiveminer.com/

8 Free Hugs? Uhh Okay, Says Japan, Preston Phro, 2013 https://soranews24.com/2013/05/21/free-hugs-uhh-okay-says-japan/

9 https://www.gotinder.com/

10 https://www.happn.com/en/

# Chapter 3
# Wearable Aura

## 3.1 What is aura?

According to the definition, the aura is an emanation surrounding the body of a living creature (Dictionary 2014). Swami Panchadasi in his book "Human Aura", described the aura as an amount of energy-particles suspended as an oval shape radiation surrounding human body for about 1 meter of average (Panchadasi 2005). This description perfectly suits the area of interest of this research. Not to mention the intriguing correspondence between the believed dimension of the aura and the Personal Distance area, both seized about 1 meter around the user.

In the design of Wearable Aura, through the correlation with the aura, it is intended to emphasize the strong connection between the device and the user. The Wearable Aura is a tool to augment one's personality and to visually deliver some clues about the user's status. The Aura[1] is visualized as a personalized animation, projected onto the floor, into the user's Personal Distance space. It moves autonomously, but at the same time, it directly responds to the movements of the user, similarly as a dog walking with its owner. Moreover, the Aura is aware of the context and the environment. Indeed the animation behaves as a spiritual pet that can interact with the user and the surroundings. On top of that, Aura is able to engage with other people as they approach it close enough. Essentially, it takes the burden of making the first move, initiating an interaction with the people surrounding the user. The reactive feature of Wearable Aura not only makes the projection to be perceived as a living creature but also encourages passers-by to start an interplay with it.

## 3.2 Design process

The methodology followed to address the problem and to finally propose the Wearable Aura, was established through the utilization of some tools from design thinking process combined with research analysis, pursuing a human-centered approach. The design process consisted of six main steps, iterated multiple times to reach the final design. The new requirements and the key points, that came to light as the result of each iteration of the process, were implemented and tested in the consecutive design.

1. **Observation**: initial non-participant observation led to disclose the lack of communication in real-life scenarios, and to start investigating about the struggle of interacting with non familiar people.

2. **Literature review**: it was carried out a research about similar studies, relevant artifices and pertinent theories. As a result, 3 main requirements to achieve awkwardness-free communication were defined.

3. **Ideation**: ideation consisted in sketching and storyboarding to outline the concept and in creating personae and defining use case to refine and actualize it.

4. **Qualitative data**: interviews and focus groups were carried out in every stage of the ideation and prototyping, in order to understand people impressions and feelings, concerns and gain insight for improvement.

5. **Prototyping**: each concept further step was prototyped in order to be tested. Three main prototype were developed in the different stages of this research.

6. **Testing**: to evaluate the effectiveness of the design the prototypes were tested, multiple times. Since the device is aimed to stimulate interaction, it was adopted a in-the-wild approach to observe the spontaneous and impulsive reactions, rather than an in-lab experiment.

## 3.3 Ideation

### Key Requirements

Based on the research and literature review, the following 3 key requirements were established to found the design:

- **Distance**: the design aims to set a comfortable distance for interaction. Through manipulation of Personal Distance, the challenge is to shorten physical distance between people, to reduce social distance.
- **Topic**: the design needs to generate a conversation starter to facilitate the conversation. Moreover it have to be an attention catalyst in order to reduce the tension of the encounter. The more interesting and unexpected the design, the more it will spark curiosity, questions and subjects for starting a talk.
- **Self Expression**: the design is addressed to overcome anonymity and feel the support of a companion in public environments. Therefore it needs to help self-expression and promote self-identity. Moreover it has to have a personality and a character to avoid it to turn out to be barely a fancy ornament of the user.

### Concept Sketching

Bearing in mind the suggestion of making people's aura visible in order to enhance communication and social presence, the ideation process started considering the three key requirements mentioned above. Making the aura noticeable leads to having a tool for self-expression in public contexts, besides it gives a starting point for a conversation. In addition, the Aura needs to be visible by bare eyes, since the interaction shouldn't be limited to who owns a required device, and above all, the aim is to avoid to mediate the communication through a screen or an application.

To display the Aura, the first idea was to have a physical object floating around the user. But, due to the technical limitations and poor flexibility of a physical artifact, the idea shifted to a digital representation. Therefore, to visualize Aura it was adopted a projection.

Regarding the positioning of the projection, the choice falls on the floor, in the area surrounding the user. Since the Aura is linked with physical distance,

the floor is where it could be more evident. In addition, the lower part of the body is the one that people take less into account for communication, focusing most of their attention on the facial expression and hand gestures. Therefore, in this way Aura doesn't interfere with upper body expressions, but enhance the communication capability of the feet and of the spatial distance. Lastly, it was noticed that people tend to look down when they walk or stand in the streets. Hence, placing the Aura on the floor could attract their attention.

Several sketches were drawn to start visualizing the concept. Afterward, a focus group and informal interviews were carried out to understand the first impression of people. The feedback received were positive and full of suggestions: people liked the idea of having their own aura visible as a spiritual pet floating around their feet and interacting with others.

Figure 3.1: Concept Sketch: Aura around user's feet.

Figure 3.2: Concet Sketch: Envisioned interaction between two Auras.

## 3.4 Scenario Design

The ideation process led to an initial idea for promoting social interactions in real-life situations. In order to consolidate this concept, and to refine it according to the real needs and perceptions of the users, target personae, scenario and user case were created.

### Target Persona

Target user of Wearable Aura are among the young generation, that is the one experiencing more the flight from the face-to-face conversation because every day more absorbed by the Internet and by the mobile devices (Turkle 2012). Young adults are also the ones traveling the most, due to abroad-studies or job-relocation. Therefore often they end up to be in countries where they barely know the culture

and the language. Instead of relying on virtual connection and online friendships, Wearable Aura's goal is to help them to actively merge within the community and to interact with the people around.

Since this research focus is how to enhance interactions between people, and interactions occur when two or more people are involved, the target users are identified in the two different party:

- **The Wearer**: representing who utilizes the device in the first person, "wearing" the Aura. This person is looking for social interaction, and for companionship but feels clumsy and has some struggle to get to know people. The value proposition to this user is to have an external push to talk with others, to reduce the anxiety of the first move, and to have a topic to start a conversation.

- **The Player**: representing the person who sees Aura and plays with it. This user is open to interacting with other people and appreciates to have an entertaining moment. Moreover, this person is curious and spontaneous. The value proposition to this user is to have an entertaining and routine-breaking interaction with others, along with the chance to connect with new people.

The target user is described more in detail in Figure 3.3 for the Wearer, and in Figure 3.4 for the Player. Further, using scenario and user case, it is outlined how those users experience Wearable Aura, highlighting the advantages of the device for their communication and sociability.

## Scenario

Storyboard: experiencing loneliness in big cities is increasingly common. Especially when new there, just moved for working reason, alone, not knowing much about the foreigner culture or language.

This is the case with Maria. She moved recently from Spain to Tokyo. She finds everything new and exciting, but, even if this is the most crowded city she has ever been into, she feels incredibly lonely. She walks in the street, hoping to find somebody to finally have a chat, but she has no clue how to start a conversation.

She decides to activate Aura. A beautiful butterfly appears around her feet and starts interacting with her. She plays with it and feels less lonely. A smile is already on her face. A guy notices the butterfly and surprised looks at Maria.

