ROBODANZA: Live Performances of a Creative Dancing Humanoid

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Abstract

The paper describes the artistic performances obtained with a creative system based on a cognitive architecture. The performances are executed by a humanoid robot whose creative behaviour is strongly influenced both by the interaction with human dancers and by internal and external evaluation mechanisms. The complexity of such a task requires the development of robust and fast algorithms in order to effectively perceive and process musical inputs, and the generation of coherent movements in order to realize an amusing and original choreography. A basic sketch of the choreography has been conceived and set-up in cooperation with professional dancers. The sketch takes into account both robot capabilities and limitations. Three live performances are discussed in detail, reporting their impact on the audience, the environmental conditions, and the adopted solutions to satisfy safety requirements, and achieve aesthetic pleasantness.

Introduction

Experience teaches that showing experimental prototypes outside the controlled environment of a laboratory is always a challenge, but often efforts are rewarded by the enthusiasm of the spectators and their appreciation. Science mixed with entertainment can transmit a direct and effective idea to a wide audience about the potentiality of a new technology. Recent models and systems proposed in the field of computational creativity (Boden 2009; Colton, Pease, and Charnley 2011), can find in this kind of presentation a perfect testbed and can benefit from the final judgement of an audience (Romero et al. 2012).

Recent scientific literature shows many examples of artificial systems operating in various artistic domains such as drama (Katevas, Healey, and Harris 2014) (Ogawa, Taura, and Ishiguro 2012) (Knight 2011), music (Wiggins et al. 2009) painting (Colton 2012), and dance (Nahrstedt et al. 2007) (Kar, Konar, and Chakraborty 2015) (Manfrè et al. 2016).

Robots having the human appearance (i.e. a humanoid) are an intriguing mean to convey the results of computational creativity models, especially for what concerns the dance domain because of their physicality, their sophisticated perception of the real world, their autonomous behaviour and their social interaction skills.

Dance presents major challenges for computational creativity and cognitive robotics, mainly because of the many factors to be considered: the perception of music (Seo et al. 2013), the execution of body movements, the execution of a sequence of movements in space, and the interaction with other dancers.

However various robotic dancing performances simply reproduce preprogrammed choreographies; robots are hence used just as a technological tool to support art and the real creative process is delegated mostly to the programmer or to the designer of the system, limiting both the decision-making autonomy and the capability of exploration of new solutions of the system.

Some works deal with more complex problems, with the aim to automatize as much as possible the robot behaviour. A basilar problem is the synchronization of music and movements in order to allow the robots to autonomously dance with real-time music introducing real-time beat extraction systems as in (Seo et al. 2013) and also the extraction of music emotions as in (Xia et al. 2012). In particular in (Xia et al. 2012) a dance is planned according to the beat end the emotions resulting from a preprocessing phase, then, a real-time synchronizing algorithm is used to minimize the error between the plan and the execution of the movements.

Other researchers focus the attention on the learning process of human movements styles (LaViers, Teague, and Egerstedt 2014); the authors investigate also the impression of an audience with regard to the consistency of the movements of the robot. In (Aucouturier, Ogai, and Ikegami 2007) a robot provided with a biologically-inspired model, simulates the dynamic alternations between synchronisation and autonomy typically observed in human behaviour. In (Michalowski, Sabanovic, and Kozima 2007) the dance is proposed as a form of social interaction; according to the authors, the synchronization of the robot's movements with the music determined a greater involvement of children with a robot.

Despite such interest in this applicative field, at the best of our knowledge, there are no works introducing in the robot also creativity mechanisms. In our opinion, a realistic dancing behaviour does not involve only the perception of beat and emotions, and the choice of the most suitable dancing style. A realistic dancing behaviour includes also the capability of being creative, i.e. to create or improvise new dancing movements. But such a creative behaviour involves different cognitive processes. It requires a motivation in creating something of new, the ability to get inspiration from the perceptions, properly represent them and comparing them with previous experiences, to assess the outcome of the creative process considering also external judgements. For this reason, we propose to model computational creativity and co-creation tools within proper cognitive frameworks. Cognitive architectures (CA) are inspired by functional mechanisms of the human brain and the various models proposed in literature (Goertzel et al. 2010) try to define the necessary modules to emulate the complex interactions among perception, memory, learning, planning, and action execution. These modules influence the external behaviors of agents and their interactions with humans.

