A Mobile Game to Explore the Use of Location Awareness on Collaboration

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Abstract

This contribution presents an ongoing study focused on how location awareness feature modifies collaboration in the context of mobile computing. First it describes the environment we designed and implemented in the form of a mobile game called CatchBob!. This application running on TabletPCs engages groups of three participants in a collaborative treasure hunt over our campus. The game is used as a platform to run field experiments to get empirical results about how information concerning partners' whereabouts impact collaborative processes. We are interested in processes such as division of labor, the inferences made by participants about others activities and the building of a shared understanding of the situation. Players can communicate by drawing information on the TabletPC that displays a campus map. Those drawings are broadcasted to each participant. Finding the object was achieved through a proximity sensor that indicates how close the user was from the virtual object. Collaboration among the peers lies in the fact that they had to surround the object with a triangle formed by their positions. We tested two experimental conditions. In one condition, users could see their partners' positions. In the other condition, participants were not given location-awareness. This poster presents the game, how it enables us achieving our goals and specifies which kinds of data we are able to extract. We then report the results of a study we conducted. According to our ongoing experiment, there seems to be no differences between the two conditions with regard to the task performance. However, players without the location awareness indications have a better representation of their partners' paths. This is due to the fact that they annotated more the shared map: positions indications (to compensate the absence of location-awareness) but also directions and strategy messages.

1 Introduction

Today's mobile technologies put an emphasis on positioning. There is indeed a growing number of location-based services, that is to say mobile applications that take advantage of location information. These systems are meant to be used in various contexts like collaborative work (Xiaodong, 2004 for example), collaborative learning (Benford, 2005) and playing games (for instance Flintham, 2003). Such systems allow users to find and track a person, a group or an artifact. There has not been so much research about how mobile users make sense of the information conveyed by those systems, namely the awareness of others' position also called location awareness. Drawing on previous research about location awareness in virtual environments (Dillenbourg and Traum, 1997; Nova et al., 2003) we are investigating how this spatial information impacts collaborative processes. This project addresses the issue of the effectiveness of location awareness tools in terms of task performance as well as how it impacts collaboration and other group processes like division of labor, coordination or the modeling of the partners' intents. To meet this end, we developed a mobile game in the form of a collaborative treasure hunt played with TabletPCs on our campus. We tested two experimental conditions: with and the other without the display of the partners' position on the interface.

This paper hence presents an empirical study of how location-awareness tools are used in mobile collaboration. It first presents the platform we developed to investigate this research question. Then it describes the first results of an ongoing study we are carrying out.

2 The game environment: CatchBob!

The experimental platform we used is a mobile game in which groups of 3 teammates have to solve a joint task. The purpose for the participants is to find a virtual object on our campus. Completing the game requires the players to surround the object with a triangle formed by each participant's position in the real space. To reach this goal, they

employ an application running on TabletPCs as depicted on figure 1. This application allows each person to see his/her position as well as the one of his or her partners as an avatar on the campus map. Another meaningful piece of information given by this tool is an individual proximity sensor. It indicates whether the user is close or far from the object through the number of red bars displayed at the top of the interface. There is actually no object on the field, it only appear on the screen when the user are close to it. In addition, the tool also enables communication: players can synchronously annotate the map thanks to the TabletPC stylus. The annotations constantly fade out until they become completely invisible after 4 minutes. When the players are close to the object, the triangle they have to form appears on the display; they then have to adjust it in a proper way.
In the condition with location awareness, the player can update his or her partners' positions by clicking on a refresh button.

Even though finding the object could be carried out alone, the collaboration in this game lies in the fact that players have to coordinate to form the triangle surrounding the virtual object. It's not possible to finish the game without collaborating. We hence avoid situations like the free rider effect: each player must participate to complete the game.

All the players' interactions with the applications (positions, annotations, getting others' positions, connection loss) are logged on a server. We also developed a replay tool that allows to show the paths of each players.