Persona 1: The Wearer

**Name** Maria
**Age** 23
**Sex** Female
**Current city** Tokyo
**Hometown** Valencia
**Occupation** Student

### Personal Profile

Maria is an Architecture student. She is in her 3rd year of studies at university, and she got an opportunity of 3 months internship in a small studio in Tokyo. She has never been to Japan before, and she doesn't know much about language or culture. She used to hang out with lot of friends in her country, but she doesn't know anyone in Tokyo.

### Frustrations

- She tried matching Apps, but the people she met are weirdos
- When she goes outs she doesn't know where to start a conversation, in Spain she always have some mutual friend to star the conversation about
- She feels uncomfortable because of the language and strong cultural differences
- She feels lonely

### Goal

- Make good memories of her time in Tokyo
- Make some international friends
- Expand her professional network and knowledge

Figure 3.3: Persona 1: Maria

Persona 2: The Player

**Name** Misato
**Age** 26
**Sex** Female
**Current city** Tokyo
**Hometown** Yokohama
**Occupation** Financial Consultant

### Personal Profile

Misato is a career young woman. She is working in a eminent consulting firm in Tokyo. She speaks Japanese and english and has travelled a lot.
She likes to discover new restaurants and bars and to visit modern art museums. She is very serious at work but she likes to be a funny and easy going girl during the free time.

### Frustrations

- she is really busy with job, so it is hard to find a mutual spare time with her friends
- She doesn't like to smoke cigarette outside alone
- She get bored really easily, especially while waiting her friends

### Goal

- She wants to meet new people
- She would like to have a boyfriend
- She wants to succeed in her career

Figure 3.4: Persona 2: Misato

They exchange a smile and before he can ask anything her a little girl starts running after the animation. A girl just in front is observing the scene curiously, Maria push the butterfly to her. She reacts, and they start playing together with it, laughing and talking. This is how Maria got her first Japanese friend in Tokyo, Misato. Maria feels bonded in the environment. Aura has broken the invisible barrier that separates her from the others.

## Use Case

In order to understand deeper the requirements and outline how the technology will be used, user cases and user journeys were considered (see figure 3.5). Using this approach the goal is to capture the trigger event that starts the process and then describe each step of the process including inputs, outputs, errors, and exceptions. The scenario was broken up into three main steps:

1. The user plays alone with the Aura. The interaction is between the user and his/her spiritual pet. The animation needs to respond to user movements and to independently move as well. Moreover, it needs to be constantly aware of the environment, to detect the context shapes and if somebody is approaching.

2. User will have a chance for an interaction when somebody is enough close to him/her. The close-range distance will trigger the Aura to become also able to interact with other presence. This is a delicate phase and crucial point to determine if an interaction between the user and the other person will happen.

3. The user needs to be able to decide if starting an interaction through the butterfly with the other person. The user can enjoy the play if the other person agrees too. Or he can decline if not willing to.

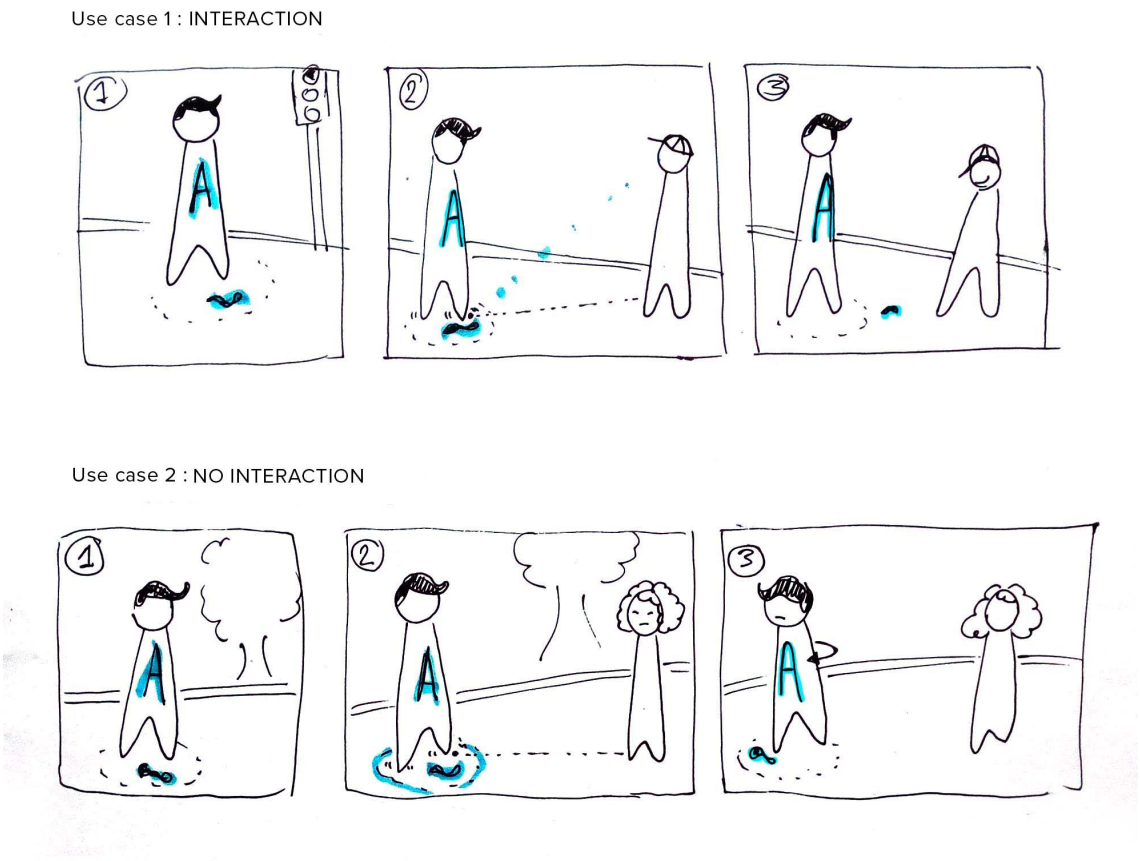


Figure 3.5: Use Cases

## Concept Summary

To summarize the initial concept of Wearable Aura, it is a wearable device that facilitates face-to-face interactions. Aura is presented as a projected animation on the floor into the user's Personal Distance area. Aura has three main features:

- Aura is responsive to the user movements. It is able to entertain the user when nobody is surrounding him or her.
- Aura is aware on the context and detects if somebody is around. In this case, Aura takes the burden of making the first move initiating an interaction with the person in the proximity, away from user's shoulders.
- Aura reacts simultaneously to both: the user and the person in his/her

proximity, behaving as an interactive tool for them to play together.

Aura will support and facilitate the encounter with the people in the proximity of the user because:

- It makes people move closer to each other, and play with their reciprocal spatial relationships.
- It provides an engagement between user and the nearby people, offering an entertaining diversion.
- It provides a topic to start a conversation.

The initial concept was prototyped and tested, revised and improved to reach the final design. All the process and the details of the prototyping procedures are described in the next section.

## 3.5 First Prototype

The impact of having a personal projection floating around the feet of the user was explored in a real-life context, namely a public place in the city. The goal of the first user test was to investigate whether the Wearable Aura increments the interaction between strangers, and, at the same time, to estimate the visual impact of Aura in public contexts. In this perspective, a low-resolution prototype was assembled and tested in a few public areas in Tokyo.