In recent works, we have introduced a cognitive architecture supporting creativity (Augello et al. 2015; 2016), involving motivations and emotions (Augello et al. 2013). In particular, we explored the features of the Psi model (Bartl and Dörner 1998)(Bach, Dörner, and Vuine 2006) and its architecture, since it explicitly involves the concepts of emotion and motivation in cognitive processes, which are two important factors in creativity processes. We successfully employed a robot equipped with our creative system in two different artistic domains: *digital paintings*, and *dance creation* (Manfrè et al. 2016; Augello et al. 2016).

In this work we describe the architecture of the dancing robot, discussing its use in three live performances and the consequent impact on different kind of audiences. The behaviour of the robot is influenced by the interaction with human dancers, and by internal and external evaluation mechanisms.The live performances are discussed in detail, reporting their impact on the audience, the environmental conditions, and the adopted solutions to satisfy safety requirements, and achieve aesthetic pleasantness.

The paper has the following structure: the next section describes the architecture of the artificial system, and choreography fundamentals adapted to a dancing robot; then we describe in detail three live performances held in 2015 and the obtained results. Finally, we discuss in the last section what we have learned from these experiences, and the developments they may have in future.

The Artificial Creative System

The performances described in this paper are the result of the exploitation of a cognitive architecture developed in the past years and experimented by using an Aldebaran NAO humanoid platform (Gaglio et al. 2011; Augello et al. 2013; 2015) .

The cognitive framework of the robotic dancer is depicted in Figure 1. The cognitive architecture is based on Psi model (Bartl and Dörner 1998), driven by *motivation* (Augello et al. 2014) (a numerical parameter), which is derived from *urges* (i.e. relevant demands of the artificial system): *Competence* and *Certainty* are directly influenced by evaluations (both internal and external) determining learning (Augello et al. 2015), affective state (Infantino 2012), behavior, and acting; *Affiliation* determines the social attitude of the robot; *physiological needs* are basic demands (Infantino et al. 2013) such as *energy, correct functionality of body parts, motor temperatures, and so on.*

Working plans are stored in a *Long Term Memory* and they can be activated by motivation parameter and social interaction stimuli (see for example the interaction of the robotic painter with a user in (Augello et al. 2016)). In the dance domain, the plan is constituted by a set M of movements and rules to be associated with the perceived music stored as a transiction matrix TM (Manfrè et al. 2016) of an HMM (Hidden Markov Model) subsystem.

The cognitive architecture supports artificial creativity trough a simple interactive genetic algorithm used in the learning phase under the supervision of a teacher. The learning phase produces a set S of possible behaviours ranked by a score determined by an external evaluation expressed by the final audience.

The perception is based on simple audio features (beat intervals and loudness) extracted from musical input. The music is modeled by using k classes over a temporal sequence of N beats. A set of m elementary movements has been decided by professional dancers (Kirsch, Dawson, and Cross 2015): some of them are directly acquired by an RGBD (Red, Green, Blue, Depth) camera and translated into robot joints movements while other ones are created by the animation tool of NAO software. We have chosen a Hidden Markov Model approach, defined by two matrices: a transition matrix (TM) m by m allows the robot to chhose the next movement after executing a given movement; an emission matrix (EM) m by k allows the robot to associate the perceived music to a given movement.

While the TM is designed by human dancers or a choreographer, the EM arises from an interactive genetic algorithm based on the human evaluation of the dance created. The n best EMs are therefore selected for each evolution step by using a fitness function based on the cosine distance from a given *master sequence* of movements (i.e. an example gave by the human dancer). During the learning phase, the dance obtained from the best EM is executed and it is evaluated by a human. If the dance triggers a positive reaction, the successful EM is saved and in the next evolution steps, it will be always considered as a parent of new individuals generated by crossover processes (preserving the unitary sum of probabilities). The evolution process ends when a given number of EMs that are selected and saved.

