

# Social F-formation in Blended Reality

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## ABSTRACT

Kendon [11] coined the term F-formation to describe the spatial location as well as the orientation of people in a small group. An example of typical F-formations for a pair is face-to-face, side-by-side or L shaped arrangement, where the pair members' mutual orientation is about 90 degrees. A precondition for being in an F-formation is that the pair members would be in proximity. F-formations have been used to analyze people behavior in the real world, to generate a robot's response based on real world analysis, and to represent mutual orientation in a virtual world (e.g. Second Life). The blended reality concept unifies all worlds. An example may be a person seating with a friend in the real world, while watching the same person interactions in a virtual world, or a hologram of two others projected in the real world. Actually, people are available simultaneously in multiple worlds. Once social interplay is involved there is a need to adjust the F-formation concept to PolySocial Reality [1,2]. This paper investigates the enhancement of the F-formation concept in a blended reality.

## Author Keywords

Social signal processing; F-formation; User model; Group model; PoliSocial Reality (PoSR) Blended reality.

## ACM Classification Keywords

I.4.8 Scene analysis

## General Terms

Measurement

## INTRODUCTION

The user modeling community accepts that a person has different needs in different contexts [5]. Providing a personalized service to visitors requires that their personal and contextual aspects be identified [21]. An appropriately equipped environment may allow a system to monitor users' behavior, reason about them, and detect such contexts. This, in turn, may allow it to provide valuable personalized services. The social context is one important dimension out

of the entire user context. The F-formation concept is an example of a social detectable behavior that may contribute to social context awareness. The term F-formation has been coined by Kendon [11], who posits that "people often group themselves into clusters, lines, or circles, or into various other kinds of patterns". These patterns are referred to as formations when such patterns are sustained. According to Kendon, "an F-formation arises whenever two or more people sustain a spatial and orientational relationship in which the space between them is one to which they have equal direct and exclusive access". Regarding pairs, Kendon describes spatial arrangements in an F-formation, such as being face-to-face, side-by-side or having L-arrangement. The F-formation concept requires extension when Poly-Social Reality (PoSR) is involved [1,2]. For example, a situation where two people watch a computer screen displaying one of them as an avatar interacting with a third person in Second Life, may require enhancement to the F-formation concept. This paper presents such possible enhancements for mixed realities and PoSR, named PoSR-F-Formation. It may serve as a step toward modeling of social behavior in a complex social context, as in the case of PoSR. It may guide future data collection, serving future evidence based personalization (or rather 'groupalization').

## RELATED WORK

The social context is an important dimension of user modeling and group modeling. Environments such as cultural heritage sites exemplify the potential use of mixed reality as well as social context. Until recently, user modeling in general, and in cultural heritage in particular, focused primarily on modeling individuals. Previous studies focused primarily on exploring the feasibility of using novel technologies to support individuals visiting a museum, mainly by improving methods of information delivery, as surveyed by Ardissono et al. [4] and Kray and Baus [12]. Some applications exemplify group modeling: recommendation systems [9,10], tabletop displays [18]; synchronous information sharing [3]; and asynchronous interaction [13]. Such applications were aimed at providing collaborative tools, such as voice communication, messaging, leaving messages or video shots for future visitors and eavesdropping during the visit, to allow and orient interaction and enhance sharing of information among visitors, with the objective of supporting groups, as well as individuals. However, these were specific prototypes that explored specific collaboration aspects.

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Kendon [11] suggests the concept of F-formation system, which may assist in the detection of the social context. It is a social concept representing members of a small group that interact. Kendon presents three spatial domains: the inner domain, which is the empty space in front interacting group members, called o-space; the narrow imaginary ring that contains all people in the group, surrounding the o-space, called p-space; and finally, the r-space, which is the area behind the interacting group members (Kendon does not present why these terms were selected [11]). As for pairs, Kendon describes three typical spatial arrangements with the prerequisite of being in proxy: face-to-face arrangement, side-by-side arrangement (facing the same way), and L-arrangement, where people are close together, about 90 degrees to each other. F-formation may describe social characteristics of a pair or its members. Some work on spatial arrangement of groups was presented prior to the presentation of the F-formation concept. For example, F-formations may be a cue for group members characteristics and personality [7,17]. In other cases, Marshall et al. [15] analyze the F-formation arrangements observed in a tourist information center, motivated by the way technology may affect the visitors' behavior. They describe the arrangements of visitors in front of areas such as a wall display, an annotation table or a help counter. Cristani et al. [8] proposed statistical analysis of social behavior based on F-formation. Finally, F-formations were also used to assist a robot in identifying a focus of attention, and to augment its behavior in the company of a human companion in front of exhibits [14,19].

The term PolySocial Reality (PoSR) was presented by Applin and Fischer [1,2]. PoSR may be described as simultaneous social interaction with others, through synchronous and asynchronous channels. A person may interact with others present in the vicinity, as well as keeping other channels of interaction such as phone or cell phone conversations, email, Facebook, Twitter, other avatars in a virtual reality environment, detecting other people locations and video conferencing. In addition, many types of interactions take place in the blended or mixed social reality of the people involved [16].

#### **FROM F-FORMATION TO PoSR-F-FORMATION**

While user modeling brings the individual, group modeling adds the social context. Cultural heritage sites add the interaction with an inhuman object, and PoSR adds the integration of all social interaction into a single social reality that involves synchronous and asynchronous interaction channels. The concept of F-formation, which is relevant for synchronous co-located interaction, seems to require enhancement. We start with preconditions for an F-formation and continue with 6 cases of social interplay to allow better understanding of the needed enhancement:

#### **Preconditions for F-formation**

F-formation arrangements are limited by the following preconditions: (1) being in proximity; and (2) having the other in sight (visual contact). For example, two people visiting a museum each in a separate exhibit hall are not in proximity, hence cannot be in F-formation; and two people speaking on the phone do not have visual contact, hence cannot be in F-formation. The above two preconditions may need redefinition in the case of PoSR. Proximity should be extended to having the "feeling of proximity", and having the other person in sight should be extended also to visual contact through technological devices. Having two avatars in proximity in the virtual world, or being involved in 'face-to-face' video conference, are extension for PoSR-F-formation.