### Prototyping

The first prototype of Wearable Aura is made with low fidelity techniques and consist in a projected butterfly, sized about 15x15cm, placed on the floor into the users Personal Distance. The projection is generated by a Smart Beam Laser Projector(see figure 3.6), reproducing a GIF video-clip[2] representing a flying butterfly. The projector is wireless and enough small (5x5x5cm) to be hidden in the user sleeve, to not be clearly seen by the people around the user. The intent is to focus the attention only on the projection (referred to as Aura) and not on the physical device (Wearable Aura). Moreover, the lightweight of the projector facilitates the user to manually control it, in order to simulate the interactive feature of the animation (see figure 3.17).

As a result, even if the device is not visible, a spiritual pet, in the shape of a butterfly, floats around user's feet. In addition, the animation follows the users movements, responding to the feet motions, and slightly reacts to the people surrounding the user.


Figure 3.6: UO Smart Beam Laser Projector[3]

Figure 3.7: First prototype of Aura interaction

## Testing and Results

In order to test and examine the spontaneous reactions of people to Aura, it was not possible to inform in advance the participants about the experiment[4]. As interactions are intended reciprocal action between the user and other people. In particular, during this testing session, are assumed as interactions the following actions:

- glances to the user
- talking to the user
- moves in the direction of the user

The user test is concealed in the of Wizard of Oz approach, as a non-participant observation and qualitative research. The test was run during nighttime, around 9 pm. This choice was driven from the necessity of a not-too-bright environment to make the projection stand out. The facilitator wore the device, and she was briefly instructed on how to simulate the interactive feature of the Aura. Not many instructions were given, to encourage her to behave as instinctively as possible. In the first set up, the facilitator was asked to walk for about 10 minutes around the neighborhood[5].

The facilitator was followed discreetly by the experiment observers, recording the reactions of people passing by and the interactions that occurred between them and the facilitator. The experiment was repeated two times with two different facilitators. In the first test around 30 people were counted in the street. Half of them had an interaction with the Aura. Specifically, 8 were clearly attracted by the projection: they expressed curiosity starting a verbal interaction with the facilitator, wondering the source of the projection, and its function. Further, 3 people attempted a physical interaction with the Aura, trying to touch it and to displace it with their feet. The 90% of the people on the street glanced the Aura and the facilitator, immediately after. In the second test, about 18 people were in the street. 2 people expressed verbally interest about the Aura. The 80% of the people encountered glanced at the Aura and the facilitator.

The results were compared with the ones from the experience of walking the same path at the same time, but without the device, which led the facilitator to receive 2-3 glances and 0 interactions. The initial results, promising even if in a quiet context, suggested a greater impact of the design in an environment where people are more willing to meet and interact with each other. Consequently,

to test this assumption, a second test was run in Shibuya[6], one of the most crowded areas of Tokyo. This place is full of people, and usually, the most of them are in their leisure time, especially at the night time. The same setting, equipment, and facilitators were employed for the second test. The number of people encountered was greatly larger than the one in the first location. However, the Aura was noticed from only one-third of the people on the street, conversely than the previous test, during which almost everyone noticed it. Nevertheless, in this context Aura caused longer-lasting interactions. Several people started a proper conversation, (not only a few words or comment to the user but a clear back-and-forth) and someone openly played with the projection (see figure 3.8).

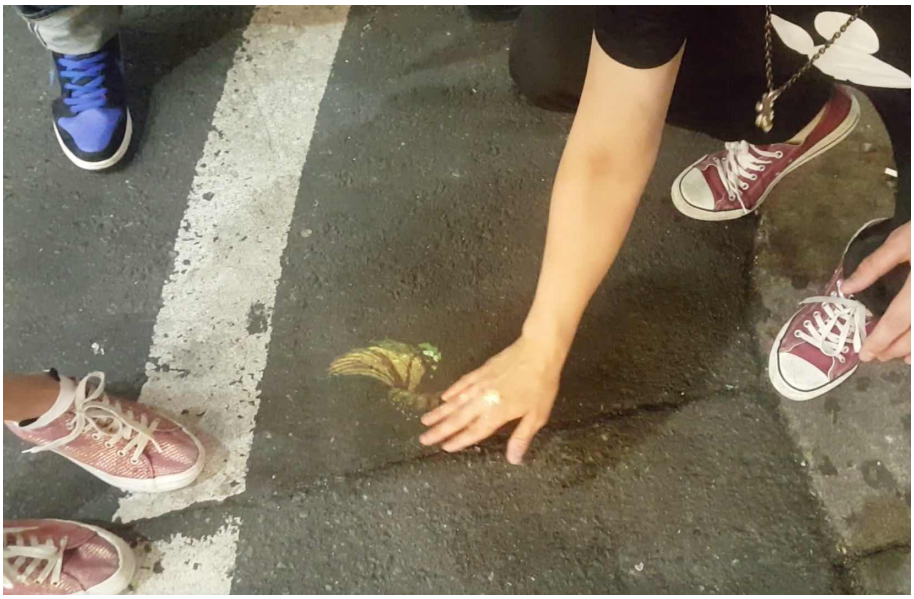

Figure 3.8: Interaction with the Aura during prototype test in Shibuya

## Revision for Second Prototype

The interactions occurred during the two tests encourage the hypothesis that Wearable Aura could be an ice-breaker and a facilitator for real-life encounters. Especially if people are willing to communicate, Aura could play the role of a good conversation trigger. Furthermore, the on-field observations pointed out three main points for Aura improvement:

- **Environment**: the difference of the results obtained in the two contrasting locations made it stand out how in a lively and crowded place where people are subjected by abundant stimuli, it is more difficult to catch people attention rather than in a quiet context. A similar pattern also happens between people walking and people standing still. The first ones are less likely to interact rather than the second ones. These results lead to a subsequent study of the utilization scenario, in order to identify the best situation to enhance Wearable Aura usability.

- **Direction**: after several observations, it was clear that the interaction happens only when people are facing each other. This leads to reconsider the shape of the area wherein the Aura is placed. It should not be circular, surrounding entirely the user, as it was initially designed. Actually, placing the Aura on the back side of the user could lead to misleading situations, completely out of the control of the user. Instead, according to the observations, the area of movement where interaction takes place is defined as the area covered by the eye-span[7] (see Figure3.9).

- **Interaction**: from the user test, it was clear how the interaction is the crucial part for the successful development of the Aura. Surely, the projection by itself generates curiosity. The people who actually attempted a connection with the facilitator, at first interacted with the animation. Moreover, it was noticed that people expected the animation to respond to their movements. Indeed, the interaction was really short because the reaction of the Aura was not interesting enough. Due to the repetition (only a few movements were possible), and the laking of real responsiveness, people didn't get hooked and lost the interest in the projection after less than a minute. Nevertheless, the gestured observed towards the animation, and the expected reactions, have been utilized for implementing the following prototype.

Wearable Aura concept and the results from the initial user study were presented as a poster (Zheng et al. 2017) at the international conference on ubiquitous computing UbiComp'17[8]. The research was commented as a very interesting possibility to encourage human interactions. Additionally, the great interest from committee chairs and conference participants made the team commit for participating in the upcoming international events.

