CONTENT 2021

The Thirteenth International Conference on Creative Content Technologies

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CONTENT 2021 Editors

Hans-Werner Sehring, Tallence AG, Hamburg, Germany

CONTENT 2021

Forward

The Thirteenth International Conference on Creative Content Technologies (CONTENT 2021), held on April 18 - 22, 2021, continued a series of events targeting advanced concepts, solutions and applications in producing, transmitting and managing various forms of content and their combination. Multi-cast and uni-cast content distribution, content localization, on-demand or following customer profiles are common challenges for content producers and distributors. Special processing challenges occur when dealing with social, graphic content, animation, speech, voice, image, audio, data, or image contents. Advanced producing and managing mechanisms and methodologies are now embedded in current and soon-to-be solutions.

The conference had the following tracks:

- Data Transmission and Management
- Web content
- Domains and approaches

Similar to the previous edition, this event attracted excellent contributions and active participation from all over the world. We were very pleased to receive top quality contributions.

We take here the opportunity to warmly thank all the members of the CONTENT 2021 technical program committee, as well as the numerous reviewers. The creation of a high quality conference program would not have been possible without their involvement. We also kindly thank all the authors that dedicated much of their time and effort to contribute to CONTENT 2021. We truly believe that, thanks to all these efforts, the final conference program consisted of top quality contributions.

Also, this event could not have been a reality without the support of many individuals, organizations and sponsors. We also gratefully thank the members of the CONTENT 2021 organizing committee for their help in handling the logistics and for their work that made this professional meeting a success.

We hope CONTENT 2021 was a successful international forum for the exchange of ideas and results between academia and industry and to promote further progress in the area of creative content technologies

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Human to Artificial (H2A): from Duets with Robot to a New Model of Relationship

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Abstract— **The current technological revolution is significantly transforming different sectors and areas, creating new cross-cutting and disruptive opportunities. Aware that the pervasiveness of certain technologies -in particular, those falling under definition 4.0- will be increasingly horizontal, it is necessary to try to hypothesize, at this time, new forms of interaction and relationships. It could serve as pillars for a change and development that defines technology as a means for innovation and not as the end of it. This research was born from the meeting between a design research group and an innovative Italian singer-songwriter, who study and experiment, each with their own skills, new possible kinds of relationship stimulated by the digital transformation that is investing our society: the research therefore aims to highlight the opportunities that may arise from the intersection between the creative and design worlds and the technologies of robotics and Artificial Intelligence used in music. Starting from the last artistic project of one of the authors, which fits perfectly in the highlighted area of interest, a second goal is to try to hypothesize a new paradigm of relationships between human beings and the aforementioned technologies, defined Human To Artificial (H2A), which can be a starting point to understand and further develop new approaches to technologies that will be increasingly present in everyday life, starting from creative stimuli.**

Keywords-Design of the new relations; robot; artificial intelligence; artistic process; music piece

I. INTRODUCTION

The continuous and recent innovations in information technology have led to the fourth industrial revolution and introduced the concept of Industry 4.0: this term refers to a group of technological advances that implement the degree of digitization of a sector [1]. Four key components (Cyber-Physical Systems, Internet of Things, Internet of Services and smart factory) and six disruptive technologies (Industrial Internet of Things, digital production, Big Data, Artificial Intelligence, collaborative robots and Virtual Reality) are normally identified as pillars of the Industry 4.0 concept [2]. Until now, the attention to these technologies has been focused almost exclusively on the technical improvements that their implementation can guarantee. In fact the term Industry 4.0 connote this technological set from a productive point of view, not considering the potential and the opportunities that could arise if they are able to intersect with less technical fields, such as critical-design thinking and creative thinking. Some authors [3] already refer to the concept of Industry 5.0, in which the different 4.0 technologies collaborate and interact in a more humanized way. They hope and hypothesize a further evolution of this concept, defining a new model of society 5.0 [4], where the cooperation and the relationship between men and technologies such as Artificial Intelligence and robots, are realized in order to seek the well-being of people and not only for the sake of technology itself [5].

