AGENT CHAMELEONS: MOVING MINDS

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ABSTRACT

Embodiment as discussed in Artificial Intelligence research to date has been implicitly based on one "mind" for one body. This paper discusses work which aims to realise a system where the "mind" has the opportunity to migrate between different "bodies" and thereby achieve a new perspective on system design and artificial intelligence through the exploitation of digital and mechanistic functionality inherent to the system. The Agent Chameleon aims to go beyond more conventional approaches where natural system paradigms are primarily the reference and develop new perspectives on agent design and functionality.

1. INTRODUCTION

AI research has developed from the classical approaches (Good Old Fashioned AI) where the mind is viewed as distinct from the body. A rethink of this approach developed from experiments with autonomous mobile robots, notably the robot "Shakey" by Nilsson in 1968 and gained considerable momentum in the mid 1980's to early 1990's as New AI. This involved a change to a more reactive approach in behaviour design and robot control. In recent times, a more balanced perspective involves the fusion of the original purely deliberative approaches with the highly reactive approach of New AI leading to hybrid reactive-deliberative architectures that take the environmental context more into account.

While to date, AI research has developed strategies for collaboration between different "minds" and their bodies, the work presented in this paper develops a new approach where the mind is viewed as more distinct from the body where it can choose its body dependent on the task to be completed. This does not contradict the interdependency of mind and body as the body nevertheless remains key, providing a strong sense of context for the instantiation of the "mind". The following sections will elaborate on these issues.

2. EMBODIMENT

In aiming to achieve a stronger sense of what an intelligent systems comprises, the physical manifestation of the system is regularly argued as an integral aspect of intelligence [1][2][6][9]. The provision of context, or embodying, influences a system's actions when deliberative and reactive components are implemented. In AI, this is generally in the form of a robotic "body" physically situated in our environment where its decisions, actions and perceptions are strongly influenced by this environment.

However, can we judiciously disassociate aspects of the "mind" from the body to a certain degree that delivers a more adaptable artificial system whilst still maintaining a sufficient degree of context to function successfully?

2.1. What exactly is embodiment?

Researchers in robotics and AI have, since the 1980's tried to negotiate "embodiment" in all its interpretations and misinterpretations (see Ziemke [13] for a discussion). While often a misused term, embodiment should refer to the more appropriate/reflective issue of complete adaptivity. In this sense, a strong sense of intelligence requires a strong sense of embodiment.

It is interesting to note that embodiment discussions for artificial systems invariably return to the discussion of natural systems, thus effectively constraining artificial systems, their designs and discussions on their achieving aspects of embodiment. The embodiment issue raises fundamental distinctions between natural and artificial systems. It revisits a fundamental issue of whether AI research aims to artificially create what we understand as intelligence, and ultimately human intelligence, or simply use the reference we can relate to of human intelligence to build artificial systems that can perform meaningful tasks with a degree of autonomy. The arguments have tended to adopt a one mind – one body approach where anything else constitutes a contamination of the stronger embodiment concepts.

But a machine is not an animal and *being* a machine is not necessarily a flaw. The digital paradigm in all its manifestations, whether real in the form of a robot or virtual, has already demonstrated considerable results by *being* different and having little reference to the natural world. It could even be said that its most successful incarnations are successful fundamentally because of this difference (i.e. repetitive assembly robots). The ability to employ biologically inspired strategies when useful but also seek new strategies in the artificial can lead to a coherent balance between the real and the artificial.

If inseparability of context and mind facilitates adaptability as proposed in debates of the importance of embodiment, will exploration of multiple contexts lead to extreme adaptability? If the system has the capacity to change its body either through a modification of a single body-form through modular engineering solutions (e.g. PolyBot [4]) or through the ability to migrate between different bodies, is this modern day artificial evolution? These features are available to artificial systems exploiting the properties of machines and their design possibilities.

3. THE AGENT CHAMELEON

The Agent Chameleon [7][11] is an agent that has the capability to migrate across hardware and software environments (a robot, an avatar in VR spaces or a character on a desktop or PDA). It is a digital friend that steps beyond today's interpretation of a Personal Digital Assistant which is inherently the hardware device. This work demonstrates that device independence allows a greater degree of freedom. Wireless technologies and digital spaces provide the medium for the digital assistant to move freely and exploit any hardware within its reach. To illustrate, if the Agent Chameleon is asked to get a cup of coffee, it "downloads" itself onto a physical robot and can now perform physical actions. Similarly, the chameleon can become an avatar in VR-space and engage in 3-D VR worlds.