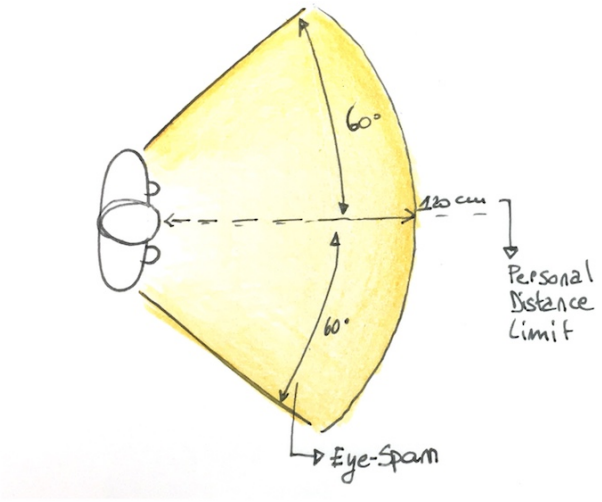


Figure 3.9: Revision of the Aura area

## 3.6 Second Prototype

The second version of Wearable Aura is prototyped taking in account the results obtained in the first user test, described above. In order to respond with a compelling solution to the identified needs and requirements, the main focus of the second prototype is to enhance the interactive feature of the Aura. Therefore, the interaction was analyzed and re-designed. Finally, it was implemented in a tangible prototype and tested.

### Revising Interaction

As required by the first user test results, the animation not only has to respond to the user but mostly it needs to be reactive to the people nearby. In this mindset, it is aimed to generate around the user a personal and portable Interactivated Space (Bongers 2002). An Interactivated Space is defined as an environment which interacts with the people that are inside it, sensing human activity and responding through a variety of signals (visual, auditory, haptic, etc.). The result is a combination of real space and action, with virtual responses displayed.

Regarding Aura, the Space around the user responds with visual signals, precisely, with the projected animation. Since this study is rooted in Proxemics (see Chapter 2), the interactivity trigger is given by the distance between the user and

the close by the person.

To understand clearly every moment of the interaction, the sequence is divided up into four consequent phases. Each one corresponds to one of the four main distances identified to set the change of the animation. Indeed, to each distance coincides a different status and purpose of the animation. According to the phase, the Aura is modified in the shape and in the actions through a combination of autonomous behavior and data controlled movements. The 4 main phases are the following:

1. Distance: more than 200cm from the user.
   Status: nobody is considered enough close to the user to start an interaction.
   Purpose: keep company and entertain the user.
   Behavior: the Aura is floating randomly closer to the user's feet, responding to the user's movements.

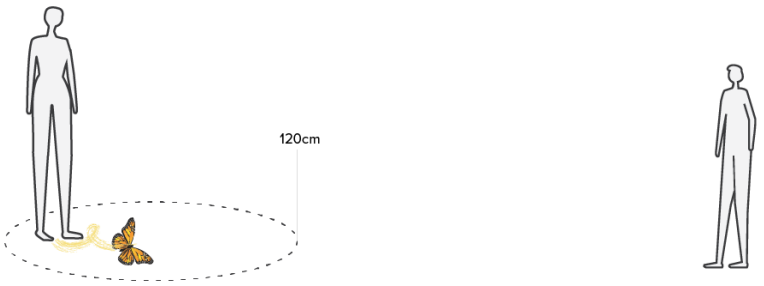


Figure 3.10: Interaction: phase 1

2. Distance: between 200cm and 120cm[9].
   Status: approaching Personal Distance.
   Purpose: grab the approaching person attention and attract him/her closer to initiate and interaction.
   Behavior: the Aura flies closer to the approaching person, moving back and forward to catch the eye.

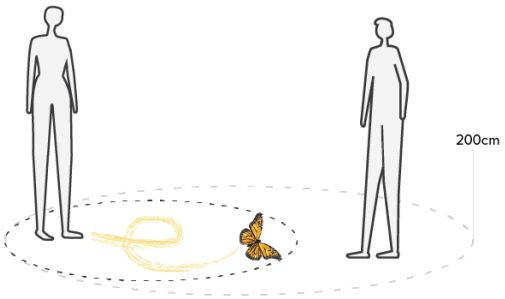


Figure 3.11: Interaction: phase 2

3. Distance: between 120cm and 50cm[10]
   Status: within Personal Distance.
   Purpose: generate an interplay with the approaching person.
   Behavior: the Aura follows the approaching person, responding to different movements. The color, shape and motion change accordingly.

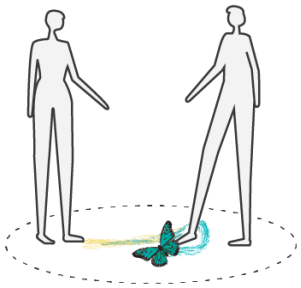

Figure 3.12: Interaction: phase 3

4. Distance: less the 50cm[11]
   Status: within Intimate Distance.
   Purpose: keep the approaching person away from the Intimate Distance, preventing him/her to come too close, occupying an uncomfortable space.
   Behavior: the Aura becomes red, as a sign of alert, and distances itself from this area, flying away in other directions.

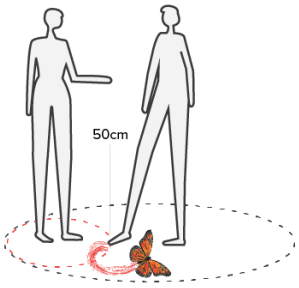


Figure 3.13: Interaction: phase 4

## Prototyping

In the updated prototype, the animation is dynamically changing, according to the position of the people surrounding the user, with the objective of welcoming them closer and enhancing the reciprocal interaction. To measure the distance between the user and others, it is used as an ultrasonic distance sensor, placed on a shoe.

Confident that technology needs to be naturally integrated into people life, the final shape of Wearable Aura is envisioned as a pair of shoes. The choice falls on shoes because feet are known as the part of the body where people often leak important nonverbal clues. Differently, from facial expressions and upper body positioning, that are cared more attentively, feet tend to slip away from people control. Moreover, spatial disposition and movements of feet are non-verbal indicators of liking. In addition, since the Aura is designed to be placed on the floor, feet are the most convenient place for placing the device.

Regarding the animation, it is generated by a small projector, according to the initial design, also embed into the shoe. However, due to technical issues (not taken into account at this point in the research, yet), this was not possible. Therefore the projector is fixed into a pouch bag with a hole for the projector lens, that comes in a set with the above-mentioned shoes. In this way, the Wearable Aura is already a complete and automated wearable device, so that the user is not distracted by manually maneuvering it. The hope is to increase the spontaneity and quality of the interaction during the testing.

The sensor and the projector are both connected via Wi-Fi to a computer, where the Aura Translator System converts the distance detected into the animation moves. The software is prototyped using Arduino[12] and Processing[13]. The

first receives the data, processes it and sends it to the second one, that uses the information to make the behavior of the animation change accordingly (see figure 3.15).

