Toward a Multiuser Social Augmented Reality Experience: Shared Pathway Experiences via Multichannel Applications

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ABSTRACT

UEIn Social Media environments, users engage in multiple relationships and networks, but may not always do so with the same people at the same times. If they share too few channels of information relevant to a common goal, there may be too little mutual information about a transaction to interact and communicate well collaboratively. Future interaction design development for the User Experience (UE) of Augmented Reality (AR) must be aimed towards people where they operate—in social, physical, and network space. A conceptual understanding of the global interaction context within which people experience the social mobile web is needed, one that emerges from the aggregate of multiplexed asynchronous or synchronous data pathways of interacting individuals. Stories are a means to relate multiple individuals' pathway experiences in a collective form. At the moment, AR is based on fixed navigational pathways and single narratives without regard for broader context or history. We encourage UE development for AR to provide environments for sociability, shared stories and shared experiences.

AUTHOR KEYWORDS

Social Computing, Social Navigation, Mobile Computing, Interaction Design, Multi-channel Applications, Augmented Reality, User Experience.

ACM CLASSIFICATION KEYWORDS

H.1.2 [Human Factors]: Human information processing; J.4 [Social and Behavioral Sciences] Anthropology; B.4.3 [Interconnections (Subsystems)]: Asynchronous/synchronous operations;K.4.3: [Organizational Impacts] Computer- supported collaborative work

GENERAL TERMS

Design, Human Factors, Performance

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1 INTRODUCTION

Future interaction design development for the User Experience (UE) of Augmented Reality (AR) must be aimed towards people in social, physical, and network space. AR is a virtual information layer, database driven, largely singular to each user, based on geolocation, and dependent upon devices carried by individuals. Although some UE concepts are beginning to drive the development of some AR games and collaborative contexts, most promote individuation rather than collective interests.

Social Media has evolved many different social networks and users can participate in several concurrently. However, within Social Media environments, users engage in multiple relationships and networks only partially in common with others that they are interacting with at a given time. One conceptual understanding of the global interaction context within which people experience the social mobile web is PolySocial Reality (PoSR). [1, 2]

PoSR is the aggregate of all interactions of locations and communications of all individual people in multiple networks, describing the network transaction spaces that people traverse with others to maintain social relationships via various apps and mobile services as well as in analog mediums. To the extent that people share common sources of information while interacting with each other, the greater their capacity to collaborate. If they share too few channels relevant to a common goal, there may be too little mutual information about a transaction to interact and communicate well collaboratively. Poor collaborative interaction can lead to further relational fragmentation with the potential to promote individuation on a broad scale.

By augmenting shared realities, physical and network-based, AR can provide layers that merge different individual perspectives into a shared group creation. Currently AR renders a layer of information onto a physical location or place utilizing information from the network, but does not augment the shared network space as well. Although AR provides a UE that enhances the data retrieval and augments grounded reality ("real life"), it is not yet active in a way that could truly shape the human sociability that is observed within PoSR. Some people may use mobile technology to augment their current social experience, simultaneously checking into a representational space on Foursquare (a location based mobile platform) whilst physically occupying a grounded reality environment. Others extend their physical space when they connect to a network and interact with their mobile devices during wait cycles in airports, stores, or public transit [1]. By changing the way that people travel through space and time during their daily routines, AR could shift our increasingly individuated user experiences by expanding our capability to draw on enhanced

sociability and collaboration within a multi-user, multiple application and multiplexed messaging environment.

That said, the AR community seems to be moving from passive AR objects placed in layers, and towards awareness that AR has the potential to be more active and more human focused. AR communities have been engaging around the idea of "storytelling" (summary of talks from ARE2011) invoking a comparison that the AR industry mirrors that of Silent Film in its early days. Through storytelling, AR could develop into extended and experimental narratives in its user experience. Stories are a means to relate multiple individuals' pathway experiences into a collective form rather than via fixed navigational pathways and single narratives. We examine the facets of AR and how it can integrate with social media to become a social UE that integrates the network, mobile devices and the environment, drawing on AR capabilities to create the opportunity for multifaceted narrative expression.

