Connecting People…with Robots

How Mixed Reality Can Enhance Human-Robot Interaction

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ABSTRACT

Robots are on a steady rise in our society and the need for a high degree of interaction between humans and machines is becoming ever more crucial. Robotic systems contain a complex array of technologies including control, perception, information feedback and planning. All these subsystems must work together flawlessly to operate in the environment it is placed in especially where there is a human presence. In this scenario, there is a need for the robot to interact and possibly collaborate with the human. An appropriate interface would be required to make this interaction meaningful and productive. Mixed reality (MR) would provide the means to do so merging real and virtual worlds producing new environments where both physical and digital objects co-exist and interact in real-time. Adopting this immersive technology for use specifically with a robot would enable an extra depth of understanding about the machine and improved confidence in collaborating with it. We investigate the key technologies that are popular within MR, observe the applications with robots and compare the benefits of using the aforementioned over traditional methods i.e. non-AR.

Keywords

Mixed reality, augmented reality, human robot interaction, robot, mekamon, ARKit, gaming

1. INTRODUCTION

For robots to work well in a shared environment with humans, they should act predictably, operate safely and accomplish the task at hand even when faced with the uncertainty that is attached with human interaction. Creating such a robust system would require testing the robots in a shared environment with humans and observing any irregular behaviour, resolving it thus eliminating the danger posed. However, whilst this may yield realistic results compared to offline robot simulation tools, the logistics required to organise the human resources, equipment all in a safe, controlled setting would prove to be a challenge.
Having a fully virtual world using a robotics simulator [1], on the other hand would offer high quality physics and graphical simulations. These tools give awareness into the problems that are likely to occur in the real world saving time and money, without depending on a physical robot. The drawback with this is the amount of computational resources needed to model these environments with true fidelity. Such systems would be prohibitively expensive for the average consumer. What technology then would present the most suitable interface capable of handling complex interactions such as that posed by a human and a robot? It is here that we turn our focus onto Mixed reality.

Mixed reality is the merging of real and virtual worlds in an articulate manner to produce new environments and visualizations. Elements from both worlds co-exist in uniform space and interact in real time [2], [3]. The term ‘mixed-reality’ encompasses both augmented reality and augmented virtuality, the former being the one which we will explore further.

2. FIELD

Our team is aspiring to create an augmented reality maze puzzler with a unique addition; being able to control a mobile robot in real-time. Drawing inspiration from MekaMon (Reach Robotics) and mixed reality robot simulation kits, we want to allow the player to interact with real and virtual objects whilst taking advantage of the robot’s sensors displaying its state as it navigates through the environment.

3. KEYPLAYERS

Figure 1. A Mekamon battle robot ready to engage. Actions are directed through a dedicated smartphone AR app.

MekaMon, Reach Robotics

Reach Robotics [4] is a start-up company looking to introduce their augmented reality driven robots to the mass market with their first product MekaMon [5]. It is a smartphone controlled robot used by the player to engage in battles with other MekaMon robots through AR. The player can also choose to play a solo campaign ‘shooting’ enemies that appear on the mobile device’s screen. The augmented worlds are created when the mobile device is pointed towards an AR mat implanted with numerous markers. MekaMon offers limited customisation options to personalize your robot but more importantly to match player combat style. Reach Robotics have created a new product for a new and emerging sector and MekaMon represents the first in line of mixed reality products in robotics that isn’t limited to the laboratory, which if successful, will pave the way for other similar creations.

ARKit, Apple

Apple’s latest iOS [6] iteration brings a multitude of new features, the primary one being ARKit [7]. Apple has described it as a framework allowing the user to create AR experiences for the iPhone [8] and iPad [9] line of devices. Where other tech companies have opted to go the route of virtual reality (VR) with products such as PlayStation VR [10] from Sony [11] and Oculus Rift [12] from Oculus VR [13], Apple’s desire to bring a genuine AR experience to the mainstream market could be what this technology needs to move from being perceived as a gimmick, to a necessity in our daily life [14].

Augmented Reality Enhanced Multimodal Robot-Programming Toolbox (AR-EMRPT), EON Development AB

An offline programming by demonstration (PbD) integrated tool, AR-EMRPT's function is a solution to simplify assembly automation, specifically the continuously changing product references making assembly strategies complex. It is described as a toolbox used to parametrise skill instances. It allows the user to select a desired tool from the toolbox during runtime operation; when a request for a robot target pose is passed to the toolbox, a pop up Graphics User Interface (GUI) would provide the user with options whether to use PbD, a pose stored in the simulation tool or starting the free drive mode of the robot to jog it to the desired position [15].

