Redefining Audience Role in Live Performances

Victor Vasconcelos[1], Mauro Amazonas[1], Thais Castro[1], Rosiane Rodrigues[1], Hugo Fuks[2], Katia Vega[3], and Bruno Gadelha[1](✉)

[1] Institute of Computing, Federal University of Amazonas, Manaus, AM 69040900, Brazil
{vfv,maurojr,thais,rosiane,bruno}@icomp.ufam.edu.br
[2] Department of Informatics, Pontifical Catholic University of Rio de Janeiro, Rio de Janeiro, RJ 22451900, Brazil
hugo@inf.puc-rio.br
[3] Department of Design, University of California, Davis, CA 95616-8585, USA
kvega@ucdavis.edu

Abstract. As an audience for great live performances, people usually act as a passive spectator or interacting poorly with the performance themselves. Typically, the audience feels the need for higher engagement in these events, what happens spontaneously in some creative ways, but in a very superficial and uncoordinated way. This work deals with coordinated human interaction in live performances using smartphones for creating special crowd effects, fostering a more active people participation during the performance. To encourage this behavior, we developed a coordinated approach using mobile devices with offline vs online and synchronous vs asynchronous visual effects. Considering that the great majority of the public already has their smartphones, our solution is cheaper than giving an armband for every person and can provide the same engagement feeling and more dynamic effects on the crowd.

Keywords: Audience engagement · Audience interaction · Interfaces for enjoying cultural heritage · New technology and its usefulness · Real life environments

1 Introduction

The human being is a social being. From its origin, they organized themselves in small groups, where generally nomads and they lived of the hunting and gathering. With the agricultural revolution, stemming from the mastery of cultivation techniques, the human being settled in villages and domesticated or animals. From the industrial revolution, cities could develop [6]. As a consequence, there are large population densities.

Moreover, societies provide the possibility to interact through a large number of people at the same place and at the same time. Thus, it is not uncommon to perceive their active and contagious participation in sporting events, cultural

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events or political manifestations, among others. These massive concentrations of people, also called crowds, are the subject of several studies in different research fields such as "Dynamics of the Crowds".

Crowd Dynamics (CD) is the study of how and where crowds are formed and move under the critical density of more than one person per square meter [14]. According to Zeitz *et al.* [17], understanding the psychology of crowds and mass meetings is crucial to understand their dynamics and predicting their reactions. Such studies apply to several contexts such as mass behavior in emergencies, which concentrates much of the research studies. In this emerging context, Li et al. [9] presents a study to prevent accidents in crowded public spaces based on the control of pedestrian movements. Another work in this direction which describes human behavior in managing crises of crowds in extreme situations [3]. In another context, In the literature, there are applications of this technique for performing crowd simulation applied to the alignment of military vehicles [10].

Entertainment gives also the possibility to research on CD. Crowds at theme parks, such as at Disney parks, have been the subject of a study that predicts the flow of people in the most popular attractions (rides, games, restaurants or shows), presenting an unequal distribution of visitors and unequal queues between such attractions [4,13].

In the field of arts, there is a movement to encourage the participation of the masses, to understand their reactions and to interact directly with the public to engage them in artistic performances and installations. *Crowd Engagement* (CE), a branch of crowd dynamics, focuses on how people in the crowd interact with each other and as a group in a particular event [11]. For example, Roggla *et al.* [12] used helium gas balloons with sensors to capture information from the public engagement in a live event and make that information visible through a panel. Another work involving CE is that of Webb *et al.* [15] that discusses how new technologies can change performance experiences.

Due to the increasing penetration of smartphones in our daily, more 66% of individuals own a smartphone in 2018 [2]. This availability represents new possibilities for CD. Our work presents a novel way to involve crowds in different contexts such as in artistic performances and sports events by the use of mobile devices. The research question that guides this work is: How can technology transform the audience's role from a spectator in a significant event to an active participant in the show? Thus, the proposal described in this paper focuses in the development and use of a technology platform based on mobile devices such as smartphones and tablets to provide more audience immersion in entertainment events, thus redefining the role of the audience in these great spectacles.

This article is organized as follows. In Sect. 2, we present previous research and products on audience engagement. Section 3 describes the implementation of our platform for providing the immersion of audiences in entertainment events. Section 4 describes our case study a two pilot studies of our implementation. In Sects. 5 and 6, respectively, the analysis of the results of the pilot test with the case study, and the final considerations on the role of the audience in an event.

2 Audience Engagement

Since the great spectacles of the Roman theaters, entertainment and involvement of the crowds had to be part of their presentations. More recently, Brazil has been a stage of significant sporting and cultural events such as the World Cup, the Olympic games, Rock in Rio and Lolapalooza. However, Brazil has a history of massive events such as the popular Carnival parades that illustrate the country's cultural scene that is preserved for many years. Most of these events attract crowds who often limit themselves to a secondary role as passive spectator, or as an interactor only in their small groups of family or friends. This research focuses on a spectacle and contest where the audience has to participate in the performing team gets more points for their final score. It is a folk festival called Parintins. Thus, the participation of the crowd called "Galera", is planned, encouraged and constitutes an evaluation item for the festival. The Fig. 1 exemplifies the use of the crew of one of the Parintins festival steers forming the Brazilian flag.

