Open Affordable Mixed Reality: A Manifesto

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***Abstract*—This article describes the main traits of a proposed Mixed Reality (MR) platform designed to be used by the general public in order to create and share MR experiences. The purpose of this MR Platform is to provide interaction with the Internet of Everything (IoE). We embrace the Ubiquitous computing paradigm, where services follow the user seamlessly across physical locations. An emphasis is made on context awareness, which is central in designing a MR application, by anchoring the right multimodal content to the right circumstance. We aim at providing an architecture which splits awareness into four levels with respect to knowledge representation, in order to provide a tool for non-programmers to design applications.**

***Keywords*—Ubiquitous computing, Internet of Things, Augmented reality, Knowledge representation, Information services, Social Networks**

I. Introduction

This article positions itself in the context of the Internet of Everything (IoE) [1]. It aims towards describing the architecture of a Mixed Reality (MR) [2] platform designed for the general public in order to provide accessible MR application building through designing complex triggers for multimodal content. There is an immense unexplored potential, comprised of all that the IoE has to offer, that can now be experienced. At this point in time, the technological developments of recent years make this idea attainable. The concept of the IoE emerged as a result of the growth and differentiation of the Internet into four distinct sectors, namely the Internet of People, the Internet of Things, the Internet of Data and the Internet of Processes [1], whereas MR is the technology that provides us with a glimpse to explore it.

As our human lives are characterized by dynamism and our inner seeker nature always endeavors to reach out in the unknown, so are the applications of MR which have inexhaustible purposes. Ranging from serving in professional activities [3] and aiding education [4], to bringing self-expression in art [5] and social circumstances [6] to a whole new level, the potential of MR fulfills our needs as human beings. The necessity for having a unified approach for easily creating complex multimodal MR interaction is constantly growing, and we already have the technology to develop such a tool/system.

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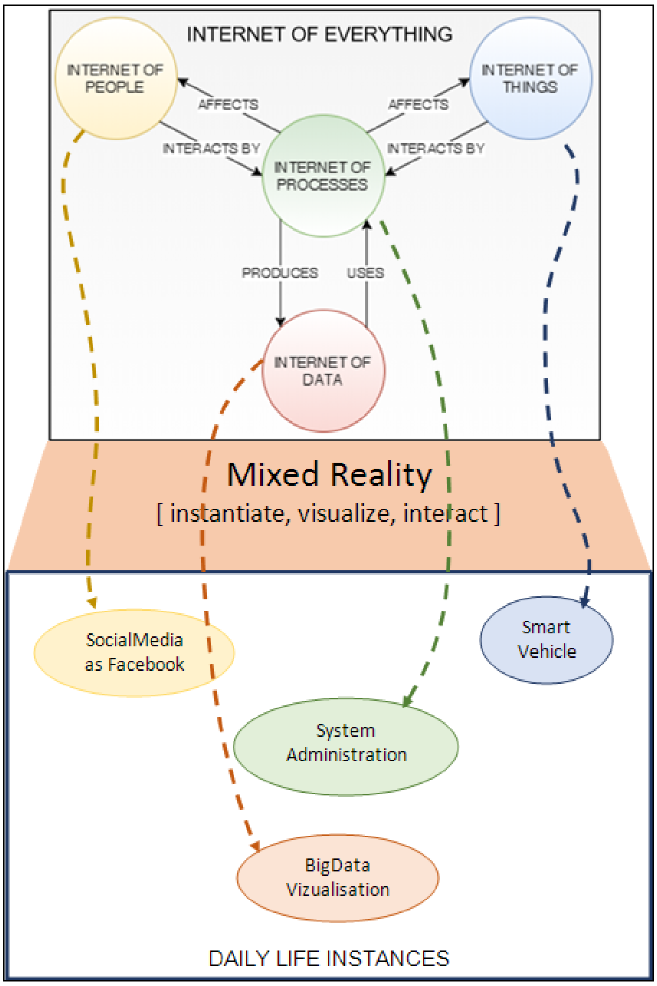

Fig. 1. Interactions between the four pillars of the IoE and instances of MR based applications.

