SOCIAL SENSORS AND POST-PANDEMIC COMMUNITIES. INTRODUCING PROXIMITY SENSING AND PERSONAL DATA MANAGEMENT CHALLENGES IN DESIGN EDUCATION

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Abstract

In the context of the Covid-19 pandemic, social distancing initiatives and the limitation of access to public places have had a significant effect on social well-being and have resulted in an impoverishment of the so-called "social capital." From a technological standpoint, the pandemic has also lead to the development of several contact tracing innovations: existing systems and new contact tracing protocols have been used globally to detect and notify possible contacts with infected people.
In this contribution, we present the case of the university workshop "Social Sensors. Design for post-pandemic communities" developed as part of the curriculum of the Communication Design BSc of Politecnico di Milano, designed to introduce issues related to the use of mobile devices as sensors, both in terms of the new interaction possibilities and in terms of challenges related to personal data, privacy and tracking risks.
The workshop results propose design strategies for digital applications that use proximity as the primary interaction modality, highlighting the range of unexplored potential allowed by the development of proximity detection technologies as well as the potential risks related to their use in contexts of reduced transparency or poorly designed data policies.

Keywords: proximity detection, personal data management, communication design, interaction design

1 INTRODUCTION

In the context of the Covid-19 pandemic, social contacts, proximity relationships, and physical relationships have all been subject to significant restrictions. The scientific, policy, and design communities have implemented several initiatives to limit face-to-face contacts, avoid gatherings, and control physical relationships to slow the spread of the virus [1].

These restrictions have had a significant effect on the social well-being of the affected populations in terms of individuals' access to social support, emotional distress, and lack of social interaction, and this dramatic reduction in social support, community involvement, and the role of personal and collective responsibility in community life is well-documented among individuals and communities [2]–[4].

The health impacts of the epidemic, in other words, are not limited to individuals alone: they affect families, communities, and societies. Social distancing initiatives and the limitation of access to public places have resulted in an impoverishment of the so-called "social capital." The bonds between people that make a community, the relationships of reciprocity, solidarity, and friendship between individuals that keep local societies alive have been put under significant stress and still experience the long-term effects of the prolonged constraints that have been imposed during the lockdowns [5].

1.1 Technological context

On the other hand, from a technological standpoint, those same limitations and the risk associated with proximity relationships have led to the development of new technologies and to the application of already available technologies to support everyday activities during the epidemic crisis. Among the many experimentations, sensors and smartphones have played a significant role in providing a new kind of "social sensor," designed to detect proximity relations between people and providing a framework for exposure notification technologies.

This "new ability" of smartphones to act as proximity sensors in the social space is not unexpected and represents the last step in the evolution of "digital senses" that smartphones and mobile devices have undergone in the last 20 years. Mobile devices, beyond their use as communication devices, are taking an increasingly relevant role as sensors that tie the physical and digital worlds together [6]: they

have access to localization, movement, direction, acceleration, temperature, humidity, pressure, orientation, inclination, ambient light, proximity, biometric measures, ambient noise. Furthermore, by being smart and connected devices, smartphones can extend their sensing functionalities beyond what it is allowed by the hardware itself, allowing for the creation of virtual sensors that enhance already available functionalities [7] (such as having faster and more precise location technologies by fusing GPS, Wi-Fi, and cell tower data), or allowing for the composition of low-level information in "higher level" sensing activities (such as step counting measures, extracted from accelerometer data), or even by allowing for new sensing capabilities by mixing local sensor data with online data or computation (such as providing access to meteorological data through GPS and access to weather databases, image recognition through camera data and AI) [8].

1.2   Social sensors

Beyond these types of sensors, in the past decade, significant developments have been made in the development of sensors that have allowed unprecedented possibilities in detecting the proximal and social context in which the person is located [9], [10].

- Through GPS and locative technologies, smartphones can provide wide-range localization measures with sufficient precision to detect if devices are roughly co-located or share the same open space. They can detect speed, direction, can be used for geofencing, and, in aggregate, can be used to measure the number of devices that are sharing a space.
- Through technologies like Bluetooth Low-Energy and Ultra-Wideband, modern smartphones can provide fine-grained localization measures with a precision of 1m to 10cm, a range up to 50 meters, and relative direction measures (in the case of UWB). They work both in open and closed spaces and can detect proximity between people or proximity to beacons and objects located in the environment [11].
- Near Field Communication technologies (NFC) can be used to detect short-range interactions (less than 5cm) and can be used as a proxy for voluntary interaction with people or objects [12].
- More recently, existing systems such as Bluetooth low-energy and new contact-tracing protocols such as DP-3T have been used globally to detect and notify possible contacts with infected people through the development of "sensors" capable of detecting social interactions and gathering situations [13].