Agent Chameleons transcends the often-misused notion of embodiment by illustrating complete adaptivity. Not only does embodiment require being situated, which can be superficially or easily dealt with by providing a body or embodying an agent in the physical world and effectively requiring it to interact with the physicalities, but it also includes a sense of immersion. The Agent Chameleons project takes an alternative slant on immersion: a stronger sense of context and adaptability as realised in a seamless integration across virtual reality and the actual physical reality. That is, the agent is so immersed in the context that both physical and virtual worlds *merge*.

The two perspectives mentioned previously, namely the *dualist* approach where mind is distinct from body

and the *embodied* approach where mind and body aim to function as one, have aimed with moderate degrees of success to bridge the gap between designed and realised behaviour. Collectively, these approaches are key to the development of the Agent Chameleon. While this can be viewed as a dichotomy, the provision of context for the agent mind, which has the capacity to migrate between bodies, must be implemented in order to achieve the successful realisation of an Agent Chameleon.

Figure 1: *One of the Agent Chameleon demonstrations at Media Lab Europe*

Agents that can migrate and mutate their embodied form present significant research opportunities, namely (a) the digital space can become more embedded in our own space and vice versa, (b) the agent can overcome the traditional shortcomings of being constrained to a particular information space, and (c) the classical interpretations of real-world attributes super-imposed on an artefact such as physical geometry and constraints (gravity) become less pertinent in VR worlds.

Experiments have been undertaken that demonstrate the concepts of migration, mutation and survival of the mobile Agent Chameleon agent (see [7][11] for details). Such deductive entities reside within embodied containers and exhibit the key attributes of autonomy, mobility, mutation and evolution. Mutation and evolution is here regarded as higher order attributes facilitating chameleon agents in developing a new and more sophisticated agent class. In such nomadic agent environments the degree of social cohesion is typically weaker since agent dynamics produce primarily transient relationships. This is further compounded by the mutation of agent forms, which degrades the visual cues that assist recognition and the forming of relationships. The perception of the agent becomes an issue. This is dealt with through visual and behavioural continuity in the agent's form and actions.

3.1. Multiple Body Issues

A number of design issues arise from the multiple contexts provided through agent migration. Seamless continuity of agent identity becomes important. How can our interactions with what is effectively one agent be maintained as it "possesses" different bodies? Would we recognise it after migration? Within this work, this is dealt with at both a behavioural level through each agent having characteristics which persist across different bodies. These characteristics help with the establishment and maintenance of an agent's unique social identity when interacting with a user (see figure 2 & 3 & 4). The physical robot is endowed with, for example, the same red glasses (visual continuity) and also behavioural idiosyncrasies to aid in character continuity across bodies. Restricting the agent to have the same voice also reinforces unique identity [10].
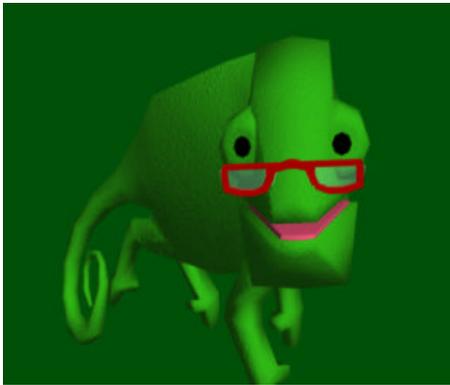

Figure 2: *The Agent Chameleon in VR space with full animation capabilities and red glasses*

Figure 3: *The Agent Chameleon in VR space after changing form (employed to facilitate illustration of particular ideas the agent wishes to communicate) with glasses*
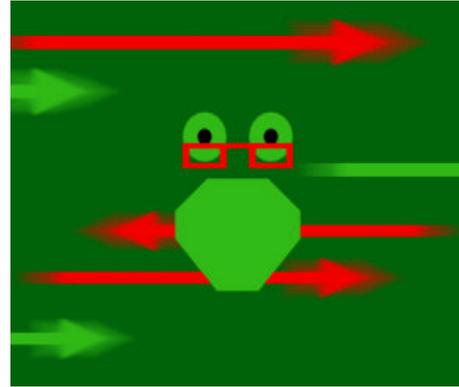

Figure 4: *The Agent Chameleon on a PDA (limited representational capabilities) with glasses*

Each of these mechanisms help to maintain identity continuity when the Agent Chameleon migrates across bodies and mutates its form in, for example, virtual environments.

4.   THE ARTIFICIAL REVISTED

The Agent Chameleons project aims to provide a new perspective on "minds" and bodies than traditionally found in artificial Intelligence. The idea of an Agent Chameleon provokes both old and new issues in embodiment. It is important to note that this concept does not necessarily work against the general embodiment debates in AI. The body provides the context for the actions and perceptions at any given time and is consequently a key element in the mechanisms for behavioural design. The added dimension of multiple bodies involves an adaptation of the robots capability sets given any particular body instantiation at a given time.