MR applications consist, usually, of elements that rely on services of all four pillars, while most of their more specialized operations take place on a specific pillar. Some applications may require more specialized services coming from the Internet of People, such as social media networks [7]. Others may be focused on elements from the Internet of Things, such as a smart house interface [8]. Applications that provide data visualization and analysis require specialized services from the

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Internet of Data [9]. The Internet of Processes provides the stakeholders with the right information and action, such as that concerning the demand-supply chain in a process-based business network [10].

As a tool, MR is exclusively used by people, but it does not belong exclusively to the Internet of People. The reason is that, as content and interactive elements, MR may be used in applications also regarding things, data, and processes. MR is a tool for connecting people with the four pillars of the IoE.

There are several platforms that provide professional AR/MR application design. Spark AR™ has become popular among Facebook™ and Instagram™ users for creating AR filters, and it mostly focuses on providing virtual assets organization and manipulation and linking them to detected features and gestures of the user. There is also a complex MR ToolKit by Microsoft™ for Unity™ that provides complex application creation for HoloLens™ and other popular MR devices.

We propose an architecture for a platform that provides a simple user interface for quickly designing MR applications, focusing on the multimodality of interaction. We focused on means of designing and providing several levels of environment awareness as a basis for MR application design. Our goal is providing the general public with an easy to use platform for creating various applications based on services from the four pillars of the IoE as shown in Fig. 1.

The paper continues with related work in Section II. Section III introduces our vision of the architecture for the MR platform and follows with proposed scenarios in Section IV. The paper ends with conclusion on the current state of our research and presents directions for further work.

II. Related Work

In this section we will present how our research and proposal of a MR Architecture position themselves with respect to Intelligent Environments, popular AR platforms and block-based visual programming platforms. We will start by explaining how the intelligent environments paradigm shift has created an opportunity for MR application development based on the four pillars of the IoE.

A. Intelligent Environmnets and the Paradigm Shift

MR services place themselves inside the domain of Intelligent Environments [11]. They are an expression of the paradigm that governs pervasive and ubiquitous computing. Interaction is Human Centered and different types of natural detection (e.g., facial identity, gesture meaning, emotion inference) and proactive reaction (e.g., virtual response, actuator based real world response) build together the MR-based user experience. Intelligent Environments are modeled as Artificial Intelligence Multi-Agent Systems, for providing multiple levels of autonomy and dependency inside them, with the help of smart devices, middleware, and decentralized computing. Under the Pervasive Computing paradigm, context aware services follow the user seamlessly across different physical locations, thus providing Ubiquity of Intelligence inside the Environment.

During the development of personal computers there was a tendency to recreate concepts from real-life inside the computer's virtual environment (calendar, chat rooms, eBooks, virtual games, etc.). Now the paradigm has shifted towards bringing all these virtual elements into reality by the means of Intelligent Environments and Reality-Based Interaction [12]. It could be stated that now the world is the screen; the natural physical interface has been upgraded with intelligent features and more insight into reality itself, mediating interaction between users and the environment.

Reality could be customizable for everyone according to their own personal interests and needs. Furthermore, this reality will have the potential to be shared between people, bringing us closer to each other. A MR experience could either be shared in a live manner or be left to linger in the cloud to be found by others. This would be a new type of user experience that will slowly be taken for granted, embedded in culture and probably evolve its own semantic (i.e., meme) in people's lives.

B. IoE as Resource for MR Application Development

Going through the categories of IoE (see Fig. 1) one by one and discovering the potential, we realize that we may now view data in a new innovative way by linking it to the real world, and bringing to life the potential of the knowledge encoded inside it (i.e., Big Data [13]).

Data is better comprehended with the help of interactive AR visualization tools, compared to the static two-dimensional paper space [14]. This leads to better decision making inside organizations that shape the world.