2 THE STATE OF AUGMENTED REALITY (AR)

Starting to think we need to tear down the walls of AR, become something more. Contextual, media, social, ubicomp, ambient, human." - Gene Becker, Augmented Reality Strategist, Layar, Augmented Reality Conference 2011 (ARE2011), Santa Clara, CA, May 2011.

Gene Becker summed up a perception many had following the Augmented Reality Event (ARE2011, now renamed AWE). Many of the demos relied on similar mechanisms for deploying Augmented Reality (AR), and were perceived not to provide enough of a User Experience. We were amongst the attendees and participants and agreed with this assessment. Indeed, one of the things that is missing in AR is a group oriented multi-user social experience that goes beyond the limitations of gaming.

Much of Augmented Reality (AR) has developed as a virtual information layer, dependent upon mobile devices carried or worn by individuals, database driven, singular to each user and based on geolocation. Layar, Wikitude, Metaio's Junaio and Aurasma have become popular AR development platforms. AR experiences are composed primarily of visual layers of graphics and video, and occasionally layers of audio, with location information attached to these, stored in a database. The stored objects are retrieved via apps, usually triggered when their geo-coordinates are matched to the geolocation of the user and then rendered into the contextual 'environment' of the user, which then 'Augments' the user's 'Reality.' AR platforms thus enable the emergence of largely individuated, visual AR user experiences.

While the current state of the art for AR is indeed remarkable as an individual experience, AR presently inhibits multi-user interaction and sociability in real time.

3 THE GEOLOCOMOTION, PATHWAY AND COORDINATE NAVIGATION SYSTEMS

"Geolocomotion" is a term used to describe the way that people navigate through space using using the capabilities of geospatial technologies to monitor and control movement in context. [3] Geolocomotion is based on contextually relevant instructions, sequentially delivered by a combination of the network and specific geospatial applications. Geolocomotion navigation, rather than using an absolute coordinate framework, utilizes a framework similar to a Polynesian 'radial' navigation model where one turns/moves only as things come up in context.

The Polynesians developed a system of navigation for the Polynesian sailors by which they turn the Vaka (a Polynesian voyaging canoe) as the stars align for their particular intended direction. Most targets for the Polynesian sailor (islands) have a low horizon (e.g. height of coconut palms), which makes it difficult for them to steer towards an island as a fixed target because the variability of wave height can impede their vision. Stars are higher than waves, and are in a fixed location that has a predictable rotation. A traditional Polynesian sailor navigates by turning the Vaka when the stars orient across the bow in the right way to reach an intended destination. The Vaka may be turned again as another star orientation appears. In this way the world appears to come to them, rather than they moving across the world. [3, 4]

Polynesian Navigation is thus very similar to the Geolomotion, particularly within AR. People walk with their AR enabled devices and look for things to come into their frame of reference to help them navigate their current environment. The series of unfolding events is how the Vaka gets navigation events to occur. The Polynesians have to move for stars and planets to come across the Vaka, very much in the same way that individuals have to move their mobile devices to find and see AR productions.

4 AMBIENT AND GEOSOCIAL SOCIAL MEDIA APPS AND NEW DEVELOPMENTS IN SOCIAL AUGMENTED REALITY

People have to be social to survive. We are dependent on each other and the systems that we build with each other to exist. Edward T. Hall wrote, "Man and his extensions constitute one interrelated system," [5] meaning that however much we might like to separate that which is 'social' from that which is in the environment, we cannot, for these are interdependent.

This means that for humans, being "social" has a function greater than getting along for the company of others or to be 'personable.' Humans connect with each other in order to cooperate with each other. Social cooperation, direct or indirect, is how we are able to maintain advanced technological environments, and it is how our "interrelated systems" work to ensure our survival. We need to be social. Social relationships are thus, used by humans to negotiate tasks within the systems that sustain us. These are not only important, they are foundational.

Social Media is one way that humans use to connect to each other to maintain, create and use social relationships. Social Media helps human cooperation by providing message channels and structures.

Social Media has expanded into the environment in the form of mobile and trackable apps that are based on connections which may be distant in both time and space. Through mobile apps, Social Media can compress time and space to offer seemingly 'smarter' connections in place as well. This further enables people to make use of their social relationships.