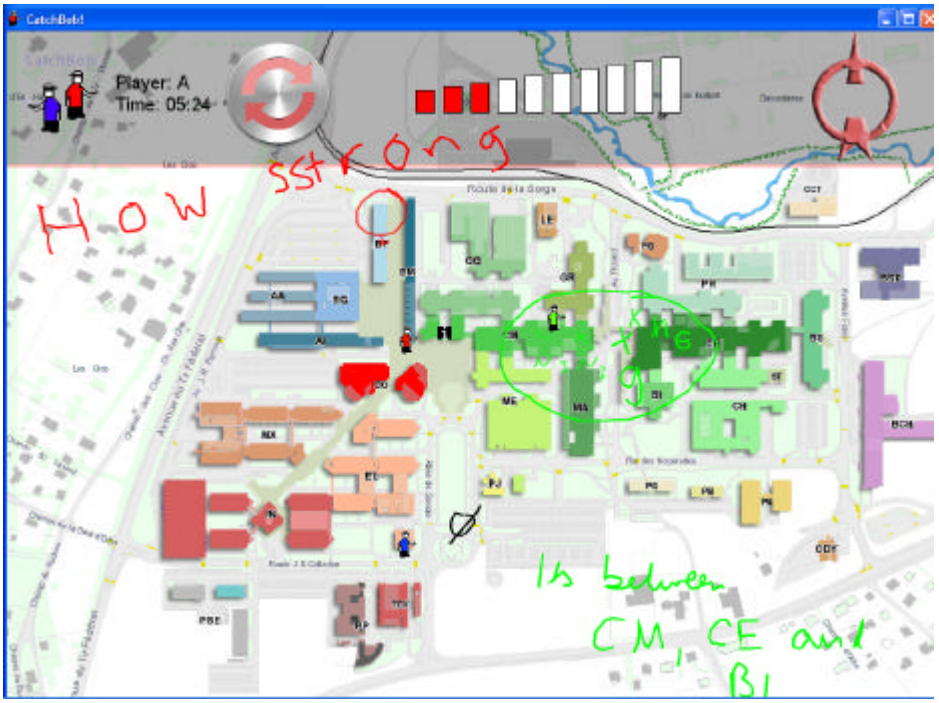

Figure 1: CatchBob! interface as seen by the red player. It shows the map of the campus annotated by the team. The proximity sensor located at the top of the screenshot shows that the person begins to be close to the object as there are 3 red bars. The button on the left of this sensor allows the user to get the position of his or her partner.

This research environment engages users in a specific kind of situation defined by different constraints. First, there is a spatial constraint since the activity occurs on the field and people are highly mobile. There is also a time constraint: the activity does not last very long: thirty minutes maximum. Moreover, the team here is fully decentralized; there are no operators at a upper level in a control room. And finally the communication constraint is due to the fact that there is no possibility of audio communication. This kind of situation can occur in various contexts like soldiers on the battlefield with limited communication channel.

3 Experiment

3.1 Procedure and method

Twenty-six students of our University (age range: 19- 26; means: 22.3) participated in this experiment. We had 7 groups in the condition "with awareness tool" and 7 groups in the condition without. All the group members knew each other and were familiar with the campus. Experiments lasted approximately one hour and were conducted in French. The whole experiment lasts approximately one hour. After presenting the game instructions at the lab, players were given 3 minutes to plan their strategy on a map. Players were then lead to the common starting point at the centre of the campus. They had 30 minutes to complete the task. After completing the game (or playing 30 minutes), players returned to our lab and filled a post-game questionnaire during 10 minutes. This questionnaire asked them to draw their path as well the path of their partners. We could hence make comparison between the path player A drawn about B or C to B or C's paths. This comparison, measured by the number of mistakes, represents the quality of A's representation of B and C's behavior in space. Players were also answered how was the collaboration, if it was balanced or not, whether they had fun playing the game and if they understood their partners' intents during the joint task.

Participants were asked to find the virtual object and surround it with a triangle made by their position with one constraint in mind: they should take the shortest path to it. We told them that the point was not to find the object in the smallest amount of time. We controlled several variables like the number of participants among the group, the fact that they knew each other as well as the field, they have the same gear (a TabletPC, no cell phone, no walkie-talkie) and they have all the same starting point.

These settings correspond to a field experiment (Goodman et al., 2004) in which we gathered different kinds of data. The performance index is the path length of each player. We also have intermediary variables like the number and they type of annotations on the interface as well as the number of mistakes they made while drawing the path of their partner after the game.

3.2 Ongoing results

Since it was a collaborative game, we analyzed the task performance at the group level. So far, we had 7 groups in each of the conditions. The task performance corresponds to the path length of each group. As depicted on figure 2A, groups without the location awareness tool seem to take longer paths; however the difference is not significant as attested by the resultants of a Wilcoxon test (the data are not distributed normally): $W = 19$, $p = 0.535$.

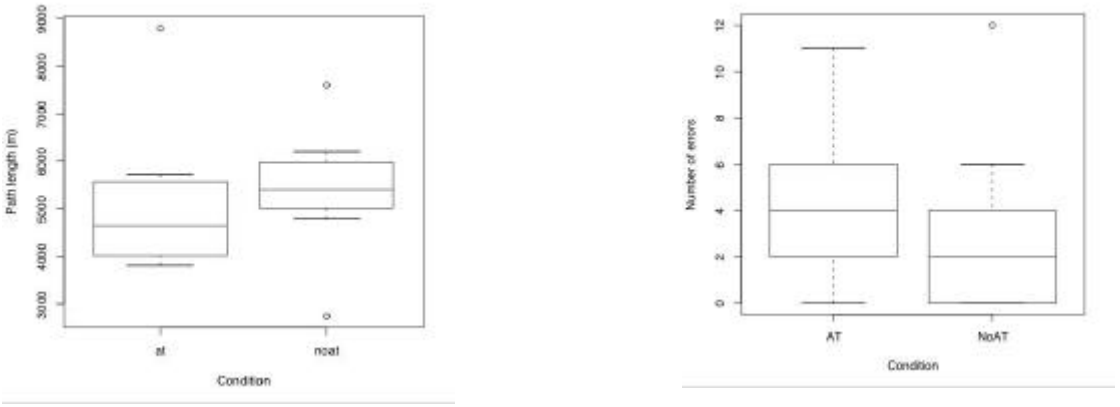

Figure 2a: path length of each group in the two experimental conditions (at: with the location awareness tool; noat: without the location awareness tool) 2b: number of errors made by each participant during the post-test (while drawing the path of the partner) in the two experimental conditions (at: with the location awareness tool; noat: without the location awareness tool).