The multimodal potential of interaction of MR brings interaction to a new level inside the Internet of People and the Internet of Things. People to People interaction and People to Things interaction will be mediated by new interfaces for the entities that are part of them. In [15] we see a futuristic scenario where a dating application provides the partner with data about his love interest. In [16] we see how MR technology bridges the interaction between us and Intelligent Environments, while analyzing the influence that we will exert in the evolution of the Environment and vice versa.

Processes which are the engine of the IoE dynamics could be visualized as to gain inside into the evolution of the affairs taking part between stakeholders [17]. In [18] we may see a demonstration of MR in a simulation of humanitarian logistics. Visualizing processes helps improve knowledge on the supply chain in a crisis management scenario.

C. AR/MR Platforms and Block-based Programming

Popular platforms for AR application building [19] developed computer vision based and geolocation-based content anchoring. Most of them require advanced programming skills in order to design a complex application. Furthermore, they don't provide on-hand the necessary tools for designing a distributed application with multimodal sensors and content/action output devices. Some open source platforms (e.g., OpenCV [20]) would make a perfect candidate to be used as software for a computer vision sensor.

Nowadays, coding skills are not anymore a necessary requirement for building applications. Using drag and drop block commands and visual tools, it has become increasingly popular for children and non-programmers to design rather complex applications, with the help of coding platforms such as Scratch [21] or MIT App Inventor [22]. Such platforms allow for importing certain modules that enable special additional features (e.g., Lego communication module for Scratch). A MR platform should contain special features to enable people to easily design applications with different levels of complexity, while allowing programmers to design new modules for different hardware.

In [23] a MR analytics toolkit is presented which features visual editors that provide insight into user experiences in MR apps, by allowing rapid data collection and filtering for visualization. Specific requirements for MR platforms were requested and analyzed as data gathered from 8 research teams. Some basic features were extracted, and they were tackled by means of the MR analytics toolkit on various MR apps designed for each team.

Our proposal described in Section III follows the paradigm of Intelligent Environments and brings the potential of block-based visual programming platforms to platforms designed to build apps that are part of the MR continuum.

III. Proposed Conceptual Architecture

This section starts by presenting what MR is and where MR is positioned inside the real-virtual spectrum (see Fig. 2), in order to understand what kind of interactions need to be solved by our proposed architecture. Organizing awareness over four levels (see Fig. 3) is key to argument the design of the proposed way of developing MR applications. Each different layer (see Fig. 4) from our conceptual architecture is designed to be accessed by a target user, be it a computer developer or the general public.

We based our interaction levels on a DIKW type (data, information, knowledge, inference) hierarchical representation in information theory [24]. We consider this to be a fit analogy, in the following sense:

- Data (know-nothing) is represented by the raw meaningless information gathered by sensors (e.g., Radio-Frequency Identification signal)
- Information (know-what) is represented by interpreted data such as identified objects (e.g., a Mona Lisa painting) or clusters of information with a group meaning (e.g., the original Mona Lisa from the Louvre Museum in Paris)
- Knowledge (know-how) is represented by information within a provided context (e.g., the student group is currently viewing Mona Lisa while waiting to be guided on their way to a Paris night city tour)
- Inference (know-why) is represented by refined knowledge of a situation that brings about subtle differences in decision-making. For example: imagine an art museum setting where visiting students are viewing Mona Lisa; in the other room there is another famous painting; they seem quite eager to explore and are not showing signs of tiredness; so, they will be provided with an invitation hint to check out this other painting.

As implementation, we propose to use an event driven architecture and provide the general public with access to the MR platform that is part of the software layer where they will be able to design a MR app by choosing one of the four levels of interactivity as a starting point. Practically, we wish to provide an accessible interface to designing trigger causal links between events in the real and virtual world environments in a two-way manner as it is characteristic of a MR application. Our contribution in the field of MR app creation is thus related to demarcating between the tasks of programmers to develop interfaces for a multitude of Internet of Things (IoT) devices and the enablement of the general public users to create MR apps by choosing from four different application blueprints corresponding to different levels of environment awareness, providing tools to create MR interactivity between elements.