Social Media applications have changed with the addition of geolocation. Previously, these provided a software ‘place’ for people to simply connect with others and share media or text. Geolocation software and the addition of mobile data devices, or smart phones, has enabled people within social media applications to utilize new capabilities. These include being able to publish,

broadcast and share their locations, earn badges, points or discounts for disclosing this information, and track the locations of others who are also members of these applications, and who share or contribute to their various schemes. Many people find that they are able to increase their social time by finding friends gathered at specific locations.

By 2011, there were apps being developed that changed the paradigms of Social Media by adding geolocation properties. Two examples of those new types of apps were Sonar and Pearescope. Sonar enabled people to target specific locations to see both who was present at the location and also how they were connected to them in terms of relevance. The app used a combination of location data and social media data that people have already made public, to build its profiles. [6] The apps Sonar used to do this included foursquare (an app based on using a physical location to update status within a network), Twitter, Facebook (a social network for people to connect with each other and share information), LinkedIn (a professional social network), Instagram (a social photo sharing site), Eventbrite (a large scale social media event organizer) and others. Once the datapoints from these sites were aggregated, the result was a 'social' profile of people 'in the room' of how they were connected to each other, and the depth of their connections. In short, privacy issues aside, Sonar attempted to fill in the narrative of peoples' lives and provide contextual information about how a crowd is related to one another socially.
Pearescope was billed as a 'spotlight for location.' It did not use other Social Media to function and was billed as being "check-in free and private." Users set the area around their smartphone, with the option to specify a time frame that they wished to be visible within and Pearescope applied their social networks to that area and time. When their 'spotlights' (and times, if specified) overlap with other users, they were connected and Pearescope sent a text message to both members introducing them. The unique feature of Pearescope was that it connected people to friends-of-friends (the second network) via specific, selected information [7].

What was interesting about both Sonar and Pearescope was their use of a combination of geoproximity and people to create social environments that were enhanced and offered extensions of the primary Social Media network. This built a foundation that could have extended Social Media towards the potential of multi-user AR, if it could have been further applied. Unfortunately, both Sonar and Perescope are no longer in business.

However, the idea introduced by those ambient apps has not been abandoned. Companies are looking at ways to extend the idea of ambient apps in ways that provide privacy (not all networks are available in some of them) and enable usefulness within specific contexts. In the matchmaking space, geosocial apps Tinder and Grindr both enable users to set up a perimeter that is then used to connect people to each other. However, this is not considered to be "ambient" in that it is a fairly straightforward connection. Foursquare can use a person's location and check-in history, in combination with other's reviews of services in the area, to make personal recommendations to an individual. This is not social in that the app is not connecting people to people, but rather to the record of their experiences. Some additional work on trust and privacy will need to be completed before ambient apps again enable social connections to the degree that they displayed from 2008–2011.

Aside from apps on mobile devices that may be shared to create a social experience through rendered data layers, the newest developments in AR towards shared sociability seem promising. Technical Illusions has developed castAR, which is a both a projected and true augmented reality combined with a virtual reality. [8] CastAR enables people to focus their eyes at a natural distance while still experiencing AR. To use castAR, people wear head-mounted semi-transparent glasses that have an open sides and top, with a projector mounted over each eye. Images from the glasses are projected onto the castMAT, a special portable screen surface that can receive castAR projections and bounce back light to users with minimal scatter. A single castMAT can be viewed by multiple people wearing multiple castAR glasses. This enables people wearing individual castAR glasses to have common shared and social experience as they interact with AR content. The hardware of castAR enables sociability: a shared mat for common shared experience along with the ability to see the real world simultaneously through semi-transparent glasses, in combination with a shared game, provides a shared highly social, individually interpreted User Experience. CastAR is an extremely encouraging step towards shared sociability in AR.

