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***Abstract*—This paper presents an overview of a research project concerning the investigation and development of a Thai Dance Training-Assist Robot. The initial phase of the project consists of literature review on backgrounds of robots, robotic applications and human-robot interaction (HRI) as a recently emerged discipline. The paper also describes the technical specifications of "Robosapien", the most popular humanoid robot series ever sold. Discussions on dance, dance robots and finally Thai dance are also covered in this paper. The paper also provides the initial design and specifications of the research. Preliminary investigation in other relevant research work done is also explored.**

***Index Terms*—Dance robot, Entertainment, Robosapien, Thai Dance.**

I. Introduction

Advances in computer technology, artificial intelligence, speech recognition, and remote controls have led to remarkable breakthrough in robotic technology. This has also caused the emergence of the field *Human-Robot Interaction (HRI)*, as a sub-field of the Human-Computer Interaction (HCI) discipline. This rapid advancement in robotic technology has made many seemingly impossible tasks to become possible. Currently, opportunities arise for the robot hardware and software developers to use their creativities to come up with products that could be helpful or entertaining to the humankind. This is happening in diverse new areas and can be seen and demonstrated in many recent researches.

This research is aimed to investigate, develop and study the effectiveness of a low-cost off-the-shelf robot (Robosapien Media) as a humanoid robot to demonstrate basic Thai dances, "*ThaiDTAR*", a Thai Dance Training-Assist Robot as shown in Fig. 1. This in turn will assist to determine the appropriateness of similar robots to be used as teaching and learning tools for other subjects. The background research and initial design are now described in this paper.

II. Background Research

The concept of entertainment robots can be thought of as one that entertains people publicly or individually and not necessarily limited to those as shown on television or in films. A good example found in research is the dancing robot, "*Keepon*" [1]. Keepon is a small creature-like robot developed to perform emotional and attentive interaction with children. The research focuses dance-oriented nonverbal play between children and Keepon. Also, being developed is the architecture which allows the robot to perceive, model, generate social rhythms and synchronizing the robot's behaviors with the human. In fact, Keepon was not designed solely for entertainment, but to develop technologies and methodologies for human-robot interaction incorporating the rhythmic properties of human interactive behavior. The study demonstrated that the rhythmic synchrony of the robot's movements with the music and the children would have an effect on the quality of interactions and the rhythmic behaviors of children. Furthermore, the analysis and observations suggested that music provide a powerful environmental cue for the negotiation of rhythmic behavior relative to that of the robot; and that the robot's responsiveness to people's behaviors positively affected their engagement with the robot [2], [3], [4].

RoboCup is another prominent international research in collaborative robot movements. It is a competitive soccer league for humanoid robots that could be considered as a form of entertainment for the audience. Behnke et al. [5] demonstrated that augmented multiple Robosapiens could be used in their research to form a team of soccer playing

Fig. 1. Robosapien Media show its Thai dance move.

humanoid robots. The robots have been added with a Pocket PC and a color camera to give it autonomous sensing and decisions. The robots were able to demonstrate individual capabilities in solving and achieving a number of subtasks. In Humanoid Walk, the robots had to walk towards a pole, turn around, and to come back to the starting point. Scoring was based on walking speed and stability. In the penalty kick competition, two robots face each other and one robot tried to score a goal, while the other acts as the goal keeper. The teams which participated in the Humanoid League have chosen very different robot platforms. While most teams constructed their own robots, a few teams used expensive humanoid robots developed by the Japanese manufacturers such as, Fujitsu HOAP-2 [6] or Honda ASIMO [7]. Some teams purchased servo-driven commercial robots or robot kits.

Further examples of other research work that have laid ground work in this area of research include: "InterRobot" - a speech-driven embodied interaction robot by Ogawa et al. [8], and "Nico" - a drumming robot which performs in concert with human performers by Crick et al. [9].

Low cost robots have begun to appear in the market during the past few years. Their costs are only fractional as compared to sophisticated industrial or research robots. For example, the robot used in this project is under USD300 whereas the Fujitsu HOAP-3 costs about USD90,000. While expensive robots from manufacturers such as Honda and Sony are capable to do many complex movements, the complexity and functionalities of the "toy" robots have also increased dramatically over the years. By developing the low-cost robots to do purposeful tasks such as assisting students to learn Thai dance, it would implicitly attract and motivate the students and enhance their learning experience. In addition, the relatively low cost could make the robot easily accessible to the community and thereby help to preserve Thai dance and to promote Thai culture. Finding and experience from this project will be extended to other topics thereby extending the use of such robots as comprehensive teaching and learning tools.