A. *Mixed Reality in the Real-Virtual Continuum*

We consider MR as multimodal content superimposed on

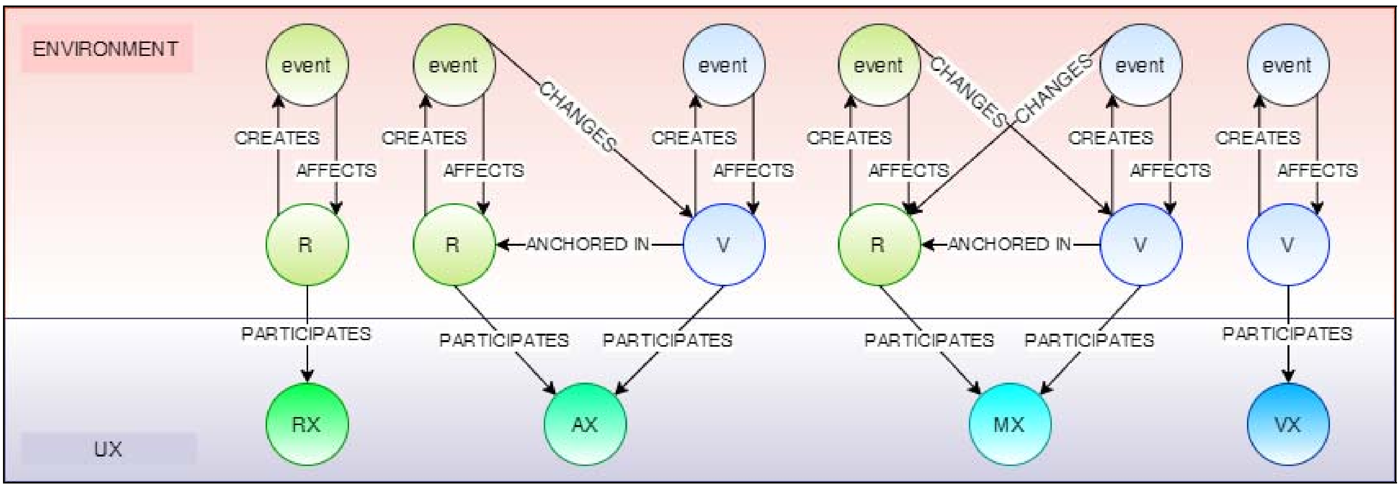

Fig. 2. Interaction between the Real (R) and the Virtual (V) environments in creating different User Experiences: Real, Augmented (A), Mixed (M) and Virtual.

reality, which has a connection to reality in a meaningful way. It interacts with elements of the real world in a two-way manner. Content may come in the form of information such as words, numbers and signs, it may be a multimodal media content, or it could bring a leap to another reality populated with intelligent agents.

Furthermore, the reality which is augmented could be our natural world (i.e., virtual elements anchored to the real world as in augmented reality, with a higher degree of interactivity) as in most cases, or it could also be an instance of a virtual environment (i.e., a virtual environment that is mapped to the real world). The meaningful connection may have a simple anchor such as a geospatial location, or it could also be defined as a sum of certain triggering events with different weights of importance that together signify the presence/occurrence of a circumstance.

Fig. 2 shows the interactions between the virtual (V) and the real (R) world elements over the continuum of MR. From left to right, there is an increase in virtual immersiveness for the user, and we identify four types of User Experiences (UX) [25], namely the Real Experience (RX), the Augmented Experience (AX), the Mixed Experience (MX), and the Virtual Experience (VX).

B. Two Way Interactions in the Proposed MR Framework

For each case, events produce changes in the world that created them. In AR, only real world events produce changes in the Virtual Environments, whilst in MR virtual world events may also produce changes in the Real world. In both AR and MR the virtual elements are anchored in the real world.

