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Improving Human-Agent Team Performance Through An Audio-Visualized Communication During A Teamwork

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ABSTRACT

In this paper, we deal with human-agent teams involving software agents and human agents collaborating to resolve a common problem. We propose experimenting the impact of integrating audio-visual interactive skills on the team performance: vocal communication act is integrated in the autonomous agent so that it can explain its behavior to human using voice as a communication channel; visual communication act is modeled to allow humans to track software agents' movement in the environment. We carry out a series of tests using the testbed BW4T (Block World for Teams) to highlight the evolution of agents' communication with new interactive capabilities partly adapted from DEFACTO(Demonstrating Effective Flexible Agent Coordination of Teams through Omnipresence) experiment . We propose implementing that experiment in Jason platform well adapted to develop such very complex systems where BDI (Believe Desire Intention) agents need to interact in complex ways with humans and/or with each other. The result is a significant improvement in team performance assessed through the completion of the joint task due to a better understanding of the overall situation of the task workflow.

Keywords: Human-agent teams, team performance, audio-visual interactive skills, BDI agents, Jason.

I. INTRODUCTION

Our study deals with multi-agent systems containing human-agent teams where software agents, autonomous, independent and proactive pieces of software denoted agents, collaborate with human agents denoted human, to resolve a common problem. A team is a set of two or more individuals interacting dynamically and adaptively through specific roles while striving towards a common and valued goal (Marks MA, Mathieu JE and Zaccaro SJ, 2001). What a team does is known as a taskwork whereas teamwork describes how teammates do it with each other (Johnson, M., Jonker, C., Van Riemsdijk, B., Feltovich, P. and Bradshaw, J., 2009). Teamwork has become a widely accepted metaphor for characterizing human and agents' collaboration to resolve a common problem performing a joint taskwork (Johnson, M., Jonker, C., Van Riemsdijk, B., Feltovich, P. and Bradshaw, J., 2009).Successful teamwork requires people and agents to working together effectively and smoothly as teammates thus reaching a best team performance. Successful completion of a human-agent teamwork's shared overall goal is the rationale for its creation. That performance was our first concern when exploring human-agent teamwork previous research. We particularly noticed a decreased team performance in a BW4T (Block World for Teams) experiment (Johnson, M., Jonker, C., Van Riemsdijk, B., Feltovich, P. and Bradshaw, J., 2009) due to an overload of information exchanged during the teamwork (Schurr, N. Marecki, J, Kasinadhuni, N, Tambe, M, Lewis, J, and Scerri, P, 2005) whereas more success sanctioned team performance in DEFACTO(Demonstrating Effective Flexible Agent Coordination of Teams through Omnipresence) experiment [Bordini, R.H., Hubner, J.F. and Wooldridge, M., 2007) thanks to the omnipresent interaction it implemented. We thus propose in this paper an experimental study which demonstrates that adding new audio-visualized communication skill within the original BW4T testbed may improve the implied team performance evaluated through the overall joint task completion time. We base our proposal on the DEFACTO omnipresent interaction that we extend to a voice communication feature. We detail the experiment set up and implementing of this study in section two before section three discusses results and a conclusion ends the study..

II. OUR EXPERIMENT

The experiment discussed here was carried to show the contribution of visual and vocal communication to improve coordination in the BW4T environment. We first set-up the experiment and then implement it and discuss its results.

A. Experiment Set-up

We carried out a series of three tests that involved a one agent-one human team. Six male participants aged 22-25 with no previous BW4T experience took turns representing human. We proposed to each of them a trial of the task to perform jointly with agent thus picking colored blocks from the room and dropping them to the drop zone. The first test evaluated blocks delivery time for an agent and a human communicating via text messages. During this test, the BDI (BelieveDesireIntention) agent cooperated with human agent by sharing its goals and intentions e.g., what it is going to drop to the dropping zone, what color block it's searching for, and beliefs e.g. what blocks it perceives in rooms. The second test estimated the time for the task carried out jointly by a human and an agent using a video communication channel, In this test there was no explicit information sharing. Human and agent used implicit information sharing e.g. human could see that agent is about to go to the drop zone and it would go and pick the next block by just looking at

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the video thus saving time and sharing information in an efficient manner. In the third test the human-agent team shared information using audio-visual communication, that is to say there was implicit information sharing through the video and explicit information sharing e.g. agent transmitted vocally its intentions and goals to human.