The need for greater engagement in events of this nature is felt by the public themselves who, on their initiative, find creative ways to participate in the show. An example can be seen in Fig. 1, where viewers turn on the lights of their mobile handsets, enriching the spectacle scene. Another example is the tiles produced by organized twisted football teams to support his club, as further illustrated by Fig. 1, where fans receive a 'mosaic kit' with instructions for use for certain situations. It is worth mentioning that these are spontaneous initiatives that emerge from the crowd and are not originally conceived by the organizers of the event.

An example that encourages public engagement by the support of technological artifacts happened during the Coldplay tour. Upon entering the venue, each spectator received a bracelet with infrared sensors that would flash, blink and change colors in the rhythm of the songs performed by the band, which increased the sense of belonging to the show. In 2018, during the opening of the Winter Olympic Games in South Korea, the use of technology was evident. In the stands, it was possible to display flags, colors and even letters, making the bleachers become a "big screen". This "big screen" was projected on the bleachers but there was no interaction with the audience. This projection generated a high impact for both, for the television broadcast and for those who were on the other side of the stadium. However, it did not make the audience to participate in the show. Figure 2 illustrates the preparation of this screen in the stands of the grandstand and the final result at the time of opening of the event.

This research discussed in this article proposes the implementation of similar visual effect, but with the active participation of the audience, which will display a big screen using the smartphones as pixels and through the collaboration of each immersed in the interaction. In addition to the above examples of large-scale events, there is great interest in research involving the use of new technologies for crowd-oriented interaction, as already mentioned in the Sect. 1. More than just searching to understand crowds [3], or improving security [9], Mobile Crowd Sensing (MCS) [8] presents the concept of a paradigm, where the author discusses the possibilities available through the use of mobile technologies, highlighting how the MCS will work, although still at a basic stage, has many possibilities opportunities to be explored, such as a hybrid network model, using each of the smartphones in a crowd as an access point.

Fig. 1. Examples of spontaneous audience engagement in entertainment events. From left to right, there is the audience such as mosaics in football stadiums, the lighting of the cell phone lantern at the opening of the Rio 2016 Olympic Games, and the Coldplay show.

There are cases of real applications using an extended concept of the MCS paradigm, *Mobile Crowd Sensing and Computing* (MCSC). They use data provided by a crowd to solve certain problems, such as measuring pollution air pollution measurement, site recommendations, crime prevention, among other situations [7]. There is also a project that detects crowds through smartphones as a facilitating tool in the collection of information [1]. Instead of using sensors, which would be very costly for both deployment and maintenance of hardware and software, it uses *smartphones* since these technologies are already equipped, making it a perfect source for collecting information from its users. An example of this is the data obtained on human mobility in an urban area, health applications and wellbeing allowing the study and creation of new technologies from these data.

As can be seen, several studies have been carried out focusing on crowds, sometimes trying to study the behavior of the same, sometimes using data provided by it. In this work we treat both concepts but with a different look, studying the visual effects of the interaction of crowds in events of great proportions, also allowing the investigation into effects initiated in subgroups with the potential to spread to others, effects that engage more or others who may even disengage.

During the opening of the Winter Olympic Games 2018, in South Korea, the use of technology was quite evident. In the stands it was possible to see flags, colors and even letters, making the bleachers become a "big screen", as a mosaic. This "big screen" emerged from the bleachers but did not come from the interaction of the present audience, which nevertheless generated a high impact visual effect in which it watched the show, both for television broadcast and for those who were on the other side of the stadium. Despite the visual effects, the present technology did not make people participate in the show. Figure 2 illustrates the preparation of this screen in the stands of the grandstand and the final result at the time of opening of the event. The research discussed in this article proposes the realization of similar visual effects, but with the active participation of the present public, which will form a big screen through the collaboration of each immersed in the interaction.

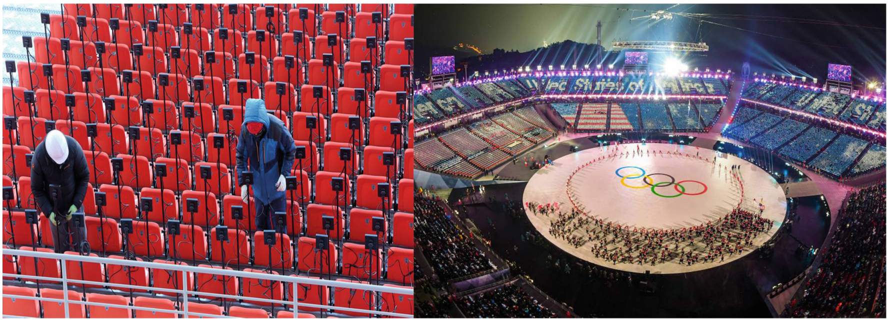

Fig. 2. Preparation process and the final result of a big screen at the opening of the Winter Olympics Games 2018 in South Korea. Source: https://www.olympic.org/photos/pyeongchang-2018/opening-ceremony

In addition to the above examples, applied in large-scale events, there is an excellent interest in research involving the use of new technologies for crowd-oriented interaction, as already mentioned in Sect. 1. More than just searching to understand crowds [3], or improving security [9], there are also searches that follow other lines, which presents the concept of the Mobile Crowd Sensing (MCS) paradigm [8]. The author smart phones discusses the possibilities available through the use of mobile technologies, highlighting how the MCS, although still at a primary stage, has many possibilities opportunities to be explored, such as a hybrid network model, using each of the of a crowd as an access point.