Two concepts prove to be fundamental to hypothesize and describe new possible forms of interaction between human beings and 4.0 technologies, which can direct innovation towards this goal: design and creativity. In design and in the design process, it is recognized the ability to rationalize inputs from many different areas and to abstract the horizontal peculiarities, in order to conceive and conceptualize new approaches, ways of use and relationship with technologies. Creativity and the creative process are instead a stimulus for the construction of disruptive interconnections between human capabilities and artificial faculties, which can be a source to develop these relationships. The construction process and objectives of this paper are based on what has been stated so far: musical creativity meets innovation, generating an experience that, interpreted and analysed through design, allows to outline the distinctive features of a new approach between people and technology.

In Section 2, a brief description of the EDME Interdepartmental Laboratory of Politecnico di Milano will

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be provided in order to better grasp the background of the actors and researchers involved in the project; in Section 3, the main questions and the core of the research will be highlighted, and the case study, which will be further analysed in Section 4, will be introduced. Section 5 will be dedicated to the introduction and the description of the suggested new model of relationship between human and digital technologies. Finally, in Section 6 a resume and the conclusions of the paper will be presented.

II. EDME LABORATORY

The Environmental Design Multisensory Experience Laboratory (EDME), established within Politecnico di Milano, is the first result of a multidisciplinary integration path that synthesizes, in a systemic optics, the multiscale relationships that contribute to delineate the complex identity of instruments of investigation, interpretation and representation of experiential scenarios. The EDME Laboratory has been organized and managed to focus on multisensory interactive experiences, and combines, in a physical space, innovative Information and Communication Technology, sensors and latest generation materials. Research and experimentation activities are based on a system able to simulate complex actions and interactions, and to generate useful data. Further research activities of the Laboratory will concern the implementation of theoretical and applicative models with the aim of investigating and creating new relationships between physical and digital dimension. Marco Di Noia's experience and knowledge, described in details in the following paragraphs, are helping to lay the foundations for the development of further research patterns able to investigate the relationship between sound and music and the digital domain.

III. THE ARTISTIC PROJECT MEETS INDUSTRY 4.0

In 2016, the Sony Computer Science Research Laboratory (CSL) released “Daddy’s Car”, a song created in the style of The Beatles, composed by an Artificial Intelligence called Flow Machines. The new hit was created with a software, which used a database of 13,000 existing songs. The catchy track, that could be easily found on the web, was later arranged and produced by Benoît Carré. This song is both a great example of interaction between man and Industry 4.0 technologies -in this case, an Artificial Intelligence- and the source for different questions: are they a tool to help artists or an artificial alternative to them? Or neither of them?

Creativity and creative process, guided by a design mindset, could solve these questions, leading to new ways of perceiving some technologies, neither tools nor a replacements, but participants themselves in the process. So, how can these technologies contribute in the artistic process, acting as cooperative actors for its development?

In the following paragraphs, the featuring experience with two real robots -iCub and TeoTronico- within two recorded songs will be described. These experiences may be the first evidence of new possible models of interactions between human beings and robots or Artificial Intelligence.

IV. CASE STUDY: THE EP “LA SOVRANITÀ DEI ROBOT”

“La Sovranità dei Robot” (The Sovereignty of Robots), released on the 22nd of October, is a music EP whose lyrics are dedicated to some of the most popular robots, replicants, androids and cyborgs of the fiction. The EP is enriched with some pioneering elements and audio experiences: in this case, the recording of TeoTronico, conceived by the Italian Matteo Suzzi, which plays the piano in one of the tracks; and the recording of iCub, one of the world most evolved, relevant and popular platform to support research in embodied artificial intelligence, created by the Istituto Italiano di Tecnologia, that reads a poem as the last track of the EP.