During the execution of the dance, the robot chooses an EM matrix from its *repertoire* S, and while perceiving the music it autonomously selects the best movement to execute. The set S could be viewed as a simplified version of a collection of styles (Ghedini, Pachet, and Roy 2016) activated by the HMM model. The robot switches between the two possible movements by counting their occurrences (for example a maximum 4 repetitions). Moreover, in order to introduce a variability of movements when the same musical sequence is repeated for a long time, we have decided to associate possible substitutes to each movement of the robot.

The training phase links given music and movements under expert supervision: the teacher indicates a reference sequence s^* of movements, and evaluates some selected sequences during genetic evolution. HHM model allows the

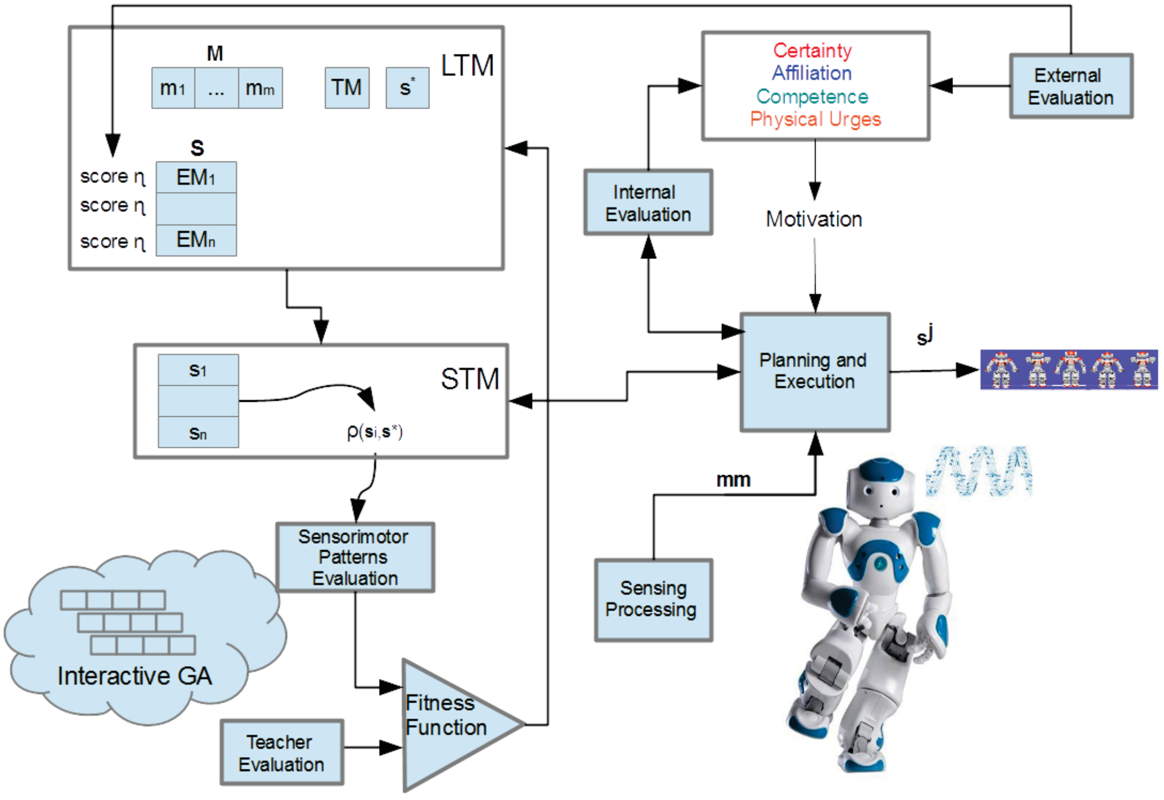

Figure 1: The Cognitive Framework of the Robotic Dancer.

system to react to any kind of music, exploiting a relation between detected musical features and an item in the movement set. The detected musical features are used to create the **mm** vector that represents the robot's model of music. The robot executes a new creative sequence of movements when listens to a new music taking into account its evaluated previous experience. Evaluation of robot behavior on new musical pieces is part of robot cognitive reaction by means of the Certainty and Confidence parameters.