There are cases of real applications using an extended concept of the MCS paradigm, *Mobile Crowd Sensing and Computing* (MCSC), applications that use data provided by a crowd to solve specific problems, such as measuring pollution air pollution measurement, site recommendations, crime prevention, among other situations [7].

In another paper that proposes to talk about MCS opportunities [1], the author talks about the use of the detection of crowds through smartphones as a facilitating tool in the collection of information. Instead of using sensors, which would be very costly for both deployment and maintenance of hardware and software, it uses *smartphones* since these technologies are already equipped, making it a perfect source for collecting information from its users. An example of this is the data obtained on human mobility in an urban area, health applications and wellbeing allowing the study and creation of new technologies from these data.

As can be seen, several studies have been carried out focusing on crowds, sometimes trying to study the behavior of the same, sometimes using data provided by it. The research discussed in this article uses both concepts but with a different look, studying the visual effects of the interaction of crowds in events of vast proportion, also allowing the investigation into effects initiated in subgroups with the potential to spread to others, effects that engage more or others who may even disengage.

3 Smartphones as an Instrument of Immersion in Shows

Mobile devices such as smartphones and tablets, increasingly embedded in people's everyday lives, are equipped with multiple sensors, actuators and processors, and have a growing capacity for storing and processing information. They increase the possibilities of communication between people and interaction with the world. Its use is common in the most different contexts, such as work, study and leisure. Considering the latter, one observes its intense use in big shows such as musical shows or sporting events both for recording the moment and for a greater interaction with the event. This interaction often occurs spontaneously, such as lighting the smartphone flashlight while playing a song at a concert. It is therefore perceived the need for audience interaction and immersion in entertainment events and the potential of mobile devices as a technological platform to support this task. Thus, a mobile-based technology platform (smartphones and tablets) was designed to increase people's engagement in crowd-based events, relying on theories such as dynamic entertainment.

Inspired by examples of audience participation in major shows presented previously and represented in Fig. 1, the technological platform was designed to turn the crowd into a large living screen, where each participant consists of a point, or pixel, of that screen. To do so, one must keep in mind that: (1) people tend to use their smartphones during events and; (2) agglomeration of people in different arrangements meeting the requirements of each type of event such as: arranged in an arched like in a football game, standing on a lane as in a show in parks or beaches or both as in the case of stadium shows Each arrangement has characteristics that influence both the audience experience and the possibilities of technological interaction in these scenarios. Unlike the initiatives of the Winter Olympics in South Korea that used mini led screens in each stand of the grandstand to form their big screen and the concert of the band Coldplay, that used dedicated devices, as wristbands with radio frequency receivers delivered to each spectator of their show, the technological platform described in this paper uses people's own mobile devices participating in the events. This solution reduces the costs of deploying technology, it has great potential for motivating interaction, and it presents many possibilities for increasing engagement and audience immersion during shows.

The developed platform allows different visual effects to be performed in different scenarios, considering the peculiarities of the public disposition expected by the event and the network infrastructures of the venues. Figure 3 presents the architecture of the proposed technology platform, illustrating the different public dispositions and different versions of the solution considering the network infrastructure availability of the event locations.

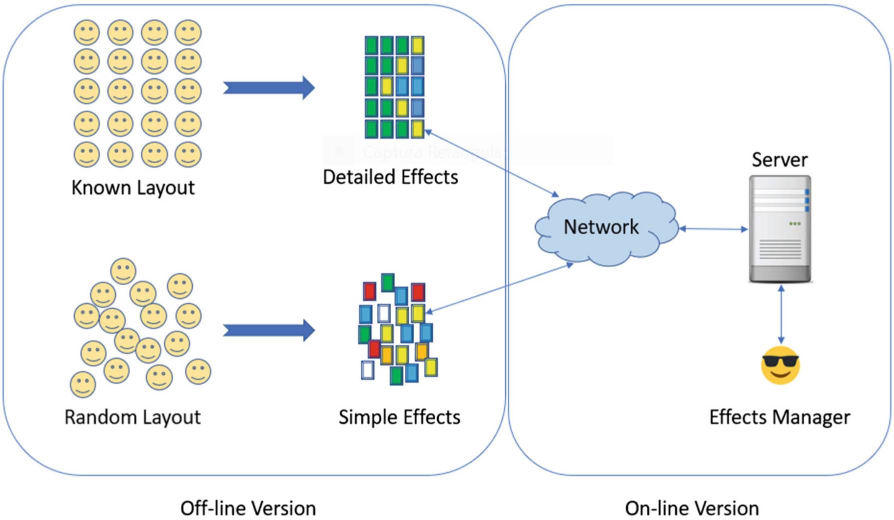

Fig. 3. Technology platform architecture considering different audience arrangements and network infrastructure of the event.