3.1 Summary

Apple's ARKit provides the user with the tools to build AR worlds only limited by the user's creativity and skill. Most importantly the only prerequisite is to own one of Apple's mobile devices or tablets to get started, which already commands a large portion of users in the world [16]. This could potentially lead to a community driven environment which facilitating talented developers with innovative AR ideas. Mixed-reality products like MekaMon would be the benefactor of such a setting bringing in enthusiasts from the robotic sector as well as attracting external investment [17]. The AR-EMRPT toolbox unlike ARKit and MekaMon is exclusively used for productivity purposes making output as efficient and less complex for the operator. It wouldn't be suited for entertainment packages due to its steep learning curve.

3.2 USP

Apple's ARKit is still in its infancy having being released under the iOS 11 update twenty six days ago, at the time of writing [18]. This hasn't affected the uptake of AR built applications of which games account for over a third of ARKit-only downloads [19]. Attention must have been focused on Niantic [20] most famous for its mobile AR game Pokémon GO [21]. The huge success of this intellectual property had an influence over the augmented reality world, so much so Apple who saw it wise to release a dedicated API. With MekaMon the authenticity of the nature inspired robot can be seen in the way it mimics the walking motion of an arachnid adding to the sense of realism it is trying to convey [22]. Another commendable feature is the physical animation seen when significant damage is dealt by a virtual rocket from the opponent causing MekaMon to collapse onto its plastic cephalothorax, legs twitching. With our video game, it would be worth contemplating how best to combine, light, sound and onscreen visuals to create an illusion of connection with the robot, should a particular encounter happen.

3.3 Technologies/Approach

Marker vs. Markerless trackers

Image recognition is a core component of AR. It is needed to recognise visual markers already embedded within the system so that real object is detected and a superimposed virtual element added. In order for an AR application to estimate the position and orientation of a camera with respect to the real world frame, a tracking technique known as marker based augmented reality is used by many applications. The marker tracking allows the use of a digital image to identify optical squares or markers and gauge their relative orientation to the camera itself [23].

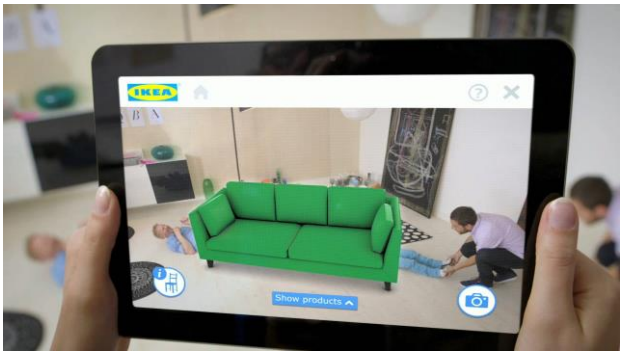

Figure 2. ARKit deploys complex but smart algorithms to produce virtual elements without the need of a marker.

4. CONCLUSIONS

A unique approach has been presented for increasing human-robot interaction based on the technology under the umbrella of mixed reality; augmented reality. Robotic developers can think of creative ways of enhancing the way we communicate with a robot using the array of sensors available in the machine in tandem with existing AR kits available, specifically Apple's ARKit. With the large user base bound to lead to a strong community driven setting. Therefore, based on our findings, fully utilising an established augmented reality kit would be the most suitable option in realising our ambitious AR puzzler.

5. REFERENCES

[1] Robotics simulator - Wikipedia. 2017. Robotics simulator - Wikipedia. [ONLINE] Available at: https://en.wikipedia.org/wiki/Robotics_simulator. [Accessed 15 October 2017].

[2] Mixed reality - Wikipedia. 2017. Mixed reality - Wikipedia. [ONLINE] Available at: https://en.wikipedia.org/wiki/Mixed_reality. [Accessed 15 October 2017].

[3] Mixed reality simulation for mobile robots - IEEE Conference Publication. 2017. Mixed reality simulation for mobile robots - IEEE Conference Publication. [ONLINE] Available at: http://ieeexplore.ieee.org/document/5152325/%5D. [Accessed 15 October 2017].

[4] admin. 2017. Reach Robotics - Reach Robotics . [ONLINE] Available at: https://reachrobotics.com/. [Accessed 15 October 2017].