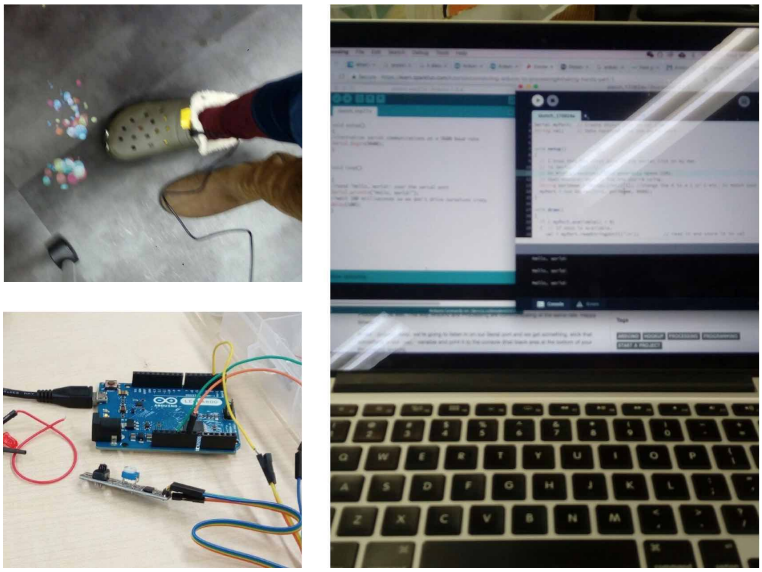

Figure 3.14: Second Prototype building

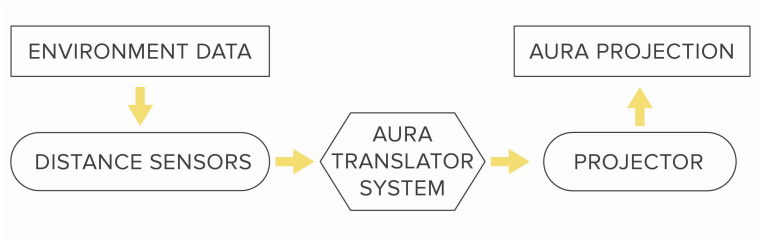


Figure 3.15: Scheme of Wearable Aura System

Aware of the importance of user self-expression to generate genuine interactions, for the second version of the Wearable Aura prototype, were designed multiple animations. Giving the user the possibility to choose the one they prefer, the goal is to create a bond between the user and the Aura, making it feel more

personal. Besides, another goal was to investigate if different figures generated dissimilar reactions. The Auras designed were three: a butterfly, a jellyfish, and colorful bubbles.

## Testing and Results

The prototype was exhibited at KMD Forum[14]. The location and the environment were different from the previous test. The choice fell on a public event because it is an occasion where people walk around, they are interested in talking with others and moreover, in this specific case, they have the curiosity to try new technologies.

During the exhibition, 5 volunteers tried to wear the Aura. All of them were female, due to the feminine design of the device, and of different nationalities. After a brief introduction, one facilitator at a time was asked to stand or walk around according to her pace and preferences. Firstly it was observed how people instinctively react to the Aura and whether it lead to an interplay with the user. Later, if they were willing to, they were asked to give their feedback and impressions through an informal interview. Around 20 visitors had a spontaneous interaction with the projection and with the Aura-wearer.

The pattern of the interaction turned out to be responding to the design: at first, the projection on the floor provoked peoples interest, and make them curious. As they discovered that the animation was responding to their steps, they challenged it trying a different position. The facilitator as well, moving her feet, participated in the interplay with the animation.

In comparison with the previous prototype, the improved responsive feature extended the time people spent playing with the projection. As a result of the little action, they felt comfortable to start a conversation, not to mention the countless chances of talking coming up during the interplay itself. However, the complexity of the design made it in a degree confusing to someone to understand why the animation kept changing shape. Also, the still limited responsiveness of the device disoriented few visitors. On the other hand, the projection led to playful interactions, generated interest and stimulated further questions.


Figure 3.16: Envisioned interaction of two Auras

## Interviews: Understanding the User

During the user test, the focus was not only on the people approaching the Aura, but it was also examined the user experience of the facilitators. Therefore right after the trial with Aura, lasted approximately 30 min, each of the five volunteers was interviewed. Generally, Aura was perceived as a fun way to be entertained alone and with others too, replacing annoying small talks.

Two of the facilitators confessed that they felt quite embarrassed and awkward having a projection around them at the beginning, but after the first 5-10 minutes they actually started to perceive the playfulness of the device and enjoyed the experience, feeling also more confident and less shy.

They liked the feature of the Aura of taking the burden of the first move and giving them a conversation topic. Even from the more extrovert's point of view, Aura helps to enhance the interaction, generating a unique experience. However, they had some concerns about safety and expressed the desire to avoid the animation to move towards some specific people. Lastly, they truly enjoyed the idea of selecting their own avatar, and actually, they expressed the desire to try all of them and to design their own.


Figure 3.17: Faciliatators during Aura testing

### Analysis ad Further Requirements

The gestures observed were considered crucial for the design of the future development of Wearable Aura. In particular, the Aura generated a great interest in kids, aged from 3 to 6 years old. Even if the design is not conceived to entertain children, it was extremely valuable to observe the little one's reaction. Kids behaved spontaneously and without bias, and played openly with the projection, careless of the purpose of it.

The main movements and gestures recorded were:

- kicking the animation
- stepping and jumping over it
- following it
- expect to be followed by it when running away
- surprise when it changed shape or dimensions

Once more, the participants were not able to identify where the animation was projected from. This aspect increased the curiosity and the illusion of a spiritual companion-pet owned by the user. Therefore, the product design of the device has to take into account this feature for future developments.

Finally, as a consequence of the feedback from the facilitators, it was clear the necessity of a solution to guarantee a safe use of the Aura and to avoid uncomfortable situations. Moreover, the personalization of the Aura itself emerged as a crucial point. Therefore, the future steps of this research look into making the animation more personal and representative of the user.

## 3.7 Refined Design Summary

Although the first and second prototypes had limitations and needed improvement, the basic function of helping not-familiar people to start a communication was validated. The feedback from the first prototype helped to refine the use scenario, to achieve some technical improvements but mostly to focus the attention on the interaction. In the second prototype was improved the interaction and the quality of the interplay, moreover was obtained an insight on gestures and on users main concerns.

All the feedback were collected to outline the final design of Wearable Aura. To sum up, in its final version Aura presents the following characteristics:

- responsive to the distance between people
- interactive (see above Revised Interaction)
- personalized by each user, according to their preferences
- easy and quick to switch on and off (double tap of the foot on the floor) to guarantee safety
- placed in the eye-span area around the user
- all the technology embedded in a single device, like a pair of shoes

A third prototype was built, to show how we envisioned the technology to be embedded in a single device (see figure 3.18). Even if this prototype was functioning, due to the poor quality of the image projected and its brittleness it was only used for demonstration purposes and not for user testing. Therefore a concept video was shot to illustrate the revised idea and the functioning of the device [15].

The research was presented at the ACM Conference on Human Factors in Computing Systems, CHI'18, in Montreal, and it was awarded as CHI'18 Student Design Competition 1st winner.

Figure 3.18: Prototype evolution: all the technology embed in a single device

# Notes

1 Aura refers to the projection, while Wearable Aura refers to the device

2 GIF source: https://giphy.com/

3 http://www.uobeam.com/

4 The in-the-wild methodology adopted in user testing is discussed more in detail in Chapter 4.1

5 The neighborhood referred to is the area around Keio University campus in Hiyoshi, Yokohama, Japan. The area is residential, populated mostly by students and young workers. Many restaurants and the presence of the train station give to the place a quiet but bustling audience.