While castAR represents the best-of-class for current shared social AR with virtual reality (VR) as well, Magic Leap is trying to develop a future based on a Dynamic Digitized Lightfield Signal™ that meets their goal that "the future of computing should be derived from respecting human biology, physiology, creativity, and community." [9] Magic Leap has recently hired science fiction author Neal Stephenson as their Chief Futurist, to ideate scenarios for how their technology can be applied. Stephenson says, "Magic Leap is mustering an arsenal of techniques … to produce a synthesized light field that falls upon the retina in the same way as light reflected from real objects in your environment." [10] While this still in development, the idea would be that people would have augmentation in their eye directly, rather than having to wear any hardware externally and that the combination of this would enable a shared experience without visible hardware.

5 POLYSOCIAL REALITY (POSR)

PolySocial Reality (PoSR) is a framework developed for representing complex synchronous and asynchronous messaging contexts. It emerges from the current way that humans communicate, and contains the aggregate of all the experienced 'locations' and 'communications' of people in multiple networks at the same or different times. Thus, PoSR describes the overlapping network transaction spaces that people traverse synchronously and asynchronously with others to maintain and use social relationships via various apps, mobile services, sensors, platforms, technologies and conversation spaces. [11] Used here, PoSR represents the aggregate of all communications between all individuals rendered conceptually as a multi-layered network where a message between individuals within a shared layer represents shared context, and knowledge of communications between individuals within layers is not accessible to individuals communicating on other layers. [12]

An instance of PoSR emerges in many circumstances. For example, someone may be walking down the street and talking on the phone and texting and someone else is doing the same thing to them at the same time and both parties may be communicating through different channels to other people as well, leaving messages (asynchronous) or communicating in real time (synchro-

nous). Instances of PoSR can emerge from automation as well, when someone enters an environment and checks into Foursquare and it delivers a tweet and a Facebook update (to multiple "friends") notating their location or experience while someone else may responds to any one of their initial messages in real time. PoSR represents the partial conversations that people are having with each other because they are unaware of the full scope of each other's set of network locations and corresponding communications. In relationship terms, the transmissions of the contact between networked human relationships is both structural and temporal, and PoSR represents the dynamics of shared information and context between individuals. Thus, PoSR describes the network transaction space that humans are inhabiting with themselves and others in order to maintain their relationships and includes doing so via various apps and mobile services.

Instances of PoSR compound. If a person is managing a portfolio of relationships through messages (these may be analog or digital, synchronous or asynchronous), and someone is engaging in similar behavior, and both people come together, how is commonality determined? The different perceptions continually compound. If a third person joins in, how are they able to sort out where there is a common ground? PoSR can get very complex, pretty quickly. This can create problems in that if our messaging transmission methods are garbled, lost, or do not connect enough, we are unable to use the social relationships we need for the cooperation within our "interrelated systems."

Outcomes from PoSR have many different impacts. Resolution of potential PoSR discontinuity between individuals in a multiple, multiplexed way, may expand social networks. Simultaneously, those expanded social networks may be connected by small, single dimension attributes that are not included in other communications and may be overlooked, if there is not enough overlap in meaning in the messaging structure, leading to greater fragmentation. Situations that are primarily composed of asynchronous messages with little common context may encourage individuation, and make it difficult for humans to be social with one another, even as they seemingly have a larger social network. If AR implementations continue to be focally individuated, this could compound that problem.

However, AR is also one of the technologies that shows promise for connecting people and resolving discontinuity between shared information and context [1,13] in that it has the potential to create opportunities for engaging, shared group social experiences that have enriched graphics, history, context and narrative, that can augment our environment. These shared experiences can foster cooperation and connection as our common experiences provide a foundation that enables us to build from that point forward. This results in more robust problem solving and creates new capabilities and tools.

6 SOCIAL AUGMENTED REALITY

Multi-User interaction is one way that humans can share a similar experience. How can AR help us be more social and incorporate Multi-User interaction? What might Social AR look like?