#### **Case 1 – Social Only: Measuring a pair F-formation in the real world**

Measuring of F-formations requires identification of the group members, detecting whether they are in proxy to each other, and sensing their mutual orientation. In our case, we used RFID sensors to identify each person, as well as explicit manual identification of people as belonging to the same social group. The sensor suite included also a proximity sensor worn by a person, which senses whether another group member is within 2 meters in a sector of +/- 90 degrees from the heading of this person. These two factors define the proximity detection zone in front of a person, i.e., the frontal proximity. Finally, to distinguish between the different arrangements of the F-formation (face-to-face, side-by-side, "L" arrangement) we used a compass, and computed the mutual orientation of group members in frontal proximity. The first row in Table 1 below presents Case 1. The columns in Table 1 present the F-formation arrangements: face-to-face, side-by-side and L (90 degrees) arrangement. In table 1, an ellipse presents a person and a triangle attached to it is pointing to the person's orientation. The second cell to the left of row 1 in Table 1 presents a pair standing face to face, interacting, while their o-space (explained above) is empty. The third cell to the left of row 1 is the case when the pair members are side-by-side interacting (e.g., walking or standing together). The right cell of row 1 describes two people interacting turning halfway toward the other.

#### **Case 2 – Joint Social + Object: Adding objects**

Taking for example a museum environment, it is special because it is dynamic, people walk from one exhibit to the other, or may stand in the pathway for a chat. Hence, there is a need to add an object, an exhibit, to generate attention patterns. As in the case of the F-formation, case 2 also requires a precondition of being in proximity, increasing the potential for social interaction. The first two rows in Table 1 present two attention patterns: the first is a joint social only attention, presented in case 1 above, and the second, case 2, presents both social and exhibit attention. The diamond shape in Table 1 presents exhibits. The second cell

to the left of row 2 describes a pair watching an object in their o-space. They have each other and the object in sight, and may have a joint social and object attention. The third cell to the left of row 2 presents two people watching an object, standing side by side. Finally, the right cell of row 2 has a pair watching an object turning halfway toward each other.

**Case 3 – External Social: Attention directed to non visual social interplay**

People may be arranged in F-formation, while one of them directs her/his attention to another social interplay (e.g. getting a tweet, an email or an instant message on a smart device; or getting a phone call). In this case the PoSR-F-formation is broken due to the attention diverted to the external interplay, as shown in the third row of Table 1, where a smart phone icon separates the two people.

**Case 4 – Shared External Social: Shared non visual social interplay**

In case 4, the external social channel is shared, e.g., when two people listen together to a conversation on a speaker, or read an instant message from the screen together. In such a case the PoSR-F-formation is back to case 2, with a small twist – the object is a socially interacting device. This case is also relevant for cases where a smart agent is serving people (as in the case of a social robot presence [14,19]). This is shown in the fourth row of Table 1, where the smart phone icon represents the shared device.

**Case 5 - Virtual reality**

Virtual reality applications such as Second Life try to imitate human behavior in the real world to support the perception of presence by the real visitor to the virtual world [6]. In this situation, a group member either sees the other members of the group, or sees them with the addition of her / his own avatar. In both cases people tend to keep social and cultural behavior from the real world, as in the example of personal distance [20]. Therefore, there is a need to present social cues such as F-formation. The whole scene is reflected in the virtual world (represented by the computer screen in row 5 of Table 1), where people's orientations may be presented based on explicit input from users, or implicitly by the role they play in the scene. An F-formation in this case is presented in the virtual world, while PoSR-F-formation includes the people who activate their avatar in the virtual world, each seating alone in front of a computer or another device having also the real life interaction.

**Case 6 – Two Realities: A pair in proximity in the real world visiting a virtual world**

When a pair is sitting in front of a computer screen the PoSR-F-formation requires two F-formations: The first has two people seating in front of an object, e.g., an interactive table display, as shown in Table 1. The other F-formation is the reflection of avatars representing the two people in the

virtual reality environment, possibly in front of another object (e.g., a virtual screen). Case 6 is presented in the last 3 rows of Table 1, exemplifying the increased complexity of PoSR-F-formation.

**Table 1.** Pair's PoSR-F-formation: combination of attention patterns and F-formation arrangements

Attention patterns \ F-formation arrangements	Face-to-face	Side-by-side	L
	Case 1: Social only		
Case 2: Joint social + object			
Case 3: External social			
Case 4: Shared external social			
Case 5: Virtual reality			
Case 6: Two realities			
<b>Legend:</b>			
Person + heading		Smart phone	
Avatar + heading		Computer screen	
Object		Interactive table	
Virtual object			

**CONCLUSION**

F-formation seems to be a basic concept that adds information about the social context. Once the social context expands into a poly social context in PoSR, the F-formation concept should be enhanced to better understand the context. We suggest the PoSR-F-formation concept, presented for 6 cases of poly social behavior, in regards to pairs, objects and dual reality. Future work may investigate expansion of these cases to small groups of more than 2 members, or to other cases of poly social context. This is a first step toward modeling of social behavior in complex social situations that take place in PoSR. Such social behavior is a group activity and group modeling may enable personalized services to group members as well as group services to the whole group, in whatever reality the group members are located.

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