Planning and Choreography Design

Thanks to the help of professional dancers, we conceived and set-up a performance under the following constraints: to physically execute admissible robot movements; to take advantage of robot peculiarities; to assure human safety; to perform the play in a real environment; to offer a performance which is aesthetically acceptable for the audience.

Conventional choreography design is based on the analysis and the planning of different aspects: composition of shape, space, timing, and dynamics. The shape is related to body posture and the dancer's figure. Real professional dancers train their bodies to be flexible and perform natural transitional movements. The shape could vary for body levels and parts involved, symmetry or asymmetry in positions and sequences, the scale of execution.

Using an RGBD (Red, Green, Blue, Depth) camera we have recorded many dance movements of human dancers, converted them in robot movements by reproducing postures (Koenemann and Bennewitz 2012) and positions of body parts (hands, legs, head). Among the coded postures and positions we have selected those that have been judged as being aesthetically acceptable by professional dancers.

Another element of composition in choreography is the design in space, i.e. the paths and patterns that the dancer traces in the performance area. Complex dances consider geometrical paths, and as for the body shape, spatial patterns could be either symmetric or not, and they can be executed at different scales. We have chosen the simplest option that allows us to have some positive advantages: the robot is placed on a table and movement of legs are limited within a circumference of 60 centimeters of diameter. In this way we resolve the problem to have robot (57,3 cm tall) and human dancers at the same level; the robot is well visible also if the audience is a crowd; the surface of the table could be used as source of rhythmic sound; the robot movements are safer either for dancers and audience. The designed choreography is centered on this table and the robot standing on it, representing the spatial reference of the dancers.

The third element of dance composition is timing: taking into account tempo, metric, rhythm, and dynamics (Xia et al. 2012). The robot is capable of estimating the position of the source in the environment. By means of a software algorithm, beats can be detected and their features recorded (time interval, and loudness) in order to recognize patterns. During the dance performance, tempo and rhythm are given by dancers by using the table or their body.

Figure 2: Learning phase in thr laboratory performing trials of a possible choreography with human dancers.

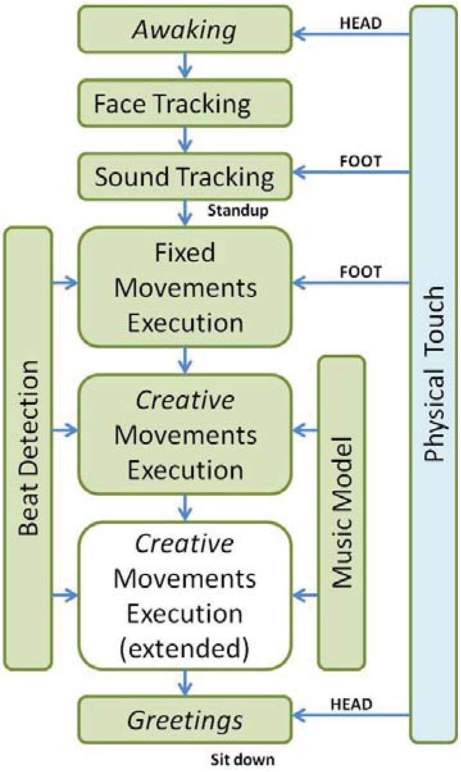

Figure 3: The choreography sequence diagram. The transitions between blocks are activated by dancers touching the robot. Music and beat detection modules drive movement executions of the humanoid. The white block represents an improvement of the performance introduced in third live event considering two more dancers and a musical piece.