We consider the scenario of starting a car. If we turn the car key, they car engine starts. Both the car key and the car engine are real elements that interact within the real environment. If we use a VR car manual, we may reproduce the same scenario in the virtual environment in order to learn how to turn on a new car. Here, all the elements are virtual and interact within the virtual environment. Examples of a real world event producing a change in the virtual environment would be starting the car using the car key, and visualizing the engine with the help of AR. A reverse interaction coming from a virtual event and taking effect within the real environment would be starting a real car engine by using a hologram interface with the help of MR.

C. From Realities to Experience

MR is the layering of multimodal content over reality and anchoring/linking this content into/to certain circumstances. Our proposed architecture will deal with multimodal content that may come in the form of multimedia content (e.g., an animation of a mechanism exhibited as a static machinery), semantic feedback (e.g., vibration feedback meaning you entered the space of the option menu operated by hand gestures), a better insight into reality (e.g., emphasis on objects seen in infrared night vision while driving in low lighting conditions), a sensory augmentation (e.g., wind blowing in a 5D cinema), etc. Reality may refer to either natural or virtual reality, but most of augmentations are designed for the natural reality.

An experience is always real to the person experiencing it, only that it may be real, virtual, augmented or mixed. For a UX to become a MX, virtual elements should coexist with and be anchored in the real elements of the environment. The User, being part of the environment, may trigger events, as well as be affected by the MX events triggered by others in the environment, be it people, animals, nature or smart things and virtual things. MR is capable of a multitude of interaction combinations by events coming from the real and virtual environments: $\{R,V\}\times\{R,V\} = \{R2R, R2V, V2R, V2V\}$, where R signifies Real environment, and V signifies Virtual environment (see Fig. 2).

D. Environment Awareness Levels

An event is the variation of an attribute of an element being part of the environment, which is detectable by an object being part of the IoT. Anchoring content to circumstances means that certain events trigger specific content by means of different complexity algorithms. For a universal all-encompassing system, triggers may come in different forms of complexity. Trigger design depends on both gathering raw sensor data and processing in into certain levels of information such as: data, information, knowledge and inference.

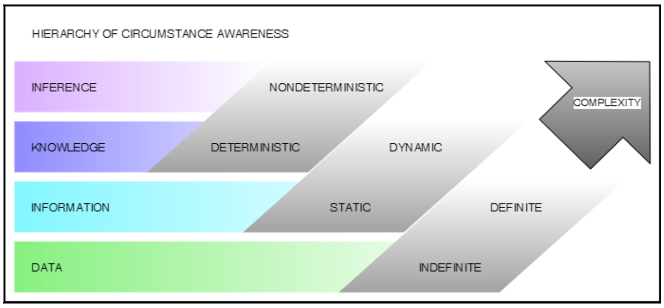

Fig. 3. Multilayer architecture of MR services.

In the proposed architecture, the awareness of the environment accessed by the application that uses events in order to identify circumstances comes in certain levels with different characteristics. Fig. 3 illustrates that information is superior to data in that it is definite and not vague, representing an identity. While data lacks specific interactivity, information provides a circumstance that triggers the same outcome every time.

Interaction at the knowledge level is dynamic compared to interaction at the information level because it possesses internal states, thus giving different outcomes for the same trigger based on the evolution of states. Furthermore, the inference level interaction is superior in the sense that internal states do not follow a predictable path, but merge into one another as a multidimensional cloud of possibilities to form a brand new state.

E. Conceptual Architecture Layers and Targeted Users

We propose a conceptual architecture composed of three layers of MR services, namely hardware, software, and emergent concepts as presented in Fig. 4. For hardware, we will use devices capable of connecting to the IoT, such as sensors, IP cameras, etc. The software layer is accessible to people of two categories, namely the general public and programmers. As depicted in Fig. 4, the yellow components will only be accessible for professional programmers, while the green component is the place where the general public may create MR apps and share them.

