Migrating Artificial Companions (Demonstration)

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ABSTRACT
Migration is the ability of an agent to transfer from one embodiment, for example a robot, to another such as a mobile phone. For agents that are to act as personal companions migration is desirable as access to different capabilities can provide more constant companionship to a user. This interactive demonstration of screen to phone migration illustrates one application of the open-source architecture developed on the LIREC project to support migration of an affective agent across many types of embodiment.

Categories and Subject Descriptors
I.2.11 [Artificial Intelligence]: Distributed Artificial Intelligence – *Intelligent Agents.*

General Terms
Design, Experimentation, Human Factors.

Keywords
Intelligence for human-robot interaction, Middleware for robot systems, Affect and personality, Migration.

1. INTRODUCTION
The LIREC project[1] (Living with Robots and intEractive Characters) investigates long term interaction that combines work on the integration of robots into human social environments with that of virtual agents. It combines the development of an innovative agent framework and user studies in an attempt to carry out experiments to guide the design of social agents that can play an acceptable long-term role. Both social robots and virtual agents are embodied, the former physically and the later virtually. Physical embodiment raises still unsolved engineering problems of power sources, mobility and localisation that typically limit the ability of robots to accompany humans as they move from one social environment to another - for example from home to work. Virtual embodiments are much more transportable but by their nature cannot perform physical tasks such as fetching and carrying.

For this reason, LIREC investigates migration, the ability of a synthetic companion to move from one embodiment to another. This of course raises a new set of research questions, of which the most important is: what exactly migrates? We define this as the companion's identity, by which we mean those features that persist and make it unique and recognisable from the user's perspective. These features, themselves a research topic [6], may include common attributes of the different embodiments, for example similar visual appearance, but also common aspects of interactional behaviour, such as emotional expressiveness, and a memory of events and interactions that have taken place in multiple embodiments.

The question of what migrates also requires a technological answer. It is clear that a degree of architectural commonality across embodiments is required if migration is to be a generic capability of LIREC companions, which consist of many (~20) different robotic and virtual platforms. This demonstration shows instances of the developed architecture on two (virtual) platforms, and allows a user to trigger migration between the two, and see that the agent's identity migrates between them.

2. CHALLENGES
There are several challenges that impact the design of the architecture for the LIREC project, and motivate some of the decisions.

2.1 Identity
The retention of identity is one of the key benefits to having a migrating personal companion, but this raises the question of what exactly makes up identity and therefore needs to be migrated. Or to paraphrase, when does a user perceive that an agent has migrated from A to B rather than that agent A deactivated and B awoke?

Identifying these characteristics, and how to indicate migration to a user, is an open problem and the subject of research and experimentation in the LIREC project (e.g. [4]). As such, the agent architecture used must support migration between diverse platforms and the ability to include things such as behaviour characteristics, appearance and memory.

2.2 Memory
A personal companion should remember and learn from interactions, e.g. an office companion robot could remember messages from callers to the office and pass them on to team members when they return. The focus of LIREC is long-term interaction so memory modelling is a key component and also impacts on migration. Memory affects behaviour, and so must in some way be migrated, but also it grows with time and so it may be impractical to remember and migrate everything. An overview of the memory models employed in LIREC can be found in [3].

2.3 Infrastructure
For a companion to function across many embodiments, each with different capabilities, we must be sure the architecture is designed to handle these differences. This is somewhat at odds with the

Appears in: *Proceedings of the 11th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2012)*, Conitzer, Winikoff, Padgham, and van der Hoek (eds.), June, 4–8, 2012, Valencia, Spain.

need to standardise the software infrastructure to allow migration. Any architecture will have to describe the available sensors and effectors of an embodiment on a meta-level so that even an agent unacquainted with a certain embodiment can inhabit it. This requires sufficient abstraction of the low level functions of a platform, and suggests a layered architecture – described in the next section.

3. AN ARCHITECTURE FOR MIGRATING COMPANIONS

Necessarily this is only the briefest overview of the architecture, more details can be found elsewhere, for example [5] provides detail on the middleware principally responsible for supporting migration and [3] has detail on the memory.

The architecture is a standard three layer design to handle the various levels of abstraction required. A summary of these layers follows, with pointers to further reading.

3.1 Top Layer

This is the highest level of abstraction, and contains the agent's "mind" and memory, responsible for action selection and reasoning over goals and emotions. For many of the companion scenarios, it is important the agents reason with reference to emotion, and so the emotional continuous planner FAtiMA [2] is used, which has been enhanced for the LIREC project with a "theory of mind" component and advanced memory mechanisms, e.g. generalisation and activation based forgetting. This level is very embodiment-independent, concerned mainly with goals and high level actions and not the details of how they can be achieved, which may vary between embodiments and is handled by the middle layer.

3.2 Middle Layer

This is the layer responsible for co-ordinating the various sensors and effectors, matching the competencies of a platform to the needs of actions requested by the top layer. The middleware developed and made available as open-source is CMION [5] (Competency Management with ION), built on the agent simulation framework ION [7]. This wraps functionalities of an embodiment in competencies, which are provided with a basic means of intercommunication and data storage. This common interface allows for a competency manager to map actions of the top layer to a predefined competency execution plan consisting of a number of competencies that realise the requested action in the embodiment. It is designed to be modular and portable, written in Java – for example there is a version for Android mobile devices. The modularity allows for dynamic loading of competencies as required. This is the layer that handles migration. All of the top layer is migrated as it is independent, whereas the exact competencies that require migration depend on the embodiments in question, therefore it must be this layer managing the process.

3.3 Lower Layer

This is the layer that handles implementation details of individual platforms, and so varies more significantly. Most of the LIREC robots use SAMGAR [1], a modular robotics framework developed within LIREC, whereas other embodiments may just use platform specific methods, e.g. Android mobile devices.

4. DEMONSTRATION

The demonstration for AAMAS will consist of a virtual agent embodied in a monitor that people may interact with via simple gestures, and an alternative mobile phone or tablet embodiment that the agent migrates to. The user can then continue to interact with the same agent. This combined with a poster detailing the architecture developed will allow us to discuss the various issues encountered on LIREC and explain the operation to those interested in re-use of the framework. The architecture has shown its general applicability in the many different embodiments used by LIREC, and its public provision under open-source licenses is a key legacy of the project and so may be of wide interest.

A video demo of one of our research scenarios, containing several such migrations, can be seen online at:

http://vimeo.com/21156543

5. ACKNOWLEDGMENTS

This work was partially supported by the European Commission (EC) and is currently funded by the EU FP7 ICT215554 project LIREC (Living with Robots and intEractive Companions). The authors are solely responsible for the content of this publication. It does not represent the opinion of the EC, and the EC is not responsible for any use that might be made of data appearing therein.

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