Through these technologies, smartphones gain access not only to the physical nature of the surrounding space but also to its social nature. Harnessing this technology, interactive designers have access to users' location, their movements, their directions, and the speed with which they are moving. They allow for geofencing (how many people are in a given area? who is entering and exiting? what is the density of people?), for social proximity detection (Who is the user close to? Is the user in a group? How long have they been in contact? How many people have they connected with?), and for object proximity detection (What is the user looking at? What are they doing?).

2   METHODOLOGY

In this contribution, we present the case of the university workshop "Social Sensors. Design for post-pandemic communities" developed as part of the curriculum of the Communication Design BSc of Politecnico di Milano, which was designed to introduce students to the issues related to the use of mobile devices as "social sensors," both in terms of the new interaction possibilities enabled by recent technologies developments and in terms of challenges related to personal data, privacy and tracking risks.

From an educational point of view, the objectives of the workshop refer to:

- The development of students' awareness with regard to issues related to the use and dissemination of personal data collected through personal digital tools, such as mobile devices and smartphones.
- The use of mobile technology as an enabling technology for the development of face-to-face social relationships, with the aim to strengthen the local sense of community and build long-term relations that are the building blocks of social capital.
- The development of hybrid applications that merge the physical territory with the social context through the use of digital applications and tools

In order to reach such objectives, the workshop has been designed and carried out in collaboration with the "Data Science for Social Impact and Sustainability" research area of ISI Foundation, a private research institute with extensive research experience both in the field of data science, computational social science (i.e., using data to understand how people behave in society), computational epidemiology and more generally on the social impact of data. Based on experience in the field of proximity contact tracking technologies and privacy issues in the context of the development of the DP-3T contact-tracing program [13], the team contributed expertise to the workshop on both the technological aspects of proximity detection using mobile sensors and the societal impact issues of such technologies.

2.1 Workshop Brief

During the workshop, the students were tasked with the design of a local-scale communication and interaction design project that harnesses contact-tracing capabilities of mobile devices to facilitate community relationships, personal contacts, and social interactions. The brief has three main elements:

- It allows exploring how mobile technology and, more specifically, the recent developments in sensor technology can be used, in a post-epidemic context, to develop digital applications for local communities, to restore the sense of closeness and community, to stimulate socialization, and lead to the development of personal interactions between neighbors, and in some way to benefit that "social capital" which has undergone a series of difficulties in recent years.
- It ties the project to the physical and local dimensions of social interactions. It stimulates the creation of projects that facilitate and stimulate communication and socialization in presence. Projects must contribute to the development of local (square, neighborhood, block) and hyperlocal (museum, library, hospital, cultural center) communities and relationships.
- It proposes a view of mobile devices as sensors rather than communication devices, able to communicate our position in space, our proximity to other people, objects, or places: detectors of our physical and social activities in the territory. It calls for using geolocation and contact-tracing capabilities of mobile devices as design tools.
- In the spirit of tactical urbanism, projects must not involve invasive interventions on the territory but instead must aim to achieve a significant impact through lightweight measures that do not require large-scale infrastructural interventions but instead impact on the territory with specific objectives.

The specific kind of artifacts to be designed has been kept general both in terms of target and in terms of typology, with the indication that the project should make use of social sensing technology and that the artifacts should be placed in urban public space in order to encourage social interaction in presence. The objective is to avoid the design of "mobile apps," in which the interaction between people takes place digitally, to favor the development of artifacts that are placed in the urban public space, and to promote face-to-face interpersonal relationships, focusing on the collective and communal dimension of local space.

2.2 Workshop structure

The workshop has been structured as an intensive course, in which students were fully committed for an entire week. Throughout the workshop, students worked in groups with the support of teachers with whom a permanent confrontation was available. The didactic structure of the workshop favored an experimental approach to the topic. Teachers' contributions have been limited to the first two days, with lectures aimed at illustrating the project brief presented to the students, providing a context on the impact of the pandemic on social welfare, illustrating the impact of data on society, and providing an overview of the technological possibilities related to proximity detection, contact tracing, and geolocation.

The five days of the workshop were divided into two phases. The first phase, reserved for concept development, required the groups to identify the project's key features:

- Identification of the area of action: where is the project geographically located?
- Identification of the users: what type of users does the project target?
- Identification of the objectives: What kind of social relationships does the project addresses or enhances?
- Identification of proximity interactions: What kind of interactions are detected, and why?

