Using Intention Recognition in a Simulation Platform to Assess Physical Activity Levels of an Office Building

(Demonstration)

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ABSTRACT

Designing a building to be conducive to physical activity can significantly contribute to reducing sedentary behavior in a workplace. We aim to develop a game-based simulation platform that provides an intuitive, interactive tool to assess physical activity levels of an office building. The platform simulates workplace physical activity in a 3D virtual building. The assessors can freely manipulate spatial metrics characterizing the building's layouts and investigate their potential associations to physical activity levels. The evaluation may facilitate stakeholders to assess a building plan on public health awareness. One of the key challenges in developing such a platform lies in simulating realistic personal behavior in a complex interaction environment. In this paper, we present our initial development of the simulation platform where we focus on tackling the challenge of incorporating intention recognition in human interactions, demonstrating how this incorporation realistically affects their behaviours. Furthermore, we demonstrate the utility of collective intention recognition techniques in improving recognition reliability as well as efficiency of the simulation platform.

General Terms

Algorithms, Experimentation

Keywords

Intention Recognition, Simulation, Computer Games

1. INTRODUCTION

The rapidly changing roles within the UK workforce have contributed to an increasingly sedentary population. Unfortunately, the evidence indicates that these prolonged periods spent in a sedentary condition are deleteriously affecting our biomarkers of cardio-metabolic risk and all-cause and cardiovascular disease mortality. The UK's National Institute for Health and Care Excellence (NICE) has recently blamed these 'obesogenic' environments for rising levels of obesity and diseases associated with sedentary behavior [1]. Consequently, strategies to tackle the problem have focused on reducing the nature. It is indeed surprising that despite modern buildings being planned on a level of details (such as the specification of the final fixings), no consideration is currently given to how these buildings' design can promote an active and healthy workforce.

This is partially due to the lacking of technologies on assessing physical activity levels for a building. The assessment could be conducted either ahead of the time when an actual building comes to life so that the new building will guarantee expected levels of physical activity; or even after the building has been built, the layouts could be restructured to provide greater physical activity opportunities (e.g., manipulating distances to key destinations, such as a printer, seminar room and reception, in an office building). In this paper, we aim to develop a game-based simulation platform for the purpose of evaluating inhabitants' physical activity levels that might occur within a building. The platform allows users to adjust spatial metrics of a building and visualize how the settings would impact physical activity levels. The most important element in building such a platform is to simulate physical activities of workforce in the building. The simulation needs to consider how individuals behave in a physical setting shared by others.

For the demonstration purpose, we consider a specific case of workforce manoeuvre in a two-floor building where individuals need to decide whether to take a lift or to use stairs, to the second floor. Simulating a realistic selection is not trivial since the selection is not only impacted by the physical setting, like locations of the lift and stairs, but also influenced by choices of other people in the shared environment. For example, a person, with an initial intention to take a lift that is close to his position, may change his mind upon observing that most people move towards the stairs, especially if among those are people he want to communicate with. We need to address the challenge of how people could quickly recognize others' intentions and reconsider their own intentions accordingly. Solutions are most relevant to intention recognition research, particularly individual and collective intention recognition techniques, which have been actively studied in AI and multiagent systems [4, 12, 10, 5, 8, 2].

2. COLLECTIVE INTENTION RECOGNITION TECHNIQUES

There is a significant amount of work on intention recognition techniques in a single agent setting while collective intention recognition research receives much less attention. In general, individual (collective) intention recognition is de-

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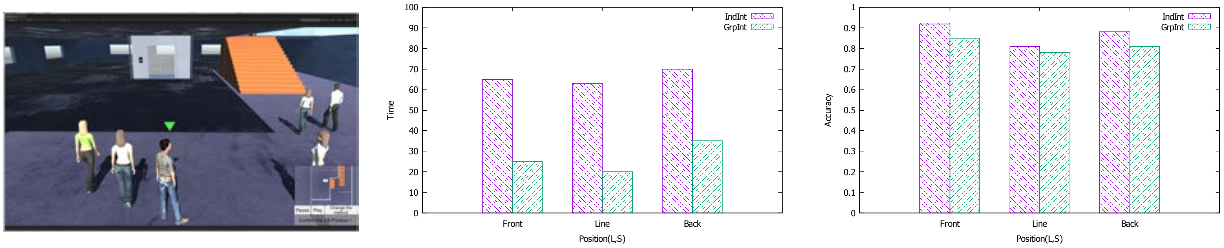