III. ROBOSAPIEN

Robosapien (RS) was designed and created by Mark Tilden, Head of Research and Development of WowWee Ltd., a Hong Kong based company. RS has been greatly successful in the toy market. Over 50 million units have been sold since the release of the first Robosapien in the year 2000, followed by the RS Version 2 in 2005 and more recently the RS Media. The original Robosapien, a biomorphic robot, was a remote-controlled machine that could be programmed to run through different sequences of commands in response to questions and external stimuli. The RS V2 is larger, more robust robot with a greatly expanded list of English verbalizations. RS V2 also introduced basic color recognition sensors, grip sensors, sonic sensors and a wider variety of possible movements. The RS Media also has a body very similar to RS V2, but an entirely new brain based on a Linux kernel. RS Media is equipped to be a media center and has the ability to record and playback audio, pictures and video [10], [11].

IV. DANCE, DANCE ROBOT, THAI DANCE

A. Dance

Dance, is defined in this paper as a series of actions with movement of the whole or part of the body in synchronization or asynchronized, with or without music rhythm. According to the Webster dictionary, dance is defined as, "*An artistic form of nonverbal communication"* or *"Taking a series of rhythmical steps (and movements) in time to music*." Similarly, Shinozaki et al. [12] described dance as "*one of the most sophisticated nonverbal communication methods and also regarded dance as the real-time type of entertainment*." In addition, as for the human body, dance activates the physical body and brain to exercise and relax. Dance could therefore be considered contributing to one's mental health. On the other hand, dance performed by a robot may not offer any direct movement, but it could instead create strong motivation for human to exercise and move along [13] and the entertaining effect on the audiences.

B. Dance Robot

Conducting a research on a dance robot certainly introduces the development of a new type of communication between human and robots. Thus, researchers must acknowledge and understand the existence of relationships among human, robot, and entertainment in a dance robot system. The role of robots in dance entertainment is to allow human to become both entertainers and spectators. In other words, human could act as spectators when watching a robot dances with its own autonomous movements together with interactive capabilities, or, as entertainers, by creating built-in pre-programmed sequence of dance motions for the robot to entertain the audience. This could be considered as a form of non-real-time entertainment for the designer. The scenarios for an interactive dance robot in real-time entertainment could be that the robot could change the dance depending on audience requests or could sense the audience mood and adopt its dancing behaviors to reflect the sensory inputs. An ideal model of a dance robot would be the one that could provide flexible entertainment that ranges between real-time and non-real-time entertainment [14].

C. Thai Dance

Based on the concepts of dance robot described above, a good grasp of the topic of Thai dance must be achieved first prior to the development of the Thai dance robot,

Thai dance, or "*Ram Thai*" in Thai language, is the main dramatic art form of Thailand and is considered as one of countless dance types in existence. Yet, Thai dance on its own, like many forms of traditional Asian dance,

can be divided into two major categories that correspond to the "high art" (classical dance) and "low art" (folk dance) distinction [15], [16].

Thai classical dance includes main dance forms like "*Fawn Thai*" - accompanied by folk music and style of the region; "*Khon*" - the most stylized form of Thai dance performed by group of non-speaking dancers, the story being told by a chorus at the side of the stage; "*Lakhon*" - costumes are identical to Khon, but Lakhon dance movements are more graceful, sensual, and fluid, the upper torso and hands being particularly expressive with conventionalized movements portraying specific emotions; etc.

V. INITIAL DESIGN AND SPECIFICATIONS

A. Robot Selection

While humanoid robots developed by large companies are impressive, they are not easily available to researchers outside of the industry labs or they are just too expensive. Some universities built their own robots, but due to limited resources, usually only one prototype could be constructed. While many mass-produced humanoid robot kits or humanoid robots developed so far by robotics companies are inarguably flexible and movements are human alike, many of them are small in size, or do not possess the ability to produce movements with many degree of freedom, or, they are too expensive as aforementioned. Thus, this makes a robot selection process currently limited to Robosapien series, in particular RS Media, which is certainly the most popular humanoid robot today. In contrast to RS V2, RS Media has more powerful brain and ability to be customized using Java programming language. In addition, during the 2007 JavaOne Conference, WowWee sponsored a set of Robosapien programming contests for Java developers and in order to make control of the robot possible, a special Robot Extension SDK was written by Sun Microsystems and bundled with only 200 the RS Media at the conference.