One way we can approach this is through games and projections, both of which have local social implications. "Seek n' Spell," by retronyms, is a game that requires players to each have a mobile device that is able to run the app. [14] Players move around an outdoor space looking for letter tiles on their device and are encouraged to move quickly to score. Tiles are combined into words and the highest word scores win. Seek n' Spell, and other games like it, are a start towards Social Multi-User AR. In these types of games, play is dependent upon at least one player being tethered to a device and needing to look through it. It is social in that people gather together to socialize before and after the game, and some may play in a team format. The games enable the player holding the mobile device to observe the competition's geolocation in real time. That can be considered a social element (at least people are in a simultaneous reality, even if it is through a device, but it is not sociability, per se). In some AR games players can go to an area and put their phone down and not have to geolocomote as they play. However, that is a stop-and-start way to address PoSR fragmentation. Laan Lab's AR game ARSoccer uses the camera aspect of the phone to detect foot movement. This is then used to correspond to the ball 'juggling' of soccer. It is for a single person to play. A way to make this game more social would both be to enable the player to find others nearby to join in a game and also once play has started to enable passing of the AR ball between players so that they could interact and share an experience. AR Soccer is limited to a single player to a single mobile device model, which in part, is what contributes to the fragmentation of PoSR and individuation within AR.

Another way that AR might become more social is through projected games or experiences. The Motion Beam project (Disney and CMU) explores small mobile projection in combination with a mobile device. [15] This enables the player to project and play a game against any surface in 'grounded reality' (the "real world"). Presently, with the Motion Beam, only a single player can play a single game, that is projected. Although sociability is limited, within projected AR there is a social aspect as others around the player may comment on play and discuss the game while waiting for a turn. However, if more people can have control, interact and be able to play simultaneously and with each other, then there is a more enabled multi-user social experience. Disney and CMU followed up the Motion Beam project with SideBySide, a multi-user experience created with handheld projectors, but it is not currently in production. [16]

7 SHARING NARRATIVES

A better way to increase sociability in AR is to determine how to create shared experiences around a narrative. Indeed, stories are how people represent and control information about themselves and about other people, and how people contribute to their orientation in the world at the time, largely the content of what is being communicated. However, in the emerging PoSR context, parts of the story are distributed over different channels and when insufficient channels are shared between two people the story fragments can be enigmatic. In the end, one of the solutions to how AR can be less idiosyncratic is for it to enable the creation, processing and sharing of stories.

In San Francisco, California, "Magic Bus" (described as "Public Trance-portation") [17] is currently an "experience" offered by Antenna Theater [18]. Antenna Theater has a history of providing individual audio tours of museums and other public works. Magic Bus is a bus that is fitted out with projection and a state of the art sound system. It offers a group bus trip through 1960's San Fran-

cisco. During the tour, window shades descend and riders see projected images from the past in 1960's San Francisco, in the form of a documentary, projected inside of the bus with an accompanying soundtrack. Periodically, the window shades ascend showing riders what documented locations are like in the present. "It's to tell people what the 60's was all about, which was a time of profound social change." [19] In Magic Bus, the navigation model is reversed: instead of an individuated Polynesian, or geolocomotion type of experience, triggered by arriving at geolocative points, Magic Bus transports a group of riders that share in the joint telling of a narrative to locations. It is gelocative, not because locations trigger events, but because the content of the narrative triggers a sequence of destinations that become the scenery to an ongoing narrative that contains many geolocative points. The riders experience the world as its points of Space-Time apparently coming to them, tacking from the past to the future.

Although Magic Bus is clearly an analog type of AR experience that is not dependent upon mobile devices with network access, and is, instead, a rather large psychedelic painted bus, there is no denying that the experience it provides is social, AR, and a group oriented, shared experience.

One problem that can emerge from PoSR is the absence of shared information. Within the multiple, multiplexed conversations and communications, information may become fragmented and there is no group social experience to give common context to the culture. In other words, there is too much social information that is missing in those extended thin, single filament social media connections. Furthermore, there is so much information that we do not know what is missing. In order to repair the absence of information shared common experiences are needed. Social AR is one approach that can help defragment the social experience of computer interaction. In short, what is the AR equivalent of the Magic Bus? Or, how do we make multiple Magic Buses for multiple pathways?

8 DISCUSSION

AR is not quite so directive nor does it have a fixed "script" like the Magic Bus. When a person is geolocomoting, there is, in every sequence of their travel, a pathway, which is determined by them from each point to each point that they travel between. If AR is to deliver more shared information it must be a part of an overall narrative, a story, on both the network and in geolocations, and not simply provide more facts about more places at isolated points.