Figure 1: ($Left$) - Individuals consider their intentions about the way to the second floor: either taking the lift or walking through the stairs. The frame in the bottom-right corner allows adjusting the relative position between the lift and the stairs; and performance comparison in terms of intention recognition accuracy ($Right$) and times (seconds) ($Middle$)

fined as the process of becoming aware of the intention of another agent (respectively, a group of agents) [4, 12, 5]. In the individual case, this process is essentially a problem of model matching against observations regarding the recognized agent's actions and states. The collective case, however, requires more than just identifying intentions of each single agent in the group [11, 3, 6, 7, 13]. It needs to determine whether the agents actually act together and are willing something cooperatively, through sharing mutual beliefs and awareness, rather than just appear to have a collective intention [7, 13, 9]. For instance, in our domain, people moving towards the stairs do not necessarily have a collective intention. To identify whether these people have a collective intention, indication of mutual beliefs or awareness need to be observed. Such an indication might be that when they are in close proximity they communicate, signalling to each other, or even diverse from their optimal routes.

In this demonstration, we develop a new technique of collective intention recognition and verify its performance in the aforementioned case of workforce manoeuvre in a virtual building. Inspired by the observation that agents may exhibit identical intentions if they have similar belief states in an environment, to identify a group of agents who may exhibit a collective intention, we measure the similarity of their belief states. Then, the intention of one representative agent can be used as a collective intention for the group [6, 7]. This new technique avoids intensive computation of intentions for individual agents in order to cluster similar intentions among all agents.

Moreover, it is noteworthy that in our domain, both individual and collective intention recognition are carried out dynamically, where agents might change their current intention or leave their current group midway. This allows us to go beyond existing studies of collective intention recognition [6, 7, 12], studying group dynamics and intention reconsideration in a dynamical and interactive setting.

3. DEMONSTRATION

This demonstration aims to show the new way of recognizing collective intention in agents' interactions, which is one of the most important parts in the simulation platform. Fig.1.$Left$ shows a snapshot of the simulation platform. Individuals may decide the way (of either taking the lift or walking) to the second floor, taking into account intentions of others in the reception hall. We compare the performance of two techniques in recognizing collective intentions. The basic method, namely *IndInt* that is heavily based on individual intention recognition, computes intentions of every single person in the hall and groups the persons with an identical intention. Every group has a uniform intention of all the persons that is used as a collective intention for the group. Our new method, namely *GrpInt*, first groups the persons who have similar beliefs over their physical positions and then computes intentions of a representative person selected from the group. Fig.1.$Middle\&Right$ demonstrate that the new method improves efficiency of recognizing intentions and achieves comparable accuracy compared to the basic method when the relative position between the lift and the stair is varied. We show three typical positions where the lift is placed either in the front ($Front$), in the same horizontal line ($Line$), or at the back of the stair ($Back$). A short version of the video that compares the two methods can be found with the link [1].

Demonstration Setup and Audience Interaction: We will run the complete simulation platform in a laptop with an installation of the *Unity3D* game engine. The simulation platform will allow participants to freely configure the lift and stair positions and choose different techniques to facilitate collective intention recognition for the purpose of individual decision making.

4. PILOT STUDY

We will choose an office building in the university that has sufficient workspace of several floors and accommodate various types of workforce. We will build the energy expenditure model by collecting personal data on physical activity in the building [2]. The energy expenditure models configure avatars in the simulation platform and measure the amount of energy conducting physical activity. The expended energy of workforce indicates physical activity levels of the building. We will use the simulated data to identify feasible layouts that optimize physical activity levels of the building. Given the results, either the building layouts shall be restructured or healthy behaviors could be recommended, which aims to improve physical activity levels of workforce in the building. The proposed collective intention recognition method will facilitate the simulation process.

5. CONCLUSION

In this demonstration, we proposed a new method of collective intention recognition in a game-based simulation platform. A pilot study will be conducted to assess physical activity levels of the building. It is expected that the building could be properly designed so as to increase workplace physical activity and decrease workplace sedentary time.

[1] https://goo.gl/2CMcYb

[2] The data collection techniques follow the methods described in the patent(No.: US20150374290 A1)

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