With regard to the audience's disposition, we have:

- **Location-based Layout (Known layout).** This provision happens when a participant of the event can choose beforehand their place in the audience or the places are limited and marked, even if they are of free choice of the participant. In this type of arrangement, each place receives a marker to be recognized by the application that must be previously installed in the event participant's smartphone. As a consequence, you get sophisticated visual effects involving animations or drawing formations in the audience.
- **Random Layout.** This arrangement happens when people have no control over the exact location they will be in during the event. This type of arrangement is common in events such as musical shows in large spaces such as stadiums, parks or beaches where the audience usually stands on the track or even in the stands, but without the commitment to remain in the same place

throughout the event. In this case, it is not possible to identify in advance where a particular participant of the event will be. The visual effects obtained with this type of arrangement are more limited such as flashing lights in random colors, all lit audience with a solid color and color change.

With respect to the network infrastructure provided at the event venues, the technology platform envisions that smartphone applications work in two ways, namely:

- **Online Version.** In this version it is possible to control each cell individually, generating the combination of numerous visual effects in real time. This version enables the visual effects to be orchestrated by a central actor, called the effects manager. This manager has full control of the whole screen formed by the smartphones of the audience of the event.
- **Offline version.** In this version the interaction happens freely, without the need of the effects manager. In order for this manager independence to be possible, the application is preprogrammed with all the sequence of effects it should display.

Table 1 summarizes the configuration possibilities of the developed technology platform. Applications generated from the platform can be online or offline. For each type, one must consider whether people have a known disposition or whether they are randomly disposed in the event in question. The possibilities of generating the visual effects will be conditioned to such visualizations.

Table 1. Technology platform configurations considering public readiness and network infrastructure.

Version	Layout	Visual effects
Online	Location-based	Detailed, commanded by a manager
	Random	Limited, commanded by a manager
Offline	Location-based	Detailed, pre-programmed
	Random	Limited, pre-programmed

In addition to worrying about effects, with all the logic and simulation algorithms implemented behind the scenes, the focus of the technology platform is also to provide the best of immersion and interaction experiences in an entertainment event involving crowds that use the applications of the platform. To this end, the application design for the user was minimalistic, so that it is simple to use as the simple act of lifting the side of the device, considering a minor impact on the battery consumption of the device, without leaving of presenting distinct, enveloping and visually beautiful effects. Considering these assumptions, we describe in this article the first case study carried out using simulations and as a result we discuss its scalability for using it in major events. For that aim, we propose differentiated interactions for certain moments so that the public feels immersed in the event, feeling an important part of the show.

4 Case Study

To determine if the application can accomplish what is intended, immersion of the audience, we conducted a case study in an experimental laboratory and an environment simulating a musical show. We applied this methodology from the literature, which argues that the case study is the most appropriate methodology to use in research where the main questions are "how?" Or "why?" [16]. The author also refers to the case study as an indicated methodology for social studies, therefore the focus of this work.

Also according to the literature [16], we should perform four steps for carrying out case studies. The first one, the **Planning**, consists in deciding if we will apply the methodology for the research. The second one, the **Design**, where the units of analysis should be defined and the probable cases for study. The third step, **Preparation**, which will consist of conducting one or more pilot case studies; the collection, where we extracted the data generated by the pilot study. The final step, **Analysis**, which consists of an analysis of the collected data. If the collection is not sufficient, one can go back to the stage of preparation for other pilot case studies, or even if the generated data are not desirable it is necessary to go back to the *design* step.

Planning: the context of this work involves the study of agglomerations, with attention in the members of a crowd and the feelings and emotions experienced by the individuals, during the use of the proposed application. Investigating why the feeling of more intense immersion, if any, and how to intervene through the technological mean so these sensations are more evident.

Design: What is intended is to identify and evaluate the audience's sensations when using the proposed application, in any entertainment event. If the audience felt more immersed, also if this was a consequence of the use of the application, and, finally, if it felt an active participant of the event.

The research involves the collection of data in events that gather crowds, but the technology platform developed is new, and since there were no references to evaluate its feasibility in real events, it was decided to conduct, first, two pilot case studies. The first was intended to focus more on the usability aspects of the smartphones with the application, focusing on the user experience at the end of the test. For the second pilot case study, after some adjustments that were necessary to be carried out with the conduction of the first test, the focus was more on the interaction of the people with the show and the unit of analysis was their experience of use. About 50 young people participated in the two pilot case studies.

We performed the data collection by observation of the interaction, post-test questionnaires made available through the Internet and an informal chat with all participants of the pilot studies after the session.

For the analysis of the collected data, each pilot case study had some of its characteristics whose data were triangulated and we discuss in detail in the next section.