A. TeoTronico

TeoTronico, shown in figure 1, is a pianist robot, conceived and designed by Matteo Suzzi at TeoTronica company, an Italian Start-Up based in Imola. Version 1.0, with 29 fingers, was completed in 2007. Starting from version 3.0 (2012), it was implemented with 53 fingers dynamically driven by electromagnets, able to control the gradations of any acoustic piano. TeoTronico can read musical scores in digital format, playing them on the piano in a literal way. Since 2017 it is also equipped with feet to control the sustain pedal of the piano. It can also play some “mirror-pianist” if connected to a digital piano played by a person. In the “mirror-pianist” mode, TeoTronico can also play as a solo pianist with orchestra, in chamber ensembles and accompanist with singers, even remotely, miles away. Teo can also talk and sing. It can reproduce written texts, grant or be dubbed in real time: in both modes, its lips movements are synchronized to the speech, in any language. Thus TeoTronico can interact with its interlocutors, even with its facial expressions: moves its head, mouth, eyes, eyelids and eyebrows. Equipped with proximity sensors, it can turn to the people who are approaching it. When dubbed in real time, it can answer questions from the audience. It can also perform with other musicians with an impressive versatility. Even if TeoTronico had never recorded any tracks before, it had a long international career on different stages.

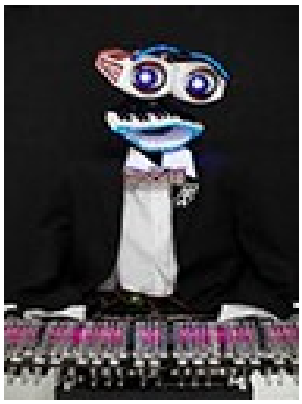

Figure 1. Photo of the robot TeoTronico (retrieved from http://www.teotronico.it/who/).

TeoTronico recorded a solo, on an acoustic piano, and some vocals on the 13th September 2020 for the track "La Sovranità dei Robot", a song inspired by Isaac Asimov's anthology "I, Robot". The musical instrument used by the robot was a Yamaha C3 Coda, recorded with a usual microphone set for acoustic piano. A couple of episodes are remarkable about this session: as TeoTronico recorded the solo three times, the team expected to listen to three identical performances. On the other hand, the three recordings were slightly different each other. So, the sound engineer had to pick the best part of each recording, and he made a composite, as it happens with human pianists. This charming evidence could have happened because the springs below the piano keys do not always react in the same way, even if they are pushed with the same force; or because TeoTronico's plastic fingers got loose more and more during the playing. Or, maybe, because of some kind of noise in the circuits. This episode could be intended as a clue for the embryo of a new model that will be further presented in the next paragraphs: exposed to the same task and activity, robots could act in slightly different ways, because of variations in sets and environments, or because minor instabilities within their system. Furthermore, before the recording started, TeoTronico "warmed up" on the piano, playing the file of "Bohemian Rhapsody" by Queen. The singer was near the robot and kept singing the song along with him, and the result was a jam session warmly appreciated by the people standing in the room, probably because of the funny facial expressions of the robot, which was playing and singing together with the artist, moving its head, mouth, eyes and eyebrows during the performance.

As anticipated, TeoTronico could sing and speak as a simple speaker, with an already recorded audio file playing from a computer, or a microphone connected to it for a live interaction. The movement of its mouth and face could be programmed with a MIDI file, or go random. By the way, the team decided to record TeoTronico in a vocal booth. Its voice had been recorded seven times (verses and refrains), with a different vocoder associated for each recording. Finally, in the control room the one which sounded better in the mix was picked. After the performance, TeoTronico had been interviewed: using its second vocal interaction mode, the one connected to a human (Andrea Messieri) speaking into a microphone, it was possible for the robot to answer the questions.

B. iCub

The robot iCub, shown in figure 2, is a humanoid robot developed by the researchers of the Istituto Italiano di Tecnologia and adopted by more than 40 research laboratories in Europe, USA and Japan. The robot iCub of the IIT laboratories in Genova is the version 1.4, with the following skills: it recognizes and uses objects, it learns to act and interact with people and the environment, he has got the senses of sight, hearing and touch – represented by an artificial skin which covers its body. The iCub has been specifically designed to support research in embodied Artificial Intelligence. At 104 cm tall, the iCub has the size of a five-year-old child. It can crawl on all fours, walk and sit