The first step in this scenario would be to solve how an individual user might use pathway based, multi-point AR. One way to construct these stories/narratives is to fill the point-to-point pathways with information, as well as at the intermediate destinations or AR hot-spots. Some geolocal apps find nearby points of interest (POI), and offer them to the user as potential destinations from a present point. To carry this notion further, the user could reveal to an AR app what the next destination might be, and the pathway between points could be filled by a narrative relating to that segment, which could include past scenes, art, music, cinema and/or dialog to form a storyline. The goal of this extension of AR would be to impose more information on top of the pathway between points to create a more cohesive narrative that can be shared.

In this way, an extended AR app could give more information to the user about the particular pathway that they are currently traveling upon. For example, one user may set up different types of music preferences ahead of time that could be triggered on the pathway to give information about mood or safety within a certain area, creating something akin to a musical 'score' accompaniment to their progress in the current narrative they are building. Or certain images could be triggered to correspond to certain cumulative events based on pathways.

An example of this is Bluebrain's location based album, "The National Mall," an app that runs as a multipoint soundtrack in a specified geolocation—in this instance, at the National Mall in Washington, D.C. [20] As an audio based experience, listeners wear a headset while walking around the National Mall with their mobile device. A soundtrack plays that varies in composition as they approach various landmarks. While Bluebrain stated that their work was "not an augmented reality application in that it does not respond to input from the listener" and contains music "composed to be heard in their specific place in the same way one would hear it on a physical record [21]," it does provide a pathway experience in that the soundtrack plays continuously as a person travels along the National Mall and the sequencing and arrangement various by the pathway of the listener.

Although Bluebrain is firm regarding the classification of their app as not being AR, it does, in a way, provide a Magic Bus experience in that within the National Mall, a contained environment, listeners are exposed to variations of similar media. The only thing that would make it more 'Magic Bus,' is if the experience was not solely directed at individuals.

To make an AR experience less individual and more social this idea could be integrated with existing Social Media channels. If the narrative from our individual extension of AR can be shared with others in other network spaces, the multi-media narratives alone would improve the sociability within PoSR contexts—collaborators would have more context in sync, improving people's ability to evaluate messages. By producing a narrative that can be shared, at the discretion of the user, the opportunity to strengthen single strand social media connections can be increased. Because an instantiation of a narrative is linear, the individual extended AR creates a suboptimal solution in that when experiences are not shared, there is a period of 'catch-up' of experiences, which take time and attention, commodities that are rare in present times. However, when AR experiences are shared, the information 'holes' in PoSR can be partially filled, easing or even neutralizing the fragmenting outcomes of partial conversations due to the multiplicity and varying time structure of communications within PoSR.

9 CONCLUSIONS

We recommend more of the Magic Bus approach for AR, which involves creating social spaces both on pathways and on the network. In this way, as users access different social, for lack of a better word, 'channels,' they will be able to collaborate with those who are having similar shared pathway experiences via these multi-channel applications.

Perhaps then, the way to develop Social AR is to change the mode of navigation from events that are triggered by location, to com-

posite pathways connecting and relating network locations, transitions and events with physical locations and events.

Eventually, AR will be distributed into the environment and not on a single individual-owned device. With AR directly within the environment, the need for individuals to constantly check personalized, cached data could be diminished as the data is offloaded into the environment in a more distributed way. Common distributed data points give humans another common foundation to build upon.

When AR can become more active and relate to pathways as well as points, AR will be able to provide an experience that is more socially condusive to cooperation. All humans have the same sensors (with the caveat of different degrees of available usage) but form different experiences. These are shared by incorporating parts of each others' experiences into one's own. Because shared experiences are interpreted in different ways, people create different individual stories.

Individualism is not necessarily individuation. If a point in the environment can project augmented layers based on its location and the context of individuals around it, AR can be just as dynamic as present reality, and more "real" in the sense it is intrinsically sharable through common experience. Indeed, distributing control and deployment of AR into the environment will literally augment reality, with all it foibles and advantages and provide an alternate method for us to explore and benefit from social relationships as humans.

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