Web interfaces of multimodal I/O devices will mediate the communication between the MR platform, the web server and the devices. In the web interfaces, programmers define certain combinations of data outputted by sensors into meaningful events (e.g. warm room temperature, excited facial expression). These combinations may further be used by the general public when designing their MR app. Programmers also define in the web interfaces of multimodal devices certain behaviors (e.g. smooth light color change, play wild natural sounds).

The MR platform is specially proposed to enable the general public to create and experience MR applications. Users of the general public may choose as a starting point one of the four levels (i.e., data, information, knowledge, inference) to work with the desired level of Environment Awareness in order to create the MR application that they desire. After designing their causal trigger links between the web interfaces of the sensors and the multimodal output devices, the users may share their MR app.

The IoE is a vast resource of IoT smart sensors and multimodal content to be displayed by other IoT devices. The user's personal vision and journey through the IoE will then be available to be experienced together with other people. Anyone strolling through the Intelligent Environment will be able to dive into this unseen/unexplored reality brough forth to them by the creators of the MR experience.

On the top layer, we may see that Environment Awareness together with Multimodal Content produce the MR. Environment Awareness emerges as Sensor Web Interfaces collaborate with the MR Platform, while Multimodal Content emerges as the MR Platform collaborates with Multimodal Output Devices.

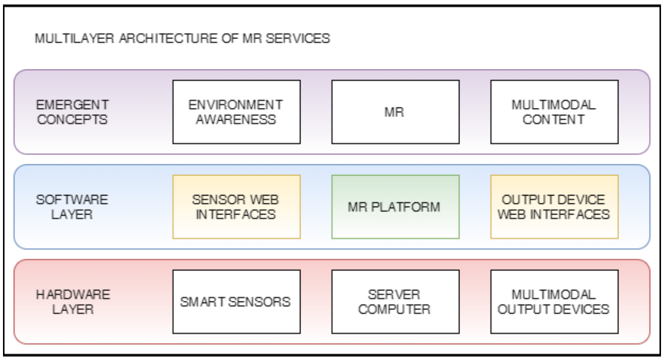

Fig. 4. Attributes of different circumstance awareness complexity levels.

IV. Proposed Scenarios

In this section, we describe several scenarios for using the system, ranging from simplistic to more complex forms of interaction. These scenarios form the premises for the proposed MR architecture that is described in Section III. Each level of complexity requires the use of a different class of tools in the design stage. We describe several real-life scenarios that could benefit from the approach to MR described above.

We focus on two environments, namely the museum and the vehicle. For each scenario we propose a possible approach to solve it using the proposed conceptual architecture. While Data, Information and Knowledge based triggers are relatively easy to implement compared to the more complex Inference level triggers, these are all feasible to develop with current technology. However, a true autonomous Environment Intelligence may only be imagined and hoped for to take shape in the near future with several technological developments such as a multitude of IoT data gathering devices populating the environment and centralized Big Data processed for Inference.

The layers of the conceptual architecture described in the previous section interact between each other in order to create a basis for MR application creation, and afterwards MR application execution for the audience. First, each of the scenarios has a device layer composed of a server that hosts the application, smart sensors for detection and multimodal output devices. In a simple scenario all of these tasks may be achieved by only one device such as the personal smart phone, which may run a MR app; it may have a smart sensor such as a QR code reader for the camera and multimodal output such as image, sound and vibration. But, as the level of awareness increases, so does the number of devices that need to cooperate in order to produce that environment intelligence. The user that creates the app will then work in the software layer on the MR platform where he may design the app with the help of block-based programming of causal trigger links between the interfaces of smart sensors and the interfaces of multimodal devices with content to be played. MR emerges as a result by connecting environment awareness with multimedia content as part of the emergent concept layer. Such a complex scenario based on multiple devices will be described in the Inference based triggers scenarios.

A. *Data Based Triggers*

The information enters the system originally in the form of data produced either as raw sensor data, or as data generated by the system. Data per se can be augmented in the sense that it could be sensed in a multimodal fashion.

In a car scenario, you may see traffic data by assigning a color to the road depending on traffic density, or average car speed on that road.