[5] MekaMon. 2017. MekaMon - Next Level Robotics, Gaming and AR . [ONLINE] Available at: https://mekamon.com/. [Accessed 15 October 2017].

[6] Apple (United Kingdom). 2017. iOS 11 - Apple (UK). [ONLINE] Available at: https://www.apple.com/uk/ios/ios-11/. [Accessed 15 October 2017].

[7] ARKit - Apple Developer. 2017. ARKit - Apple Developer. [ONLINE] Available at: https://developer.apple.com/arkit/. [Accessed 15 October 2017].

[8] Apple (United Kingdom). 2017. iPhone - Apple (UK). [ONLINE] Available at: https://www.apple.com/uk/iphone/. [Accessed 15 October 2017].

[9] Apple (United Kingdom). 2017. iPad - Apple (UK). [ONLINE] Available at: https://www.apple.com/uk/ipad/. [Accessed 15 October 2017].

[10] PlayStation VR. PlayStation. 2017. PlayStation VR. PlayStation. [ONLINE] Available at: https://www.playstation.com/en-gb/explore/playstation-vr/. [Accessed 15 October 2017].

[11] Sony UK. 2017. Sony UK. [ONLINE]. https://www.sony.co.uk/. [Accessed 12 October 2017].

[12] Oculus Rift | Oculus. 2017. Oculus Rift | Oculus. [ONLINE] Available at: https://www.oculus.com/rift/. [Accessed 15 October 2017].

[13] Oculus. 2017. Oculus. [ONLINE] Available at: https://www.oculus.com/. [Accessed 15 October 2017].

[14] Augment News. 2017. 4 Ways Augmented Reality Will Change Everyday Life - Augment News. [ONLINE] Available at: http://www.augment.com/blog/4-ways-augmented-reality-will-change-everyday-life/. [Accessed 15 October 2017].

[15] AR-Enhanced Human-Robot-Interaction - Methodologies, Algorithms, Tools - ScienceDirect. 2017. AR-Enhanced Human-Robot-Interaction - Methodologies, Algorithms, Tools - ScienceDirect. [ONLINE] Available at: http://www.sciencedirect.com/science/article/pii/S2212827116007241. [Accessed 15 October 2017].

[16] Fortune. 2017. Apple iPhone Owners: Here's How Many iPhones Are In Use. [ONLINE] Available at: http://fortune.com/2017/03/06/apple-iphone-use-worldwide/. [Accessed 15 October 2017].

[17] TechCrunch. 2017. Reach Robotics closes $7.5M Series A for its augmented reality bots | TechCrunch. [ONLINE] Available at: https://techcrunch.com/2017/07/17/reach-robotics-closes-7-5m-series-a-for-its-augmented-reality-bots/. [Accessed 15 October 2017].

[19] Dylan Waits. 2017. Games Lead ARKit App Downloads, Which Top 3 Million Since Launch . [ONLINE] Available at: https://sensortower.com/blog/top-arkit-apps. [Accessed 15 October 2017]

[20] Niantic. 2017. Niantic, Inc. . [ONLINE] Available at: https://nianticlabs.com/. [Accessed 15 October 2017]

[21] Homepage | Pokémon Go. 2017. Homepage | Pokémon Go. [ONLINE] Available at: http://www.pokemongo.com/en-uk/. [Accessed 15 October 2017].

[22] YouTube. 2017. MekaMon launches robots ready to rumble in augmented reality - YouTube. [ONLINE] Available at: https://www.youtube.com/watch?v=ewqGwgM5dAM. [Accessed 16 October 2017].

[23] Markerless vs. Marker Based Augmented Reality - AppReal. 2017. Markerless vs. Marker Based Augmented Reality - AppReal. [ONLINE] Available at: https://appreal-vr.com/blog/markerless-vs-marker-based-augmented-reality/. [Accessed 16 October 2017].

FIGURES

[Fig. 1] YouTube. 2017. Battle Robot "Mekamon" - First Live Gameplay - YouTube. [ONLINE] Available at: https://www.youtube.com/watch?v=NE6F3fNsn88. [Accessed 15 October 2017].

[Fig. 2] Retail News Asia. 2017. Ikea ventures into augmented reality | Retail News Asia. [ONLINE] Available at: https://www.retailnews.asia/ikea-ventures-augmented-reality/. [Accessed 16 October 2017].