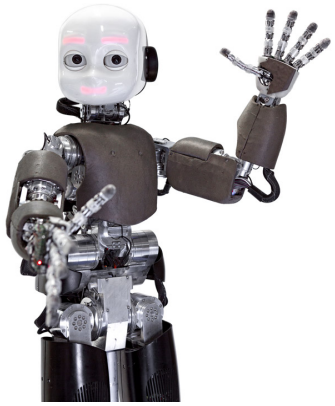

Figure 2. Photo of the robot iCub (retrieved from https://robots.ieee.org/robots/icub/)

up to manipulate objects. Its hands have been designed to support sophisticate manipulation skills. The iCub is distributed as Open Source following the General Public License/Lesser General Public License, and can now count on a worldwide community of enthusiastic developers. The iCub has 53 degrees of freedom with the majority in the upper body and 9 in each hand. The iCub sensors include cameras, microphones, force/torque sensors, a full body skin, gyros and accelerometers and encoders in every joint. The iCub controllers have been designed to be programmable and its software system as a state-of-the-art middleware called YARP.

The recording of iCub's voice took place at the IIT Center for Human Technologies of Genova, on the 5th October 2020. The sound environment around the IIT symbol's voice has been designed using synths and space sounds publicly released by NASA on its own website (Kepler Star, First Likely Marsquake Heard, Jupiter Sounds, Cassini Saturn Radio Emissions etc.). Moreover, the audio track finally published has been mixed binaural (so called "3D audio"). As it had been done with TeoTronico, the desire was to record iCub's voice with microphones, and getting the video of the experiment, instead of having its voice sent by email as a simple file to insert in the mix; although this last process would have been surely faster and easier. iCub has a vocal system different from TeoTronico: the IIT robot speaks with a speech synthesis system. The vocal timber of iCub and its pitch was chosen by the IIT researchers, but it was decided to record also the noise made by the machines used provide energy to it, that, in a sense, represents part of its true sound emission. Anyway, if TeoTronico is a robot made just for entertainment, iCub is a humanoid platform used mainly for research purposes in scientific environments. So, the IIT staff set up iCub standing still on a trailer, with the movements of its mouth, legs and arms, disabled. Even though, factually, only its voice was needed, the experience resulted a little bit cold. So, the researchers in the room were asked to activate iCub's mouth, arms and hands, through strings of programming language, which made easy to ask it to say particular words in real time, making the experience richer and warmer. This episode is also interesting to get

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partial answers to the overarching questions posed throughout the paper: is it possible to hypothesize a new model of relationship with this technology? Which should be its characteristics and shapes? When the robot started to act like a human, it became easier to be involved with it and to collaborate towards the mutual goal.

C. *Other experiment: sound morphing*

The EP "La Sovranità dei Robot" includes a third experiment, which doesn't feature real robots, but it is inspired by fictional robots: in this case, replicants. The hosting song is titled "Westworld", whose lyrics are a reference to the homonymous modern TV series based on Michael Crichton's movie. In quite the same way, the song is enriched with the digital replicas of two human musicians, a woman and a man, playing two acoustic musical instruments. To achieve the expected results, the sound engineers tried to recreate the sound and the touch produced by the musicians. In practice, the musicians were asked to write and record their parts with their instruments and send the scores to the team, to generate Musical Instrument Digital Interface (MIDI) files. Thus, the engineers recreated the two musicians' sound, using virtual instruments and audio editing software, and their "touch", working on dynamics. Finally, they made a morphing of the real registrations and the virtual ones to have "sound replicants" for confusing the listeners' perception.

V. Towards a New Model of Relationship: Human to Artificial

When robots are not considered just instruments to improve the artistic activities, like any other editing software or MIDI execution devices, but they are involved as co-performers or co-artists, they can succeed in creating a relationship with humans that can move beyond the master-slave paradigm: through the explanation of the case studies, we wanted to show that it is already possible to interact in a less detached way with robots and Artificial Intelligence. Collaborating to achieve an objective needs all the actors involved to communicate and to coordinate in the right way, to trust each other, and to act with a mutual approach towards the goals [6]. This, as stated before, can be applied to the reference scenario, especially because in this case the artist and the robot were expected to join forces in order to achieve a shared goal [7]: the creation of a track. So, as these relationships will for sure continue to grow and to be improved exponentially, the interactions between human and robots will have to change: today, the perception of their roles is moving fastly to higher expectations [8].