- Identification of feedback: What does the user see/hear during such proximity interactions in the various communication devices that are part of the project?

The second phase, conversely, was reserved for the development of the project in terms of a low-definition prototype and the construction of usage scenarios through the definition of interaction dynamics, interfaces, communication channels, languages, and modes of expression.

The students, as part of a Bachelor in Communication Design, while in control of the skills related to modes of expression in contexts of digital communication, had limited knowledge and experience in the technological field concerning sensors and interaction design. In order to fill this gap, in the context of the first day's lectures, an overview of the design possibilities enabled by location and proximity sensors was provided, identifying the potential of such tools and presenting possible ways of using them in terms of interaction mechanics.

3   RESULTS

At the end of the one-week workshop, twelve projects were delivered, all responding to the brief, albeit with highly varied interpretations and proposals.

- A virtual experience, halfway between a detective story and a survival game in which the tenants of university residences can participate in the solution of a mysterious murder perpetrated by a robot through direct interaction and questioning of the other players. In addition to being an interesting example of a social game, it also allows young people who find themselves in a new context with no previous connections to each other to get to know each other through playful interaction.
- A "Capture the Flag" game for teenagers, which mixes real territory and proximity detection in the construction of a game in which two teams must gain control of a series of virtual elements while trying to block opponents from taking possession of them. Although the game takes place in the physical territory, the operations of appropriation of the elements necessary to win are done through proximity detection technologies that allow to take possession of the elements, to hinder opponents, to defend their teammates through physical collaborations that are recognized by the digital system (e.g., group formations, spatial configurations).
- An urban game in which two teams fight to conquer a territory through the use of an event app that leverages tracking sensors to guide participants through game experiences and make them collaborate in order to complete objectives. Participants, meeting as a group, will be able to take possession of locations in the territory and only through their physical presence complete tasks designed to stimulate collaboration in the real world.
- An application to support neighborhood events, which exploit the technologies of proximity detection in order to stimulate the establishment of collaborative relationships in the context of activities related to environmental sustainability and civil intervention for the improvement of the neighborhood. The application, activated in the context of a sustainability-related event, allows to propose and collaborate on specific actions for the local community, and such collaborations are visualized in the same neighborhood in order to engage the population and promote these initiatives.
- An application for welcoming first-year students to college that allows them to get to know each other and socialize during the very first days of college by leveraging personality traits common interests. During an on-campus event, students are challenged to get to know their fellow students through humorous communication. The app allows users to discover the interests of the people around them and likewise discover people who share the same interests or backgrounds as themselves through entertaining interactions.
- A collaborative treasure hunt project that involves the entire neighborhood in solving tasks and objectives designed to bring together the participants of the game. The people involved in the activity begin by solving the first tasks on their own, to be guided by the application towards the following objectives, where they will collaborate in larger and larger groups to solve problems that require physical collaboration to pursue the search for the Treasure.
- An urban installation realized with the aim of creating a "social square" that highlights and exposes in the physical territory relationships of proximity, affinity, and sociality through the synthesis of sounds and visualizations that physically represent the relationships between people, with the aim of enhancing human relationships by encouraging encounters and providing excuses to make new ones.
- A social fitness application that promotes outdoor group physical activity designed for young people who play sports at an amateur level in city parks and allows for the development of

interpersonal relationships through sport. The application allows people to join groups in running, jogging, slackline, and other sports, and to earn badges for fulfilling tasks that combine the achievement of fitness goals with the performance of group activities, rewarding activities such as running in groups and performing community physical activities.
- A Hybrid communication system that allows people to learn about other people's stories shared anonymously. The app, designed for sharing distressing personal stories related to episodes of discrimination and violence, allows people to broadcast while ensuring the privacy of those who share them. As with the contact tracing activities carried out during the pandemic, the app allows users to learn that over the course of the last few days, they might have been in contact with a number of people who have been victims of violence or discrimination and learn their stories.