Live performances

The aim of the live performances has been to test our cognitive robotic technologies in a real environment under the evaluation of a real audience. The choreography conceived with dancers (see Figure 2) include both artistic and technical aspects: we stressed the environment sensing capabilities of the humanoid, robot's "naturalness" to execute sequences of movements, its artificial creative mechanisms to obtain an emotional impact. The whole performance had to be a logical artistic structure, including a prologue, a main part, and an epilogue. The choreography has tried to capture the spectator attention adding step by step a growing complexity both of the scene structure and of the interactions between humans and robot. Figure 3 shows the sequence diagram of the choreography. During the whole execution of the performance, the robot is completely autonomous and its behaviour is not controlled by anyone. Only the dancers in the scene can establish a coordination with the robot to synchronize the transitions among subsequent blocks of the choreography. We have chosen to use physical touches, exploiting some sensible areas of the robot (i.e. head, and bumpers on feet), assuring both robustness in the real complex environment and a strong emotional relationship between the human performer and the robot. The epilog shows three basilar capabilities of the robot: motion, face and sound tracking. The initial position of the robot is seated and with a crouched posture. The dancers start to go around the robot and observe with curiosity the strange "inanimate" object on the table. One of the dancers touches the robot' head in order to awake it, wich starts to searching and tracking human faces. In this phase, the dancers play with the robot searching for gaining its attention, swapping their positions, and overlapping. A touch of a foot bumper causes the robot to localize rhythmic sounds. The dancers start to beat hands and to tap on the table. The robot turns its head in the direction of the perceived rhythms and opens and closes its hand following the perceived tempo. After another touch of a robot' foot, the performance reaches its main part, where dance and creativity capabilities of the robot are exhibited to the audience. The robot stands up, processes the audio input, tracking the rhythm generated by dancers and executing a sequence of three fixed movements. During this phase, the robot is not creative, but it simply reproduces movements learned by the dancers. Automatically, after this phase, the robot exhibits its creative capabilities by trying to compose itself a sequence of movements. This task is accomplished by following the perceived model of the music and selecting a dance style from its repertoire (i.e. one individual of the privileged population selected during the learning phase based on the GA). The synchronization between movement and music is obtained by beat detection algorithm. The creative execution ends when a dancer touches one of the feet of the robot.

In the final part of the performance, the robot and the human dancers thank and greet the audience with a bow. After the two first live performances, following useful suggestions obtained by the audience, we have introduced a new creative phase that followed the first one: robot dances on a music and two more dancers have been introduced in the scene. The new very young performers have improvised their own dance both imitating robot postures, and professional dancers movements, and creating their own original movements.

The *cognitive architecture* has a great importance mainly because realizes a closed loop among learning, perception, execution, and final evaluation. In the loop humans strongly influence the robot behaviour by natural interactions, and avoiding a hard-coded programming of the robot. Artificial creativity allows the robot to explore new sequences of movements and to evaluate the effectiveness exploiting its internal evaluation (calculated by suitable distance metrics) and by expert judgments (by interactive GA). During the execution, the cognitive architecture drives the human-robot interaction by searching human faces (Affiliation needs), and by reacting to physical contacts between human and its body parts (head, feet), in order to establish a *feeling* with the human dancing partners. Also, physical urges could cause different behaviours among various performances: for example in the reported performances, the first two were done inhibiting the use of robot's left foot since the final joint was not working. Finally, external evaluations of the performances have determined the updating of the scores of S (depending by computation of Certainty and Competence): live performances have reinforced the element of its executed repertoire, but during the various rehearsals, dancers evaluations have caused the change of the rank of the S items.

All the videos of live performances and others testing sessions are accessible at the following link `http://www.pa.icar.cnr.it/scarlab/robodance/`.

Evaluation

After each performance, the spectators were asked to fill a questionnaire to evaluate the performance, expressing the following numerical ratings on a scale from 1 to 5:

- originality of the choreography
- naturalness of the robot-dancers interaction
- timing and movements of the robot
- evaluation of overall performance

Spectators were also asked if the performance had caused them some emotional impacts (possibly specifying which one), and if the robotic dance was perceived or not as being "mechanical". Table 1 reports the obtained results, which could be considered positive taking into account also that many of the spectators were experts of disciplines related to robotics. The spectators wrote on a free text space of the questionnaire, what they would have liked also the execution of the dance with a music accompaniment.