6 The test was run in the surroundings of Scramble Crossing, in Shibuya, Tokyo, Japan.

7 The visual field of the human eye-span is approximately 120 degrees of arc.

8 Published in UbiComp'17 Proceedings of the 2017 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2017 ACM International Symposium on Wearable Computers. Pages 141-144. Maui, Hawaii September 11-15, 2017

9 120 cm is the external limit of Personal Distance (see Chapter 2.1)

10 50 cm is the internal limit of Personal Distance (see Chapter 2.1)

11 50 cm is the external limit of Intimate Distance (see Chapter 2.1)

12 https://www.arduino.cc/

13 https://processing.org/

14 Keio University Graduate School of Media Design open campus, held on 3-4 November 2017 At Keio University Hiyoshi Campus, in Yokohama, Japan.
http://forum2.kmd.keio.ac.jp/

15 Concept video of Wearable Aura:
`https://www.youtube.com/watch?v=nIZf1ttlIt4&t=30s`

# Chapter 4
# Evaluation

In the previous chapters is described the concept of Wearable Aura and the process followed to design it. It was employed an iterative process that implied a sequence of prototyping and testing, from the initial stage of the ideation to the final prototype. Consequently, during the previous section about the concept building, part of the design was already evaluated. Through the initial tests, indeed, it emerged positively that Aura is capable of raising the interest of people and encourages interpersonal interactions.

However, a further evaluation is needed to assess whether the finalized features of the design favorite the start of an interaction between strangers. The intent is to test the effectiveness of the Wearable Aura as an ice-breaker, in particular, the aim is to assess how the distance and the placement of the projection influence the outcome, to define the appropriate position and behavior. Moreover, it is evaluated the revised interaction to determine its effectiveness. Lastly, the test is aimed at collecting first-hand users' feedbacks, to understand the general perception of Aura.

## 4.1 Methodology

To evaluate the design, the prototype was tested in situ, following the methodology in-the-wild. Prototyping in-the-wild refers to a research pushed out of the lab into the in the context where the application is envisioned to be placed. The purpose of this methodology is to overcome traditional evaluation methods in controlled laboratory settings since they often don't take into account the complexities of the environment in which the applications will perform (Rogers 2011).

This approach is not new, and the Ubicomp community is increasingly shifting from the traditional in-lab testing to the in-the-wild approach, confirming how the data obtained this way are more rich and varied. Indeed, studying how people

behave, interact, and use the new technologies, directly in their everyday context, gives quite different insights compared to the bare data obtained in the lab (Rogers et al. 2007).

In-the-wild testing generally consists in introducing a new design to the users and letting them try it out for an extent of time. However, this research follows the original approach that E. Gröonvall et al. adopted to evaluate the unexpected experience generated by their design (Grönvall et al. 2014). In short, Grönvall et al. applied the methodology without formerly instructing the users on the device. Before or during the experiment, not the purpose or functionalities of the Wearable Aura were revealed, as well as it was not declared the ongoing test. Only after the interaction with the device, if willing to, people were approached and interviewed, in order to get further insights, or to answer their inquiries.

The impossibility of prior informing the participants of the experiments involved few limitations. However, in order to understand the effectiveness of the Wearable Aura to break-the-ice and facilitate the interaction between strangers, it was fundamental to evaluate the reaction to the device as spontaneously as possible.

## 4.2 Experiment Settings

The scenario for using the Wearable Aura is a public context, in which the user is not particularity familiar with anyone, but wants to have an interaction with others. Therefore the user test was conducted in a public space within Tokyo, where people use to assemble. The location is Hachikō-Mae Square, Shibuya, known as one of the most famous meeting spot in the city. Hence, it is likely to find there a multitude of people gathering. Anyhow, it was chosen a weekly day to not meet too much crowd. The time was around 7:30 pm. At this time in the evening, even if the streets light are switched on, the environment is enough dark to make the projection stand out. Moreover, people start leaving offices and going out.

The objective of the experiment is to evaluate the effectiveness of the Aura in people interactions. Therefore the device itself is not considered to be relevant to the experiment. Rather, the focus is on the animation and its behavior. Accordingly, the prototype adopted for the user testing consisted of the Smart Beam Laser Projector used in the same manner as it was employed in the first prototype (see Chapter 3.5). The projector, hidden into the facilitator sleeve, was

maneuvered by hand to simulate the movements of the Aura and to be positioned at different distances from the user. The animation is transmitted by Wi-Fi to the projector and controlled by an iPhone. Therefore the facilitator could simulate different effects and manipulate the reactions of the Aura.

To execute the user test the cooperation of two facilitators together was required. One facilitator, the user of the Aura, was holding the projector. The role consisted of walking around with the animation floating around the feet, trying to stimulate the interaction with the passers-by. The second facilitator had the task to follow from a limited distance, manipulating the Aura effects and reactions. Moreover, this facilitator videotaped the user and the surrounding environment too. It was crucial to not reveal that the two facilitators know each other, to not make people suspicious. For this reason, and to be as unnoticed as possible, even if it was planned to record using a GoPro, the video was executed with an iPhone. The video-clips collected were reviewed at a later time, for further analysis. The facilitators were one male and one female. They interchanged roles during the experiment, without any remarkable difference in the outcome.

## 4.3 Test and Results

The test aimed to evaluate two main aspects of Wearable Aura: the opportune distance where to place the projection around the user, and the Aura effectiveness of encouraging an interplay. The two aspects were examined simultaneously, during the same user test session, adjusting the investigation according to the response of every single user. Below, it is described in detail the process and the findings.

### Assessing the Appropriate Distance

Part of the evaluation focused on assessing the optimal positioning of the animation in the area around the user. From the previous user study, it was determined how Aura should be placed on the frontal side of the user, in particular into the user's eye-span area. In this test, instead, it was evaluated how the distance between the projection and the user influences its effectiveness. It was observed that people do not approach the Aura if it is placed into the user's Intimate Distance (between 0 to 50cm from the user). Actually, most of the people considered Aura unapproachable till 1m distance from the user, except for situations in which they

are forced to be one next to the other, for example at the traffic light. In this case, is accepted, as long as it stays is outside the Intimate Distance zone.

Moreover, it was observed that the first reaction of people, right after noticing the animation, was to look up and turn the head around, trying to find the source of the projected image. However, if the animation was placed too close to the user, this didn't happen since the passers-by did not want to act improperly observing further the private space of the user. Therefore, the result obtained in this case was the opposite of what expected.

On the other hand, if the animation is too far from the user (more than 1m), it was difficult for the people nearby to understand that the Aura was related to the facilitator. Therefore, any interaction happening in this scenario was considered pointless to the scope of this research. To overcome this issue, the facilitator moved the butterfly closer and further from her/him. Through the back-and-forth movement, it stood out that the projection was related to the facilitator, and, at the same time, the dynamism of the motion helped to draw people's attention. As a proof of it, it was noticed how the back-and-forth movement attracted the eyes of the people around, and right after they looked at the facilitator, establishing a eye contact, often together with a reciprocal smile, already identified as an interaction. Only later, and not always, they looked around trying to discover the source of the projection. This result highlights, even more, the relevance and the need for a clear bond between the Aura and its user.