As mentioned previously, two pilot case studies were conducted, with a week apart. The first one tested two versions of the application (the version of *on-line* with people's known disposition and the *off-line version with random disposition of the people* and the second only the version *off-line* with random array of participants was used, since the goal of the second was the immersion experience and not the technology anymore. For ease of understanding, in the remainder of the article, we name the *on-line* version with the known layout of **Version 1** and the *off-line* version with a random array of participants of **Version 2**.

4.1 First Pilot Case Study

The audience very present in shows is composed mostly of young people. Thus, this study was applied with students volunteers of the freshman class of Software Engineering course and some graduate students also volunteers, all of them being from the university X. In all, there were 35 participants, and as previously reported, both were tested versions 1 and 2 of the application with the primary objective of observing the feasibility and acceptability of the technology and its effect on participants' perception of immersion.

– **Setting:** For this first pilot study, a room was set aside to accommodate the number of participating students. We prepared the environment of the class to create space for the students to have freedom, for this, we removed the chairs, the artificial lights turned off, and we connected a party light globe. The intention was to simulate the atmosphere of a show, so that, as in a real event, the participants could have free space. It was also necessary to previously delimit with the *QrCodes* the places where the participants should be during the Version 1 tests of the application, forming a *grid* 6×6 (six rows and six columns). As the simulated environment was that of a show, a multimedia projector and a sound box were provided in the room to show the video of the band's show *Coldplay.* The aim was to increase the feeling of the participants being in an entertainment event. Also, two cameras were placed in strategic locations (in the corners of the room, diagonally facing the participants) and recorded the test, with the reactions and behaviors of the participants (Fig. 4).
– **Execution:** We divided the study into two different moments, each one with a different app setting:
  - **Version 1:** Each student had to select the online with a known layout option on the app. They had to stand right above a QR code, so they'd have a known position. To inform their position to the app, they scanned the QR code their standing. The music started, and they could move, dance or do what they wanted to, but they were not allowed to change places to keep their position. If someone moved to a new spot, the person should scan the new QrCode to inform the new position to the app. Knowing the position of each person in the class, we could test the app by sending signals to each mobile device through the network. This way, we could observe the generated effect in real time.
  - **Version 2:** Each student had to select the off-line with a random layout option on the app. By using this functionality, they were able to stay

Fig. 4. Students in a simulated party setting.

wherever they want to without the obligation of staying in the same place marked with QR codes. The music played, and students started to get more involved in the experiment and started dancing. While they were dancing, their mobile devices changed colors according to a preset script. In this setting, we programmed all the effects in advance, and it was not possible to change its behavior through controllers' commands.

- **Primary analysis:** Looking at the student's behavior during the two moments of the study; we verified that while in Version 1 we had much more control and diversity in effects, on Version 2 we will always have only the preset effects what makes the experience less dynamic. In contrast, Version 1 limits the interaction by making the audience remaining in the same position, reducing their freedom of movement. On Version 2 we do not have this limitation, because regardless of the position of each participant the effect will succeed giving all freedom for the audience to come and go as they wish, theoretically giving a greater sensation of immersion.
  Another issue we observed was that even though the songs played were from the famous band Coldplay; not all participants demonstrated that they were enjoying the show, either because they did not know the lyrics well or even not be fans of the band itself. We concluded that this condition might have interfered in the level of immersion of some participants.
  We also noticed that depending on the context of use, Version 1 tends to stand out more than Version 2. For example, in an event with marked places, or football stadiums that have a numbered chair and, consequently, each person has his seat reserved, Version 1 stands out as there would be no need to change places. But in a context like a music festival, where the public often moves, Version 2 stands out, as it would not be possible at this time to form pictures or images with the mobile devices due to the lack of communication of the application with a controller as it functions as a stand-alone application.

In the post-study chat, the participants made some suggestions such as: disable the automatic screen lock, control the brightness of the screen and corrections in the behavior of the application. Still, in the chat, the participants still took the opportunity to discuss how the application could be used in other contexts and with new features.

4.2 Second Pilot Case Study

After a primary analysis of the results of the first pilot study, we corrected small errors in the application (bugs in the application) pointed out by the participants and detected by the researchers. The observations made in the first study resulted in the decision to, at this point, further explore *Version* 2 by providing greater immersion and engagement in events because of the higher degree of freedom for the audience. Thus, the same class of students of the Software Engineering course was invited to participate in the second pilot study, together with a group of students of Gas and Petroleum Engineering of Federal University of Amazonas, totaling 40 participants.