B. Experiment Implementation

As part of our implementation work we had to:

1. program BDI agents using Jason platform (Bordini 2007),
2. modify a standard adapter to connect them to BW4T environment,
3. convert text-based communication in BW4T to a vocal communication and,
4. develop a visual communication act for human agents.

We detail the third and fourth points in what follows.

Vocal communication we integrate in BW4T is based on Mary Text To Speech System (MaryTTS) an open-source multilingual Text-to-Speech Synthesis platform written in Java (Charfuelan. M., 2012). Fig. 1 below illustrates the MaryTTS operation in the BW4T environment.

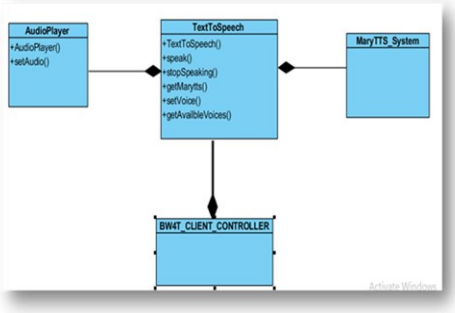

Figure 1: (BW4T_Client_Controller) receives notifications from software agents that it converts into speech by using the (TextToSpeech class). The latter produces an audio file to be played by (AudioPlayer class).

The visualizer we integrate in BW4T is a sockets-based software to provide human agents with the option of tracking what software agents are doing in the remote location. The remote server regularly takes screen shots that it transmits to the remote client, which makes it a good quality video. They may therefore intervene to help them leading to a best team coordination. Fig. 2 following shows the original BW4T evolution to visualized BW4T

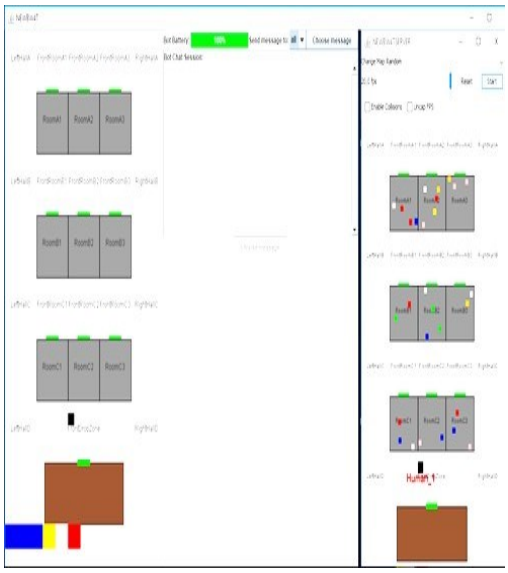

FIGURE 2: VISUALIZED BW4T

III. RESULTS

The series of tests carried out to test the integrated techniques were conclusive (Fig. 3 below shows a noticeable improvement in team performance evaluated through the joint task completion time due to a better understanding of the task workflow of the overall situation). Future experiments should employ a larger number of participants and conduct statistical analysis in order to have a more significant result.

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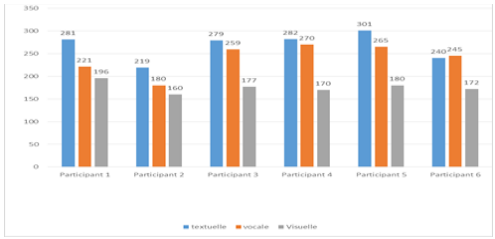

Figure 3: Joint-task time expressed in seconds depending on communication (left stick representing textual mode, middle one representing mixed textual-voice mode and right stick representing visual mode) between a software agent and a human agent represented by one of the six experiment participants.

IV. CONCLUSION

We hypothesized an expected improvement of the performance of a human-agent team operating in the BW4T

testbed by extending their communicative abilities to a more natural audio-visual form: we added in BW4T a visual communication based on that proposed in DEFACTO, extended to a voice communication resulting from a conversion of text messages to a voice form. Additional efforts were necessary to master the BW4T environment and successfully connect it to the multi-agents platform Jason.

We estimated a normal improvement of the exhibition of a human-agent team working in the BW4T testbed by stretching out their open capacities to a more regular general media structure: we included BW4T a visual correspondence in view of that proposed in DEFACTO, reached out to a voice correspondence coming about because of a transformation of instant messages to a voice structure.

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