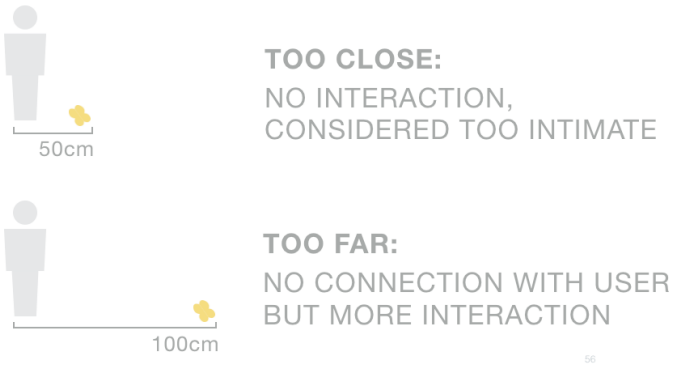


Figure 4.1: Analysis of the distance between the user and the Aura

## Effectiveness of Interaction

Aura is designed to respond to both: the user's movements and the surrounding people's motion too. Aura encourages nearby people to play with the projection.

In the previous user test, it was already confirmed that the Aura is capable of stimulating interest into the people surrounding the user. In the second testing, it was assessed that the interactive movement of Aura generates a playful environment and people enjoy spending some time playing with it. However, the context was limited at an exhibition event, and even if the results were positive and the engagement spontaneous, the focus was more on testing the interaction itself, rather than the ability of the Aura to break-the-ice between strangers. Nevertheless, as a result, the design and behavior of the animation were considered crucial in determining whether the approaching person would play with it or not.

In the former section, it is analyzed how distance matters in the interaction between people. In the second part of the experiment instead, it was tested whether a change in the animation provokes a more intense reaction.

As already mentioned, the projection itself, because of its novelty in the city environment, generated surprise and provoked an initial interest in the people around the user. Moreover, during the evaluation, it was proved that the unexpected reaction of the Aura to the people around it, increased their enthusiasm and led to an interaction. The main reactions we noticed were: laugh, step back, surprised expressions, move closer, and try other movements to challenge the animation. Also, especially when not alone, people tend to question each other about the projection or to make a loud comment. In this case, it was smooth for the facilitator to answer or enter the conversation, even without knowing well the language. Not all the people encountered played with the projection, but most of the people who noticed it got curious and stopped by.

The simple feature of making the butterfly change direction, orientating it towards the people around, increased their interest. Moreover, as people started playing, most likely an interaction happened. Aura was the lure for a possible conversation.

## Multiple Players

During the experiment, unexpected and unforeseen aspects of Wearable Aura came up. It was noticed that the interplay with Aura tends to happen more often, and there is more chance to start a proper conversation if the people approaching it

are more than one. Indeed, on one hand, when people are two or in a small group, they show less shyness. Since they can rely on each other's support, they also are less suspicious or afraid to interact. On the other hand, they spontaneously communicate with each other, commenting on the projection. The most of the comments are exclamations or open questions, so the Aura user has a hook to smoothly enter in the conversation. As a result, it is evident the need for a further study of the interaction between multiple players. The last Chapter, as part of the future works of this research, cover this topic.

Furthermore, the testing session revealed a peripheral effect of Wearable Aura. In other words, when the user undertakes an interplay with anybody, often also the people in the surrounding will notice it. Indeed, it was observed how the not-active people around had an interest in the circumstance. This clue is also used for future development of Aura, supposing a larger-range effectiveness, capable of bringing even more people together.

Figure 4.2: Interaction between strangers and the facilitator during user test in Hachikō-Mae Square

# Chapter 5
# Conclusion

An increasing number of on-line applications aims to connect people and build new relationships between them. Although this may help individuals to meet, generally it makes even more difficult for people to interact with each other in real life, since they prefer to rely on a screen instead of directly facing who is around them.

In this context, Wearable Aura looks at the challenge of connecting people off-line, without the intermediation of a screen or any other device. The objective of this research, indeed, is to take advantage of emerging technologies in order to stimulate genuine and spontaneous face-to-face interactions. To achieve this goal is proposed Wearable Aura, a wearable device that generates a projection onto the floor, within users' Personal Distance zone. This animation floats around the user's feet and responds to user's movements. If nobody is near the user, the animation behaves as a spiritual pet, entertaining the owner and making her or him feel less lonely. Instead, if Aura detects somebody in the proximity of the user, the projection will take the burden of the first moves and start an interaction towards this person.

The concept of Wearable Aura was evaluated several times and in different contexts. The goal of the evaluations was to assess if the capability of the device to break-the-ice with strangers and whether it stimulates a verbal or non-verbal interaction. Overall, Aura has been proven to be a useful tool to encourage communication. However, the limitations of the current design along with the insight from the final evaluation leave room for future improvement and development. Below are described in details the current limitations and the ambitions for future improvements.

## 5.1 Limitations and Future Works

From the results and the analysis of the last evaluation came to light more insight about Wearable Aura features. In addition, the limitations of the current design allow for further improvement. The main areas of interest for further development of this research are explained in detail below. Those cover: the diversification of the utilization context; the interaction with more than two people; multiple Auras interplays. Moreover, there is an ambition of reflecting the user's emotions into the Aura. We believe that this feature will bond the animation with the user and make Aura an actual communication tool.

### Diversifying the Context

Wearable Aura is a tool to stimulate and enhance communication between strangers in real-life scenarios. Heretofore it was proposed and tested in two different environments: in an urban public space, namely a square and street in Tokyo, and in a public exhibition held at the Keio University campus. However, Aura is believed to be valuable and useful in diverse contexts. The concept, indeed, is suitable to be deployed in any social situation, for example, in a conference, at a party, at a school event, etc. An ambition of this research is then to test Wearable Aura in more scenarios. In particular, it is expected a positive feedback in situations in which people actively look for interaction with others, such as gatherings. However, the content of the animation will need to be designed and programmed according to the situation and the context.

### The More the Merrier

As previously mentioned, during the user test, the possibility of more than one person interplaying with the Aura come up (see Chapter 4.3). This aspect has to be kept into account in future developments. Indeed, it is already proven that is more likely the rise of a conversation if more than two people are involved. A multiple-player function will facilitate the interaction, increasing the chances of communication.

In this context, it is also important to mention the ambition to design the interaction of multiple Auras simultaneously. This would allow not only one user with Wearable Aura to interact with the nearby people but also two Aura users to play together. In other words, the next step of this research is to understand how

Auras will react to each other in the moment of the encounter. In the initial part of this research, a possible interaction was envisioned (see Chapter 3.3), however, the feature was not developed further since it was more important to first test the validity of the design standing alone. As a result of the assessment of the Wearable Aura as an ice-breaker, the challenge of making Auras communicate and interact becomes the next priority.

### Making Aura Emotion Aware

Lastly, there is an ambition to reflect or synchronize the user's feelings through Aura, modifying the behavior, the interactions and the appearance of the animation according to the emotional state of the user.

The aim of this feature is to build a stronger connection between the user and the Aura. Reflecting the user's emotions, Aura will behave as a proper extension of the user and an actual communication tool. For example, given Aura as a butterfly, it will fly quietly if the person is calm, it will become brighter and fly in a lively way if the user is excited, or it will turn dark and almost static if the person is in a bad mood.