The first performance (see Figure 4) was held during a demo session of the AISC cognitive science conference (AISC midterm conference)[1]. We obtained 30 evaluation forms by experts in various fields of Cognitive Sciences, and the results are reported in table 1. In all categories of judgment, the obtained values are above average, and the various comments provided on the questionnaires show that the audience was very attentive to the technical aspects, and considered artistic and creative aspects as secondary.

Figure 4: Live at AISC midterm event

The second live performance took place at Tavola Tonda Event on 28th June 2015, in the presence of a heterogeneous audience, among them many professional dancers, and musicians were presents(see Figures 5). We collected 30 evaluation forms, and the results are reported in table 2. In this case, unlike the first performance, the evaluations expressed a greater emphasis on the emotional and artistic aspects. The opinions were very positive, and the *Robodanza* performance achieved a great interest and curiosity. An important consideration with respect to the first indoor performance is the execution of the performance in an outdoor environment

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[1] http://www.aisc-net.org/home/2015/03/05/aiscmidterm2015/

characterized by high loudness and with a wider audience, but inserted in a real context of music and dance event (see Figure 5).

Figure 5: Live at Tavola Tonda Event. The second live has been performed in an external location, and in the presence of many people.

We also asked the dancers to express some qualitative evaluations of the played performances. Synthetically their judgment has been the following:

- the potentiality of artistic expression by choreographies involving robot are very high
- the interaction with the robot has been natural and funny and stimulates improvisation
- robot's movements have been considered not enough satisfying to perform more complex dance postures
- the positive reaction of the public has proved better than expected

The third live performance (see Figure 6) was held at the Conference on Biologically Inspired Cognitive Architectures (BICA) on 6th November 2015, in Lyon (France)[2]. Following the suggestions and evaluations of audiences of previous live performances, we decide to add a new element in the choreography: the robot played a music (obtained in the learning phase when it recorded rhythmic beats and vocalizations) similar to previous creative phase (see Figure 3), and two children danced together with professional dancers and the robot. Also in this phase, the robot used its creative mechanisms while playing the musical piece. The children were free to execute their movements: they performed just two rehearsals the day before the live performance, and they autonomously conceived their dance behavior. In this case, we observed an interesting side effect: children imitated robot's movements and created a sequence similar to the robot one, synchronizing with it. The evaluation results are reported in Table 3.

Figure 6: Live at BICA 2015

Discussion

The three live performances have been completed asking the people attending the event to give a score on multiple aspects of the robodance and, to provide their ideas and opinions with open answers. It is straightforward to represent in a table the collected scores, while the opinions and open answers written in the form are not presented here. In any case, the ideas and the proposal have been taken into account and the evaluation of the public has been used to address learn-

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[2] http://bicasociety.org/meetings/2015/

Results	Means	Medians	%
Originality of choreagraphy	3.07	3	61%
Naturalness of interaction	2.63	3	53%
Timing and Movements	2.87	3	57%
Overall judgement	2.73	3	55%
Perceived as dance (or mechanical)	.	.	50%
Emotions (yes/no)	.	.	60%

Table 1: Judgements expressed by audience of the first live performance at AISC 2015 midterm event.

Results	Means	Medians	%
Originality of choreography	4.07	4	81%
Naturalness of interaction	4.23	4	84%
Timing and Movements	3.87	4	77%
Overall judgement	4.20	4	84%
Perceived as dance (or mechanical)	.	.	80%
Emotions (yes/no)	.	.	86%

Table 2: Judgements expressed by audience of the second live performance at TavolaTonda event

Results	Means	Medians	%
Originality of choreography	3.58	4	72%
Naturalness of interaction	3.64	4	73%
Timing and Movements	3.55	4	71%
Overall jugdement	4.03	4	81%
Perceived as dance (or mechanical)	.	.	69%
Emotions (yes/no)	.	.	63%

Table 3: Judgements expressed by audience of the third live performance at BICA 2015

ing and performing aspect of the robot dance through the update of learning capabilities and The audience of the three performances was bound the events where the demo took place. And since the events were oriented to people with different cultural background the form were filled by people from a variety of interest and all the three evaluation were good but being able to improve the cognitive system according the received feedback can be detected a positive trend in the evaluation of the creativity aspects.