In a museum scenario, you could extract some additional information of interest by yourself just by viewing a timeline of the museum artifacts, where height corresponds to artifact quantity and color is associated with a geographical region, thus determining which time period prevailed. Alternatively, every artifact may be attributed a color as to how many times it has been viewed over the past month so you could find the most popular exhibit rooms.

Such visualization will be possible using our proposed architecture, by linking data types and mapping intervals, such as by providing a bijective function between ranges of numbers and a hue scale. This does not replace data with information, it is just data augmented with data, a process which helps the user sense the data in a more natural way.

Devices suited for the purpose of data visualization are the smart phone and specialized MR devices such as the HoloLens™, the Oculus Rift™ or the Magic Leap™. Even a hand held smart phone can provide the user with the right data at the right moment, while it may also render it accordingly in the 3D mapped space such as a MR headset would do.

B. Information Based Triggers

In a car scenario, the user could see information about past traffic incidents happening during conditions similar with the present ones (e.g. weather, time of day) as ubiquitous accident blackspot signs.

During a museum visit, information tagging could be used to enhance the user's experience by bringing an item to life through spatiotemporal immersive animations and providing data visualizations and other multimodal interactions such as sound, movement, wind, etc.

This could be achieved by linking each item's identification (e.g., QR code) to the content of interest. Guides could prepare an enhanced tour experience the day before a special tour. Using an interface based on our architecture, they would only need to provide one-to-one links between the existing identification tags and some content they uploaded inside their tour application.

Mobile devices are capable of communicating with the Intelligent Environment and provide the user with a seamless experience while moving across different places. The environment will identify the user by his wearable devices and provide him with personalized data, while collecting data for information update and system knowledge improvement.

C. Knowledge Based Triggers

We exemplify this type of context aware system with the help of a tutorial scenario. Suppose you need to check a car engine for a specific problem, and you have no prior knowledge of the engine. In our proposed architecture, this scenario may be approached by presenting the user with information in a step by step manner and react according to their voice input. This would require that, beforehand, the tutorial is modeled based on a finite-state machine. Each state corresponds to a specific content, just as the information based triggers are modeled by a one-to-one link. The application then gathers feedback from the user in order to move from one state to the other. This feedback is also a one-to-one link between a transition and an event, such as a detected key word.

Now let's take the museum experience one step further. In a classical knowledge-based interaction, one application may come in the form of designing a virtual guide that is adaptable to the user's preferences by building a dynamic route through a museum. Such a virtual museum guide will first let you check some fields of interest and mark some popular items that you would like to see. You may also fill a short questionnaire on your smart phone based on what describes you as a person (age, sex, purpose of visit) or the composition of the group (children, students, professionals), in order to be assigned to a specific tour. Based on your choices, an initial route may be proposed according to your most probable interest. By expressing appreciation towards different items, the route could be recalculated dynamically.

The interaction described above may be achieved with the help of a personal smart phone and QR codes. Suppose the route is given in terms of rooms to be visited. For each identified object that you further check out for AR content, it will be inferred that it is of a particular interest for you. For each room/exhibit that you visit, you will be prompted with a like/dislike button, and another one will be recommended for you.

D. Inference Based Triggers

High level interaction should mimic usual human social interaction. Ubiquitous computing could create, for the user, the right MR experience at the right time, seamlessly across different contexts, such as during driving or visiting a museum. While in a driving context the emphasis will be on driver safety features such as traffic monitoring, driver physiological monitoring and driver stress relief through driving task assistance and mood elevation, in a museum visit context, the emphasis will be on immersiveness inside the recreated virtual world of the exhibits.

Different devices may be needed to accomplish together such an experience. The sensor layer should be composed of devices collaborating to obtain knowledge about the user and the external situation. Such user oriented devices may come in the form of sensors measuring physiological data. The external situation may be assessed by sensors that are able to detect gestures such as Kinect™, and verbal communication such as Google Assistant™.