- **Preparation:** For the accomplishment of this study, the same previous room, that has up to 50 participants, was reserved. Again, we removed the chairs to provide more space and to simulate a music event. This time, a DJ was invited to participate in the study to have a broader range of songs, and thus try to please as many participants as possible. Just as in the first test, the lights were turned off, and instead, we attached a party light globe, creating a simulated show environment. The DJ was responsible for bringing the sound system (box and sound table), put the music station facing the participants. We also recorded this study through a camera, but this time it was positioned facing the participants. Another differential in preparation for this test was to have used the multimedia projector connected with another camera pointed at the participants so that they could see themselves (visual feedback), trying to create a way to motivate them to use the application and create a greater immersion for them.
- **Execution:** This time the participants were only asked to enter the application, if they wanted and had their smartphones, to let them interact spontaneously. It is worth mentioning that some participants were not with their smartphones and were asked to participate in simulating what happens in significant events, where most are with their device, but there are always some that are not. Figure 5 shows the students interacting with their smartphones during the study.
  As previously mentioned, the purpose of the study is to make participants feel relaxed and feel as if they are in a real event. For this reason, the DJ was asked to mix musical rhythms with the most popular hits among the participants' age group.
- **Primary analysis:** We observed that even though they were left free and allowed to use the application and even without much previous instruction,

Fig. 5. Students participating in the second pilot study, in a simulated party setting.

the vast majority of participants were eager to use the application. We concluded that the visual feedback provided in this study stimulated the participants to use the application making them curious to see the result of their interaction in the event. As a result of feedback, participants' engagement could be perceived more spontaneously by observing how they were singing the songs played and doing "choreographies" and rocking the smartphone from side to side in more romantic songs. A priori, the app provides the audience with a new way of interacting with an event, giving each user the experience of being part of the event, not just as a spectator but as a show apart.

After each of the pilot studies, the participants were asked to respond to a questionnaire about the experience they had just mentioned, emphasizing the feelings and emotions they felt. In addition to the questionnaire, also soon after each test, all participants were invited to give suggestions, criticisms or question something about the study. It was through these methods that we were able to collect enough data for a more in-depth analysis, which we present in the next section.

5 Results

Through the triangulation carried out for the two pilot case studies some preliminary conclusions can be drawn on the user experience using the proposed application in the context of this new technology. This triangulation consisted of the activity itself, with a *in loco* observation of the researchers and audio and video recording, a post-test questionnaire on the user experience and an informal conversation to record impressions of the participants who did not want or could have been exposed in the questionnaire.

One of the conclusions that can be reached, through observation and also the information extracted from the forms, is that the visual feedback makes the user experience even more vibrant, making the participant feel more and more part of the event, as shown in Fig. 6.

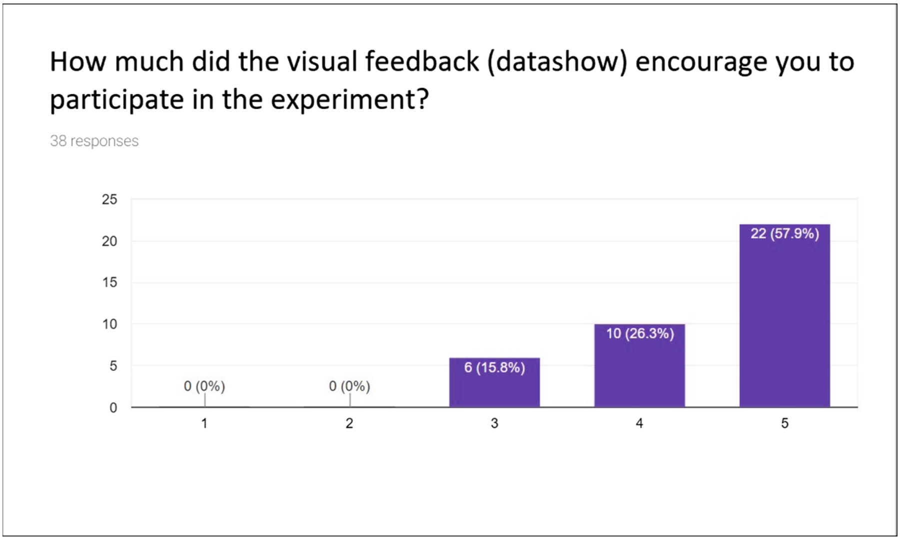

Fig. 6. Feeling of immersion due to the visual feedback provided by the data show projection.

The freer the participants feel more engaged, according to the data from Fig. 7 show that from the first pilot, where students passed through *Version 1* and felt less freedom, to the second study where we tested only *Version 2*, the students felt much more belonging to the event because they had greater freedom. But this does not invalidate the alternative presented by *Version 1* since there are events in which the audience does not usually change places, such as in a play, a soccer stadium or a grandstand. In this case, version 1 may perform similarly to *Version 2*.

The issue of the need for the participant to have his arm raised during the use of the application was a point of discussion because, during the study that lasted on average 20 min, we did not file any complaints in this regard. However, what the students asked was that in a context where the event could last two hours or more, participants would not be willing to stand in this position throughout the event. Thus, during the process of planning and designing the application,