The evaluations and feedbacks obtained by the audience in the three live performances led us to the considerations that are briefly summed up below.

The *overall judgment* considers the global evaluation that tend to consider the engagement of the people to the exhibition. The fruition of an artefact should be straightforward and should not pass through the analysis of the piece of art that should be a second step. The value of *overall judgment* started from a value of 55% to reach a value of 81% in the last performance, showing an impressive improvement thanks to added components of the choreography, and reachings values comparables with the ones obtained with the generic audience of the second event.

The *Originality of the choreography* is bound to the richness of the dance and to the fact that the movements were repetitive or not. The score reaches its maximum during the Tavola Tonda Event where the audience was not bound to the robotic and technical world but it was more interested in the aspects of music and dance. The same trend has characterized the evalutation of the *Naturalness of Interaction* and the *Perception as dance* that were positively evaluated with the highest ratio by people interested in artistic aspects. The *emotions* raised by the performance were principally felt by the audience of the Tavola Tonda Event and less in the context bound to technical conference (the first and the third ones); nevertsless, the third performace had a higher ratio of positive results in the last event.

Conclusions and Future Work

We have tried to explain the complexity to realize a live dance performance involving humans and robot. Thanks to a cognitive architecture supporting artificial creativity, such aim appears to be feasible, and the obtained positive feedbacks have encouraged us to design further *live experiments*. At present, we are working on improving music perception capability of the robot. We are trying to stress the architecture in order to respond quickly to changes or interruptions of musical inputs, by synchronizing music and movements at different rhythms (fractions of the main tempo of the musical piece). Moreover, we are planning to introduce also a verbal interaction with the robot in order to stimulate a deeper empathy with the audience, and use artificial emotions to drive part of creative process. We are working on the improvement of the interactive genetic algorithm considering more suitable fitness functions. Besides, we are studying how to generate and evaluate new movements involving several robot body parts (e.g. symmetry, shape, and so on.

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References

Aucouturier, J.-J.; Ogai, Y.; and Ikegami, T. 2007. Making a robot dance to music using chaotic itinerancy in a network of fitzhugh-nagumo neurons. In *Neural information processing*, 647–656. Springer.

Augello, A.; Infantino, I.; Pilato, G.; Rizzo, R.; and Vella, F. 2013. Binding representational spaces of colors and emotions for creativity. *Biologically Inspired Cognitive Architectures* 5:64–71.

Augello, A.; Infantino, I.; Pilato, G.; Rizzo, R.; and Vella, F. 2014. Robotic creativity driven by motivation and semantic analysis. In *Semantic Computing (ICSC), 2014 IEEE International Conference on*, 285–289.

Augello, A.; Infantino, I.; Pilato, G.; Rizzo, R.; and Vella, F. 2015. Creativity evaluation in a cognitive architecture. *Biologically Inspired Cognitive Architectures* 11:29–37.

Augello, A.; Infantino, I.; Lieto, A.; Pilato, G.; Rizzo, R.; and Vella, F. 2016. Artwork creation by a cognitive architecture integrating computational creativity and dual process approaches. *Biologically Inspired Cognitive Architectures* 15:74 – 86.

Bach, J.; Dörner, D.; and Vuine, R. 2006. Psi and micropsi: a novel approach to modeling emotion and cognition in a cognitive architecture. In *Proceedings of the 7th international conference on cognitive modeling, Trieste*, 20–25.

Bartl, C., and Dörner, D. 1998. Psi: A theory of the integration of cognition, emotion and motivation. In *Proceedings of the 2nd European Conference on Cognitive Modelling*, 66–73. DTIC Document.

Boden, M. 2009. Computer Models of Creativity. *AI Magazine* 23–34.

Colton, S.; Pease, A.; and Charnley, J. 2011. Computational creativity theory: The face and idea descriptive models. In *Proceedings of the Second International Conference on Computational Creativity*.