Despite the always growing numbers of interactions between us and computers and machines, we need to feel and perceive that these interactions are taking place with another individual. This phenomenon is known as social presence [9], and it can be used to introduce the concept of believability [10] as one of the most relevant in this kind of relationships: how much an individual can forget that a robot is artificial and not in possession of typically human abilities. Other authors [11] affirm that to make socially acceptable robots they should have a high level of reliability, simplicity of use, and a human friendly design. So, for sure, if we analyze the relationship in the direction that moves from artificial to human is easy to define its foundations through the merge of the previous characteristics: it can be sum up in the concept of human friendship, conceived as the grade of reliability and believability a robot should have. Higher the grade, deeper the level of the involvement they will achieve, and major the suspension of belief regarding their artificiality will be, while relating with them.

As stated in the introduction, these technologies are going to be even more innovated and implemented, and so their presence and influence in our lives will grow dramatically. What we want to try to highlight with this contribution is the necessity to design a bidirectional relationship with the aforementioned technologies, in order to let everyone be prepared for the upcoming changes that will not only invest the technological fields, but also different areas of human activities. We can adapt to technology and we have done it several times before. Let us think about the evolution of User Interface (UI): we were not used to the gestures (scrolling, swiping, pinching) when they were once introduced in smartphone interfaces, but we have learnt how to use them without even thinking. When the disruptive power of a technology can deeply modify the way we conceive our existences, its development must be also guided by seeking innovative approaches, modalities of use, opportunities for well-being, and not only by the search for progress itself. The period we are experiencing right now is showing us how much we are not aware of their potentialities and of the possibilities they can open up to conceive different aspects of our daily life. So, by taking into account the other direction of the relationship, from human to artificial, and, thus, addressing what we need to do in order to facilitate this new relation, some concepts become fundamental. At first, we must acknowledge the importance of constant updates within the domains regarding technologies, their potential impacts on our life, and the languages they use to communicate. We must not fear them, but always try to convert into opportunities what we first saw as a threat. This should be the approach that guide us in this relationship, because it implies the need for continuative learning and updating regarding technologies. Thus, learning is what become essential and, in first place, comprehending not only what concerns our interactions with technologies, but especially the logic behind them, their history and their influence on culture and other factors that not only interest their technical side [12]. We need to spread model of distributed knowledge in order to accelerate this process. Therefore, creating a rich, diffuse and distributed body of knowledge in regards of robotics and Artificial Intelligence would enable an increasing number of people to interact more smoothly and naturally with these technologies. This would create a mature environment for the implementation of certain innovations, lowering the possibilities for misuse or unjustified fears.

We must understand that we are not dealing just with instruments, but with beings increasingly looking and acting like companions. In a metaphorical perspective, we have to let our counterpart build trust in us. How should we do it? By

implementing and not replacing them, as we do with our household appliances. Again, as stated before, distributed knowledge and Open Source models must be spread in order to let more individuals get to understand how to act with these technologies, repair, update and get used to them.

VI. CONCLUSION

First of all, with this paper and by showing the experiences presented as case study and applied research, we want to stress the importance of creative mindsets and approaches, which can be found in music and song production and composing, towards technology and its possible uses: it is already a powerful and helpful tool for musicians and music producers, but it can become a real companion, someone that should be able to participate in the process of creation, by means of something more than mere instrumental functions. Furthermore, and in the regard of the aforementioned questions, we want to try to understand which elements and features of robots are contributing in the shift regarding their conception from tools to co-actors of creative processes. This passage helped us in defying the initial and possible characteristics of a new model of relationship between human and artificial, which highlights the importance of a biunivocal direction, while keeping in mind the next technology developments and their consequences.

We recognize in design one of the discipline able to further deepen this area of research for its attitude to see technological innovation as a catalyst for other forms of innovation: compared to engineering and hard sciences, design surely lacks the capabilities and the know-how needed to fully grasp every aspects, features and characteristics of technology. Nevertheless, design analyses and uses it guided by needs and aims which differs from the improvement and the innovation of technology itself: directed by this different point of view, it could bring to disruptive and innovative applications, uses, and modalities which, therefore, could shape new relations, mediated by and together with the reference innovations. In this way, an already thriving and established connection between engineering and design disciplines could become one of the most suitable methodology to address the deep changes at various levels, caused by technological innovations.

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