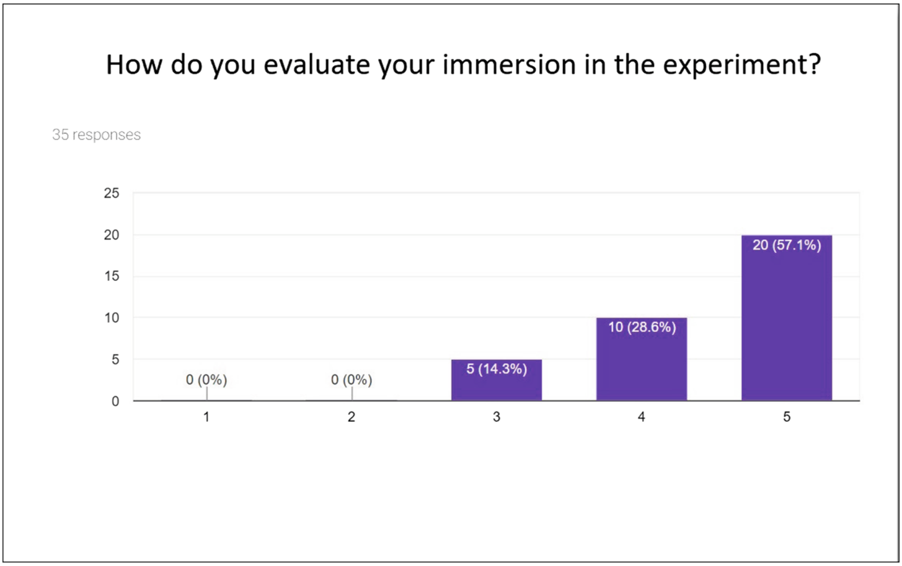

Fig. 7. Feeling of immersion degrees of the participant in the first and second pilot studies, respectively.

this was one of the situations that were taken into account, and the project envisages the use of the application only in some moments of the event, both for this matter and for the preservation of the battery charge of the participant's *smartphones.*

Other ideas may also arise as you use this technology in different types of events. For example, during the execution of the second pilot study, a participant wanted more freedom of movement to dance and pinned his smartphone on his cap, which is unusual, but an alternative to move more freely in dance parties, making it another possibility to investigate further as an extension of this work (Fig. 8).

Another question asked both on the form and to the students directly was whether they would use this technology in a real event, and then the vast majority of students said they would use it with certainty, as Fig. 9 shows. This response from the students reinforces, once again, our assumption that people wish not only to watch and themselves, they want to interact with the event that is participating. For event planners, this is a promising point, since the more the public is engaged, the higher the success of the event. And from the viewpoint of the audience, the higher the sense of participation, the more unique will be the experience of the individual in the event.

In addition to direct questions about each participant's experience, we leave an open space for suggestions for possible improvements to the immersion experience at an event. Given each response, or rather each suggestion, we applied the *Explanation Method of Underlying Discourse* [5], which consists of a method

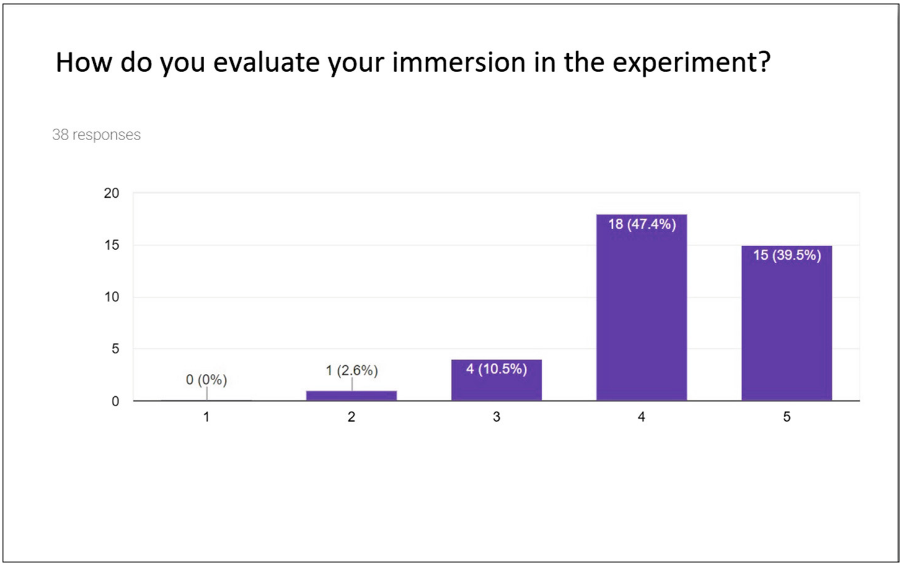

Fig. 8. Feeling of immersion degrees of the participant in the second pilot studies.

of categorizing the data to better analyze the participants' feelings as an all to understand better how a crowd feels using the application in an event. Thus, we organized the suggestions into four categories, which were: improvements in the application; music as an influencing factor; facilitating the use of the application; and, real engagement. Table 2 shows how responses are distributed across categories. It is worth mentioning that in the text, when any of the answers are quoted, the names used will be pseudonyms and not the true name of the participants.

Application Enhancements: this category encompasses all the answers where the participant suggests some improvement in the application. Whether such a suggestion is to increase the number of possible effects or even, as in a specific suggestion from a student, "reduce battery consumption". The majority of the study's audience, possibly because they were from computing field, were focused on such questions as for whether the application worked; which could be improved in it; new features; and so on. We realize that there is a need to vary the range of visual effects provided by the application, especially in Version 2, where there is no possibility to change in real time what is predefined in the application. This would allow for greater engagement as the user would not tire of the effects easily. In identifying such suggestions, we observed that in the videos of the experiments performed, there was a drop in engagement after a few minutes. We assume, then, that after a few minutes, the effects became predictable, and consequently, the participants' motivation and engagement declined.