Existing approaches to embodied Artificial Intelligence generally constrains the system to using natural system references that are very often inherently difficult to achieve. Arguments for more naturalistic systems (i.e. bipedal motion because we use stairs) become difficult to maintain with the advent of more sophisticated environments and solutions (a lift). The assembly robot is a prime example of a very successful implementation of a machine directly employed for its inherent properties without complicating its design. It is a tool and functions as such. For as long as robots, and more generally artificially "intelligent" systems, are tools, their design should be the most efficient, robust and cost effective solutions for a given task or set of tasks.

In adopting the stance that one can utilise the capability set provided through digital systems, communication strategies, and hardware devices, the Agent Chameleon can migrate between different bodies

and achieve an unprecedented degree of "embodiment options" than has been exploited to date. The *key* issue is context, the provision of context for each body at a decision level and the ability to manage differing contexts with migration.

While supporters of embodiment [2][3][6][8][12] almost imply inseparability of mind & body, does the concept of migration represented in Agent Chameleons suggest that inseparability of mind & body is not literal? In order for the agent to effectively exist, it must be instantiated in one of its body options. But allowing the mind to separate from the body does not undermine the role of the body.

5. CONCLUSIONS

In looking at old (and new) books written on robotics predicting its future and how artificial intelligence will develop (and inevitably take over the world and wipe out mankind), the predicted development of the humanoid as the ultimate *useable* reference has simply not happened. Yet robots and intelligent systems *are* everywhere. It sorts our mail, builds our cars and washes our clothes. The robot form is designed around its function as the objective of developing powerful versatile tools removes the romantic starry-eyed humanoid illusion. With this in mind, research can freely explore the digital domain of the machine and its embodied form will reflect this.

From a naïve perspective, artificial systems sometimes can be viewed to be an improvement on ourselves with capabilities that extend beyond ours. Realistically, we are not machines and vice versa so, in fact, it becomes a non-issue.

Such research as presented here highlights another dimension of adaptability. Artificial systems can even be more adaptable than ourselves in certain ways we never could have considered. Using the human as a reference inherently means that an artificial system will fail in its replication, but allowing it to be a machine can facilitate new perspectives.

The sophistication of the artificial will develop and their role in our environments will be quite different than originally proposed in popular robotics books of old. They will become useful in ways that we cannot even imagine today.

6. REFERENCES

[1] Brooks, R.A., "A Robust Layered Control System for a Mobile Robot*", IEEE Jour. Rob. and Autom., 2(1) 1986*

[2] Clark, A. Being There: Putting Brain, Body, and World Together Again. *MIT Press. 1997*

[3] Dreyfus, H.L, Being-In-The-World : A Commentary on Heidegger's Being and Time, MIT Press, 1991

[4] Dreyfus, H. What Computers Can't Do, Harper, 1979.

[5] Duff, D., Yim, M., Roufas, K., "Evolution of PolyBot: A Modular Reconfigurable Robot", Proc. of the Harmonic Drive International Symposium, Nagano, Japan, Nov. 2001, and Proc. of COE/Super-Mechano-Systems Workshop, Tokyo, Japan, Nov. 2001

[6] Duffy, B.R. & Joue, G.. (2000). Intelligent Robots: The Question of Embodiment, Brain-Machine 2000 December 20-22, 2000, Ankara, Turkey

[7] Duffy, B.R., O'Hare, G.M.P. , Martin, A.N., Bradley, J.F., Schön, B. "Agent Chameleons: Agent Minds and Bodies", 16th International Conference on Computer Animation and Social Agents (CASA 2003), Rutgers University, New Jersey, May 7-9, 2003

[8] Lakoff, G., Women, Fire, and Dangerous Things. University of Chicago Press, 1987.

[9] Lakoff G. and Johnson. M., Metaphors We Live By. Univ. of Chicago Press, 1980.

[10] Nass, C., Steuer, J. & Tauber, E.R. (1994). Computers as social actors. Proceeding of the CHI Conference, 72-22. Boston, MA.

[11] O'Hare, G.M.P., Duffy, B.R., Schoen, B., Martin, A.N., Bradley J.F. "Agent Chameleons: Virtual Agents Real Intelligence" *4th International Working Conference on Intelligent Virtual Agents (IVA) 2003, 15-17 September 2003 at Kloster Irsee, Germany*

[12] Sharkey, N., Zeimke, T., "Life, mind and robots: The ins and outs of embodied cognition", *Symbolic and Neural Net Hybrids, S. Wermter & R. Sun (eds), MIT Press, 2000*

[13] Ziemke, T., "Disentangling Notions of Embodiment: Does a Robot Have a Body?" Developmental Embodied Cognition DECO-2001, Workshop at the University of Edinburgh, 31 July, 2001