As mentioned in the section about the experiment procedure, we measured the number of mistakes between the path player A drawn about B or C to B or C's real paths. This represents the quality of A's representation of B and C's behavior in space. We did that for each player. Figure 2b shows the number of errors in each condition. Players without the location information seem not make less errors and the differences is significant (W=466.5, p = 0.022).

The map annotations have been coded using different categories depending on the content of the messages (position/direction/strategy/proximity to the object/off-task/acknowledgement/corrections). We analyzed these variables at the individual level. The main result is that players without the location awareness tool wrote more messages (as shown on figure 3a as well as the variance analysis: F = 12.43, p = 0.001). Looking closer at the content of the message shows that the differences are significant for messages about player's position (W = 103, p = 0.002) and annotations about strategy (W = 139, p = 0.03). It's almost significant for messages about direction (W = 157, p = 0.08). We used a Wilcoxon test when the distributions of the variables were not normal.

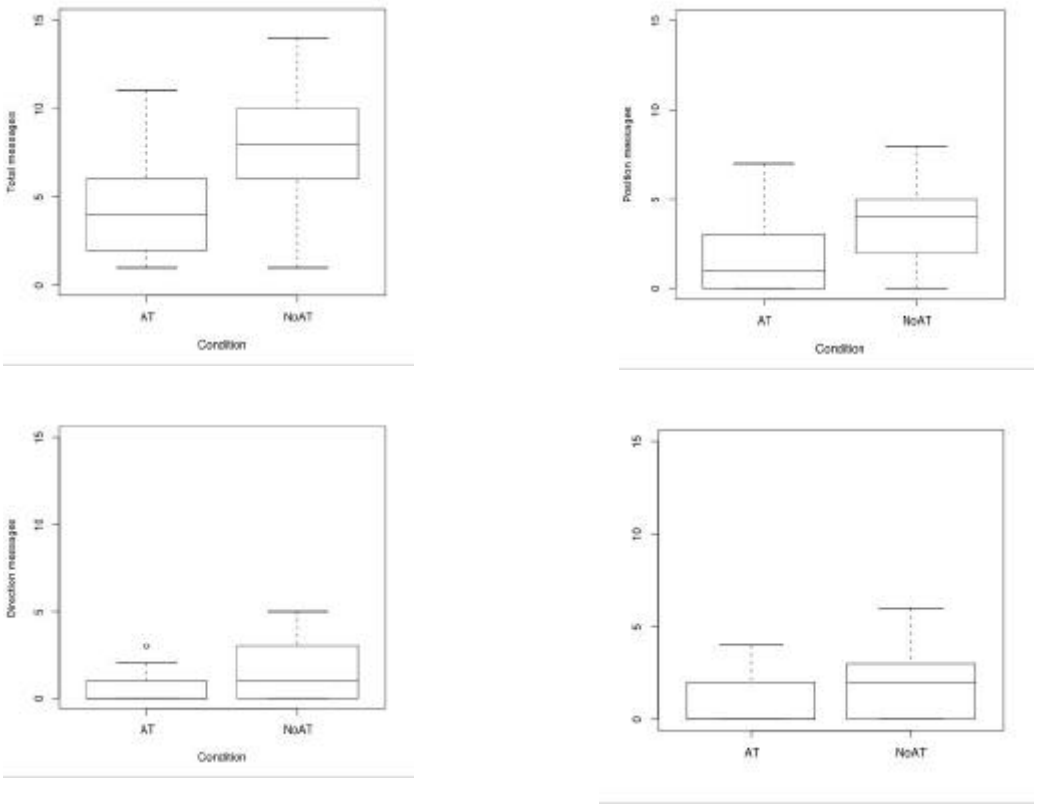

Figure 3: number of messages sent by each participant in the two experimental conditions (at: with the location awareness tool; noat: without the location awareness tool): 3a: total number of messages, 3b: messages related to their position, 3c: messages related to their direction, 3d: messages related to strategy.

4 Conclusion

In sum, participant who knew where were their partners did not perform the task better than participants who were not aware of it. In addition, people among groups without the location information did fewer errors when drawing the path of their partners after the game. These two results might be explained by the messages sent. First the amount of messages is more important in the group without the location awareness tool. And when we look at the content, we see that there is a significant difference concerning the number of messages about position, direction or strategy. It then appears that players without the tool take better advantage of the annotation capabilities, using it to express their path and their strategy. We can then conclude that in the context of this experiment it was better to

leave users without the location awareness tool with a broad channel of communication. They chose the information they perceived as relevant (position, direction and strategy) and sent them to their partners.

We are currently conducting more experiments and running complementary analysis concerning various indexes like the path of each participant.

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