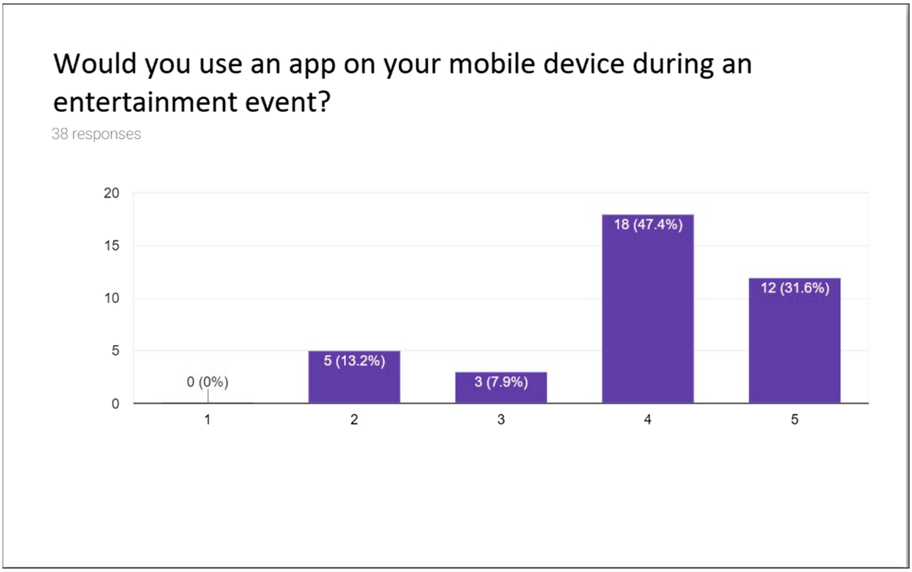

Fig. 9. Possibilities of the participant to use the application in an entertainment event.

Table 2. Categorization of the participants' suggestions of the pilot studies.

Categories	#Answers
Application improvements	10
Music as an influencing factor	6
Make the application easier to use	12
Real Engagement	7

Music as Influencing Factor: In this category are answers like that of a specific student who said, "It would be nice to vary the *playlist* more". Although not the majority that suggested such changes, it may still be noted that music is an essential point of influence for an audience of any size engaging in an event. It is worth remembering that for this work the simulated environment is that of a show, so music is essential. Therefore, even if it was not such a scope, for example considering the fans in a stadium for a football game (which is also an entertainment event, but of sports), there are always musical instruments and a vast audience singing songs. One thing to consider is that for this pilot study only the students who attended the invitation spontaneously participated. In this way, the students did not necessarily have the same musical taste. So what pleased one student probably did not please the other. In a real situation, it is expected that the individual who is predisposed to go to a show is a fan of the artist, band or even the musical style, where the musical genre is preferably not a relevant variable.

Facilitating the Use of the Application: for this category, answers like that of a specific student suit naturally. The student said that we should “improve the issue of holding the cell phone all the time”. Other comments that also fit in this category are those that request the use of the application in devices of the manufacturer *Apple*, that owns the IOS operating system, considering that until the moment of the experiments reported in this work, there was only the version for the Android operating system. Another request made by another specific student was: “update the application without having to use third-party sites”. At the time this study was run and because the version used was still experimental, the developed application was not yet available in the mobile application store running the Android operating system (*Play Store*). In this way, the participant had to perform the demo app download on a website hosted on the university servers and install the demo application.

Real World Engagement: this category was identified for responses that required more experiments. Some users have asked to participate in future tests. According to a specific student, “it would be interesting if, at any cultural event held here at the university, there was the possibility of using the application.” We can see that the application provided a greater engagement so that several participants would like to use the application more often, however simple the idea may seem.

6 Concluding Remarks

Given all that we observed in the pilot case studies and the analysis, in addition to what the public already does today, the feeling of participation in an entertainment event is essential, becoming an extra attraction. If in the past, with little or no technology, the audience could get some interaction, today with the technology proposed, the audience besides watching can interact if is participating.

It still requires more testing and case studies on a larger scale, so the technology and application become a tool for immersing participants in events. Both case studies were conducted with about fifty young people and highlighted essential elements that we not considered previously. In order to be able to observe the impact of using technology more faithfully, it is necessary to conduct a broader case study, with at least 1,000 people, already characterizing a crowd, so that it is possible to visualize the potential of the application for engagement and spontaneity of the public. Based on participants feedback, we can glimpse a scenario in which the possibilities of the development of more elaborate, complex and visually beautiful effects.

With our technology, we are redefining audience role in live performances by making them more engaged and immersed. Our technology enables interacting at a lower cost than the expensive bracelets used by Coldplay or Taylor Swift. After the case studies in a real scenario, the technology will be ready to provide a richer experience of interaction in mass events.

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