3.1 Insights

The wide variety of projects allowed us to highlight a number of traits that characterize this approach to the conceptualization of smartphones as sensing devices. Specifically, the students' projects have highlighted a wide range of communication typologies that make use of proximity detection technologies to facilitate and foster social relationships in a variety of forms:

- The dynamics of play and physical collaboration used in solving specific tasks, typical of projects close to urban gaming, can facilitate relationships of acquaintance that can persist even after the end of the ludic experience, potentially giving rise to longer-term relationships, therefore bringing people of the neighborhood closer together and introducing people to each other. This approach has been applied to several projects involving different types of users, from middle and high school students to adults.
- Proximity detection capabilities, used as a way of interacting with and exploring one's social network, allow one to engage with people with similar interests, share experiences, and create lasting relationships. Social sensing and proximity detection technologies augment the space of the city, giving visibility to social relationships and allowing to share experiences that would otherwise go unnoticed. The display and visualization of these connections and relationships give rise to an explicit sharing of space and the initiation of a bond that can be further developed.
- Privacy-preserving contact tracing technologies, developed in order to maintain anonymity during the contact tracing process during the pandemic, can use proximity detection technologies to anonymously interact with the people that we cross paths with every day. While this does not directly lead to the development of interpersonal relationships, it does, however, serve to foster a general empathy and closeness with the people around us who can broadcast anonymous messages in order to let them communicate safely with the community.

The workshop experience has also highlighted a number of insights for the design of applications with regard to issues related to the limited familiarity of users with applications that use physical space and proximity relations as a mode of interaction.

- Defining spatial and temporal limits: when designing applications that make use of proximity detection or contact tracing, it is essential to define a limited scope so that the project does not become a potential vehicle for covert monitoring. If the scope of use is limited to a specific event temporally defined or, alternatively, to a specific physical context (i.e., a square, a building), the problems related to the use of data, privacy, and the possibility of control by private parties are strongly reduced.
- Transparency: Given that, in general, mobile users are highly reluctant to grant specific, intrusive access to mobile applications if the use of such access is not clearly tied to an otherwise unattainable functionality, it is critical to establish transparency mechanisms with respect to the terms of use of the data, the modes of interaction, and the motivations behind the use of the data. This means not only including disclaimers declaring the use of sensors but revising the entire application design process in order to clearly communicate to the user the rationale for any authorization requirements regarding the use of sensors and the collection of personal data.
- Visual coordination between physical and virtual elements: considering the limited popularity of hybrid projects that mix the digital dimension with the physical territory, it is essential that the communication that takes place in both channels acts as a connecting element in order to clearly define the relationships between the elements of the territory and mobile devices.

- Progressive Onboarding: given the low diffusion and innovative dimension of applications that use proximity-related mechanisms to interact, it is required to mitigate the unfamiliarity of users with respect to interaction modes, social gestures, and social interaction mechanisms through an onboarding process that showcases interaction mechanisms and provides adequate feedback as these processes unfold, in order to introduce users to unfamiliar interaction processes.

3.2 Feedback and peer evaluation

As the workshop did not require any evaluation on the part of the teaching staff at the end of the week, students were given an anonymous feedback survey through which they could express their evaluations and comments on the work presented by their peers in order to provide feedback to their classmates in terms of Concept, Development, Look and feel and Presentation. The evaluations expressed by the students showed high satisfaction with the quality of the projects presented, both in terms of concept and in terms of project development, and the feedback provided was generally related to the possibility of expanding the project with additional functionality.

In the section of the survey devoted to the evaluation of the workshop and of the learning experience, the comments on the workshop were overwhelmingly positive, highlighting the interest in the topics of interaction design in relation to communication design, underlining how this area of application was stimulating even considering the limited previous experience. Although some comments pointed out the challenge in developing such an ambitious project in the course of a week, they also highlighted that the focus on concept definition and low-fidelity prototyping made it adequate to the time available.

The involvement of guests who could provide an outside point of view was much appreciated, and there was a great appreciation for expertise with respect to issues of data use and its impact on society.

4 CONCLUSIONS

While the workshop combined the complexity of a difficult topic such as the facilitation of face-to-face socialization in the post-pandemic era with the challenges associated with the use of cutting-edge technologies, the results in terms of both design proposals and skills acquisition by students have shown that engaging with current issues and technologies has the potential to stimulate reflection and critical attention from students.

The workshop development highlights the need for highly interdisciplinary skills to successfully account for the different components of communication, interaction, and digital design projects. The workshop results highlight the range of unexplored potential allowed by the development of proximity detection technologies, as well as the potential risks related to their use in contexts of reduced transparency or poorly designed data policies.

A critical approach to the use of mobile technologies with social tracking capabilities has also allowed students to appreciate the opportunities and challenges associated with the use of data, the risks related to controlling and monitoring, and the risks of misuse of such information. These issues have furthermore allowed the course to emphasize the social role of designers, who, far from being passive executors, are responsible for both the project and the effects that it can have on society.

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