Colton, S. 2012. The painting fool: Stories from building an automated painter. In *Computers and creativity*. Springer. 3–38.

Gaglio, S.; Infantino, I.; Pilato, G.; Rizzo, R.; and Vella, F. 2011. Vision and emotional flow in a cognitive architecture for human-machine interaction. In *BICA*, 112–117.

Ghedini, F.; Pachet, F.; and Roy, P. 2016. Creating music and texts with flow machines. In *Multidisciplinary Contributions to the Science of Creative Thinking*. Springer. 325–343.

Goertzel, B.; Lian, R.; Arel, I.; de Garis, H.; and Chen, S. 2010. A world survey of artificial brain projects, part ii: Biologically inspired cognitive architectures. *Neurocomputing* 74(1-3):30–49.

Infantino, I.; Pilato, G.; Rizzo, R.; and Vella, F. 2013. Humanoid introspection: A practical approach. *International Journal of Advanced Robotic Systems* 10.

Infantino, I. 2012. *Affective human-humanoid interaction through cognitive architecture*. INTECH Open Access Publisher.

Kar, R.; Konar, A.; and Chakraborty, A. 2015. Dance composition using microsoft kinect. In *Transactions on Computational Science XXV*. Springer. 20–34.

Katevas, K.; Healey, P. G.; and Harris, M. T. 2014. Robot stand-up: engineering a comic performance. In *Proceedings of the Workshop on Humanoid Robots and Creativity at the IEEE-RAS International Conference on Humanoid Robots Humanoids (Madrid)*.

Kirsch, L. P.; Dawson, K.; and Cross, E. S. 2015. Dance experience sculpts aesthetic perception and related brain circuits. *Annals of the New York Academy of Sciences* 1337(1):130–139.

Knight, H. 2011. Eight lessons learned about non-verbal interactions through robot theater. In *Social robotics*. Springer. 42–51.

Koenemann, J., and Bennewitz, M. 2012. Whole-body imitation of human motions with a nao humanoid. In *Human-Robot Interaction (HRI), 2012 7th ACM/IEEE International Conference on*, 425–425. IEEE.

LaViers, A.; Teague, L.; and Egerstedt, M. 2014. Style-based robotic motion in contemporary dance performance. In *Controls and Art*. Springer. 205–229.

Manfrè, A.; Infantino, I.; Vella, F.; and Gaglio, S. 2016. An automatic system for humanoid dance creation. *Biologically Inspired Cognitive Architectures* 15:1 – 9.

Michalowski, M. P.; Sabanovic, S.; and Kozima, H. 2007. A dancing robot for rhythmic social interaction. In *Human-Robot Interaction (HRI), 2007 2nd ACM/IEEE International Conference on*, 89–96. IEEE.

Nahrstedt, K.; Bajcsy, R.; Wymore, L.; Sheppard, R.; and Mezur, K. 2007. Computational model of human creativity in dance choreography. *Urbana* 51:61801.

Ogawa, K.; Taura, K.; and Ishiguro, H. 2012. Possibilities of androids as poetry-reciting agent. In *RO-MAN, 2012 IEEE*, 565–570.

Romero, J.; Machado, P.; Carballal, A.; and Correia, J. 2012. Computing aesthetics with image judgement systems. In McCormack, J., and dInverno, M., eds., *Computers and Creativity*. Springer Berlin Heidelberg. 295–322.

Seo, J.-H.; Yang, J.-Y.; Kim, J.; and Kwon, D.-S. 2013. Autonomous humanoid robot dance generation system based on real-time music input. In *RO-MAN, 2013 IEEE*, 204–209. IEEE.

Wiggins, G. A.; Pearce, M. T.; Müllensiefen, D.; et al. 2009. *Computational modeling of music cognition and musical creativity*. na.

Xia, G.; Tay, J.; Dannenberg, R.; and Veloso, M. 2012. Autonomous robot dancing driven by beats and emotions of music. In *Proceedings of the 11th International Conference on Autonomous Agents and Multiagent Systems-Volume 1*, 205–212. International Foundation for Autonomous Agents and Multiagent Systems.