Secondly, another limitation so far is that in every culture the Personal Distance has different sizes and relevance. Moreover, every person has a slightly different perception of the space too. Indeed, the dimensions indicated by proxemics are approximate, since each individual has its own needs. If the Aura is aware of the emotional status of the user, it will be able to set a comfortable space for the user. In addition, also the movements and the interactions of the animation could be calibrated accordingly. For instance, Aura will be more active if the user is energetic or it will be quieter if the user is tired.

This feature will give the animation an alive feeling and consequently, it will be more interesting for others to play with it. To sum up, connecting the Aura with the user's emotions will empower the communication and encourage even more interpersonal interactions.

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# Appendix

## A Prototype Processing sketch

```
//   AURA by Atsuro Ueki and Laura Lugaresi, 2017
//
//   Adaptation of WANDERING PARICLES
//   from OpenProcessing.org by Andr Casey
//   into Processing using p5js.
//   https://www.openprocessing.org/sketch/446535

// ******************************************


// ---------------------------------------
// Serial Configuration
// ---------------------------------------
import processing.serial.*;
Serial serial;

// ---------------------------------------
// Configuration
// ---------------------------------------

// GLOBALS
int MAX_PARTICLES = 170;
color[] COLORS0 = { #31CFAD, #ADDF8C, #3438BA, #520042, #DAF7A6 }; //#FF6500 #FF0063
color[] COLORS1 = { #69D2E7, #A7DBD8, #E0E4CC, #F38630, #FA6900, #FF4E50, #F9D423 };
color[] COLORS2 = { #581845, #900C3F, #C70039, #C70039, #FFC300, #DAF7A6 };
```

```
//ARRAYS
ArrayList <Particle> particles = new ArrayList<Particle>();
ArrayList <Particle> pool = new ArrayList<Particle>();

//VARIABLES
float wander1 = 0.5;
float wander2 = 2.0;
float drag1 = .9;
float drag2 = .99;
int force1 = 2;
int force2 = 8;
float theta1 = -0.5;
float theta2 = 0.5;
int size1 = 5; // minimum size
int size2 = 120; // maximum size
float sizeScalar = 0.97;
float swingTheta = 0.0;
float swingSpeed = 0.03;
float circulateTheta = 0.0;
float circulateSpeed = 0.05;
int circulateRadius = 60;
int maxBubbles = 20;
int minBubbles = 5;
PVector orig, center, current;
float val;
float data;
color[] COLORS;
String myString=null;
int nl = 10;


// ----------------------------------------
// Particle Class
// ----------------------------------------

class Particle {
  boolean alive;
  int size;
  float wander, theta, drag;
```

```
  PVector location, velocity;
  color col;

  Particle(PVector pos, int size) {
    CreateParticle(pos, size);
  }
  Particle(PVector pos) {
    CreateParticle(pos, 10);
  }
  void CreateParticle(PVector pos, int size) {
    this.alive = true;
    this.size = size;
    this.wander = 0.15;
    this.theta = random( TWO_PI );
    this.drag = 0.92;
    this.col = #ffffff;
    this.location = new PVector(pos.y, pos.x);
    this.velocity = new PVector(0.0, 0.0);
  }
  void move() {
    this.location.add(this.velocity);
    this.velocity.mult(this.drag);
    this.theta += random( theta1, theta2 ) * this.wander;
    this.velocity.y += sin( this.theta ) * 0.1;
    this.velocity.x += cos( this.theta ) * 0.1;
    this.size *= sizeScalar;
    this.alive = this.size > 0.5;
  }
  void show() {
    //arc( this.location.x, this.location.y, this.size, this.size, 0, TWO_PI );
    fill( this.col );
    noStroke();
    ellipse(this.location.y, this.location.x, this.size, this.size);
  }
}

void spawn(PVector pos) {
  Particle particle;
  float theta, force;
```

```
  if ( particles.size() >= MAX_PARTICLES ) {
    pool.add( particles.get(0));
    particles.remove(0);
  }
  particle = new Particle(pos, floor(random(size1, size2)));
  particle.wander = random( wander1, wander2 );
  particle.col = COLORS[floor(random(COLORS.length))];
  particle.drag = random( drag1, drag2 );
  theta = random( TWO_PI );
  force = random( force1, force2 );
  particle.velocity.x = sin( theta ) * force;
  particle.velocity.y = cos( theta ) * force;
  particles.add( particle );
}

void update() {
  int i;
  Particle particle;
  for ( i = particles.size() - 1; i >= 0; i-- ) {
    particle = particles.get(i);
    if ( particle.alive ) {
      particle.move();
    } else {
      pool.add( particles.get(i) );
      particles.remove(i);
    }
  }
}


void moved() {
  int max, i;
  setParameters();
  circulate();
  max = floor(random( minBubbles, maxBubbles ));
  for ( i = 0; i < max; i++ ) {
    spawn( current );
  }
}
```

```
void setParameters() {
  //data = mouseY/2;   // mouse testing
  center.y = orig.y + sin(swingTheta)*200 -200;  // movement on Y axis


// --------------------------------
// ENGAGED - distance < 60cm
// --------------------------------

  if (data < 100) {       //60
    MAX_PARTICLES = 300;
    COLORS= COLORS2;
    swingSpeed = 0.5;
    circulateSpeed = 0.1;
    circulateRadius = 100;
    maxBubbles = 40;
    size1 = 5;
    size2 = 120;

    center.x = map(data, 0, 100, width+200, 0);   //50, 150, 200, orig.y);
  }


// --------------------------------
// APPROACING PERSON - distance < 150cm & distance > 60
// --------------------------------

  else if (data < 200) {
    MAX_PARTICLES = 100;
    swingSpeed = 2;
    circulateSpeed = 0.2;
    COLORS=COLORS1;
    circulateRadius = 60;
    maxBubbles = 30;
    size1 = 5;
    size2 = 100;
    center.x = random(100, 300); // 200
  }
```

```
// --------------------------------
// NO INTERACTION - distance  150cm
// bluish, small, slow
// --------------------------------

  else {
    MAX_PARTICLES = 100;
    swingSpeed = 1;
    circulateSpeed = 2;
    COLORS=COLORS0;
    circulateRadius = 5;
    size1 = 5;
    size2 = 60;
    maxBubbles = 10;
    center.x = width -150;
  }
  swingTheta += random(swingSpeed);
}

void circulate() {
  current.x = center.x + sin(circulateTheta)*circulateRadius;
  current.y = center.y + cos(circulateTheta)*circulateRadius;
  circulateTheta += random(circulateSpeed);
}

void updateSerial() {

// if serial port has information do something

    while (serial.available() >0) {
    myString = serial.readStringUntil(nl);
    if ( myString != null) {

// takes data to serial and turn it into numbers

      data = float(myString);
      println( "data", data);
```

```
      moved();
    }
  }
}

// ----------------------------------------
// Runtime
// ----------------------------------------

void setup() {
  //size(800, 800);
  fullScreen();
  serial = new Serial(this, Serial.list()[1], 9600);
  orig = new PVector(400, 600);
  center = new PVector(400, 600);
  current = new PVector(400, 600);
  noCursor();
}

void draw() {
  //moved();         //to test with mouse
  updateSerial();
  update();
  background(0);
  blendMode(ADD);
  for (int i = particles.size() - 1; i >= 0; i--) {
    particles.get(i).show();
  }
}

void mouseMoved() {
 moved();
 }
```