Imagine an interactive workshop inside an Olympic Games Museum. Complex interfaces of smart sensors will be present and have certain events that may be detected with a probability. The user may choose from those events when creating the MR app. Health sensors may detect a level of high arousal or relaxation from heart beat parameters. A camera may detect a face expression such as excitement. Kinect™ may detect body movement in a certain pattern and conclude it looks like physical exercise with a 70% precision and 30% like dancing. The user may than be able to link such data and define it as a pleasant fitness activity. If the user's face is upset it may define it as strenuous fitness activity. Some environment data may also be collected such as room temperature, number of people present and overall noise level in order to design better environment proactivity and reactivity.

Multimodal devices may be smart light bulbs that change color and luminosity, speakers that may play natural sounds or music, a smart air-conditioner, and a wall video projector. For a pleasant fitness activity with friends and a warm environment, the MR app creator may choose to bring down the room temperature, play some popular hits, and vary the light color in a playful manner. For a strenuous fitness activity with nobody around, the MR app creator may choose wild natural sounds with adrenaline rising imagery from a mountain climbing video to be projected on the front wall.

Supposing many such detected circumstance profiles and designed environment reactions are intertwined, the transition between changes detected and reaction needs to be smooth and the user feedback continuously tracked. Certain thresholds may be visually designed by the app creator in order to demarcate between circumstances using Venn diagrams, actual programming or Feed-Forward Neural Networks.

E. Future Scenarios

The pinnacle of a MR ubiquitous intelligent system would be the automated universal software for augmenting reality based on reinforced learning. As it is forecasted that the IoE would be the source of creation for a general AI (a general AI is in contrast to the present narrow AI which is goal oriented and possess skills in a narrow field), the conceptual framework that we propose could aid such a goal by providing data for learning to such a future system

V. CONCLUSION

Our work that deals with building MR applications inspired us to propose a conceptual architecture for a general platform to build such applications. Using the proposed platform, building apps such as these becomes accessible for a more general public. We demonstrate, in the following, how existing AR/MR applications fit the general MR platform proposed in this paper, in order to provide a reason for its immediate development.

The vehicular data characterization along 5 dimensions inside a connected car [26] represents an example of an information-based application design. Organizing data as such provides a cue between content and a real world event, such as gazing towards the topological allocated space for the data. Data may as well have a virtual origin, as in the case of notifications coming from a system that expresses events happening inside or outside of a system. The adaptive filters of notifications presented in [27] could be designed using the MR interface with four levels of complexity to choose from. Simple applications may be built using data as a real world trigger of virtual events, or using data as the multimedia content to be visualized when certain interactions are detected. The solution proposed in [28] for the delivery of AR content in an in-vehicle context can be characterized as being "information-based" triggered. Interaction feedback for the user and interaction effects inside the virtual environment may both be created using a four level MR application design interface, enhancing a museum experience. In [29], interaction feedback was designed over three levels corresponding to the data, information and knowledge-based detection. This was shown to be a valuable asset in human-computer interaction. In [30], interaction from several different users and across multiple interaction devices may be managed by the MR framework.

In the paper, we tackled means of designing and providing environment awareness. The proposed architecture of the MR platform follows the Ubiquitous Computing [11] paradigm, where services follow the user seamlessly across contexts. Requirements are extracted from the use cases of the application designed for the general public. They are met by providing interaction development at four different awareness levels using visual programming. The aim of exploring the IoE through a MX has two pillars: providing environment awareness and providing multimodal content. We demonstrated the usefulness of the proposed platform by characterizing existing AR/MR applications according to the main traits of the platform described here.

Current efforts are concentrated on providing a prototype implementation for the platform, in order for it to be experimented with for an AR graduate-level university course, at the Ovidius University in Constanta. Future work will include recreation of some existing MR apps, such as those in [26] and [29], in order to test the usefulness of the platform.

Further research is needed into the means of creating, managing and storing multimodal content. Creating content may be achieved by using third party applications and importing it to the MR platform. Managing content includes providing content classification and search algorithms with the purpose of reusing content between applications and optimizing storage.

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