Hence, to take a full programming advantage of this, it is crucial to proceed with the choice of RS Media Java SDK capability for this research. Nevertheless, Mark Tilden mentioned in his November 2006 interview [17] that his team has started developing Robosapien Version 3, a four-foot high biped robot with functional knees that is able to walk up and down stairs and more flexible than RS Media. In addition, RS V3 will have the ability to connect to the internet and respond to voice commands.

Therefore, should RS V3 release in the early stage of this research, it might be acquired to use as an alternative or a replacement as RS V3 movements would be more flexible.

B. Robot Features and Specifications

RS Media measures approximately 58 cm. in height and its weight is about 5 kg, including six D type and four AA type batteries. These batteries are located in its feet. The low center of mass makes RS Media very stable. The robot operates on a Linux operating system with the two 32-bit processors for handling the control of sensors and movements, making it a powerful programmable humanoid robot. RS Media has a true vision capability with a built-in full-color camera into its chest and face-tracking intelligence. It can play MP3 music through multiple speakers and back-mounted woofer as well as displaying photos and MP3 information, playing Java games and playing MP4 video on its 1.9-inch 16-bit color LCD screen. It also has 40 MB of internal memory with the ability to use up to a 1 GB SD card in its external card slot as shown in Fig. 2.

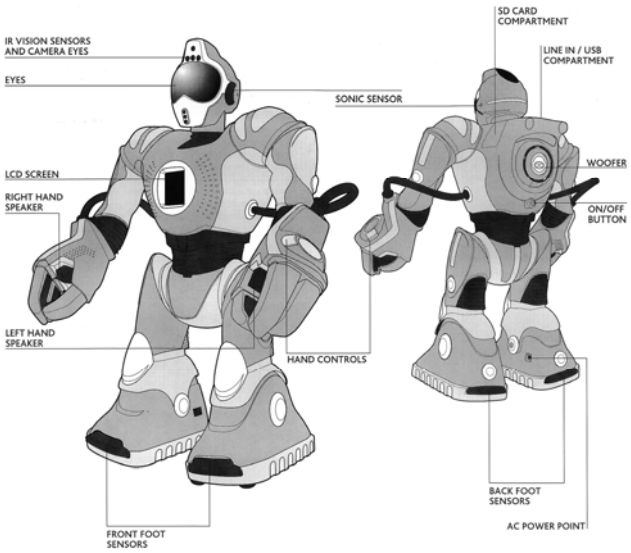

Fig. 2. An overview of RS Media [18].

As RS Media comes with three distinguish sensors: sight, sound and touch, this makes motion and color tracking, and sound localizing the unique features of the robot. Moreover, its infrared vision is also used to differential between certain colors. When the robot is stationary, the infrared system can detect movement at two different ranges, approximately six inches and approximately two feet out. If a hand is placed directly in front of its face, it will respond with a flinch response, and then try to identify the color of the object if the hand is there within an inch. The sensors in his feet will also detect objects that it has bumped into and stop. Sensors are also built in to the hands so that it knows when it's picked it up successfully, if not it will provide you with an audio feedback.

The RS Media has a variety of internal sensors which include 4 pots, 3 tilt switches, 5 encoders and 2 switches. It also has a range of external sensors, including 8 touch sensors (button), 3 sound sensors (microphone) and 3 sight sensors (IR Receiver) [19].

C. Software Development

RS Media can be programmed using Java SDK extension capability and the following software are freely available: NetBeans IDE 5.5.1, NetBeans Mobility Pack 5.5, Java SE Development Kit (JDK) 6, and J2ME Wireless Toolkit 2.2. This also keeps the cost of software development low.

D. Software Development

Since the acquired RS Media is programmable by using Java SDK extension as aforementioned, therefore, Java will be the language of choice for this research. Nonetheless, in the future as this research progresses and with a new release of robot and software technology, should a new robot is more suitable than the current one with a more appropriate programming tool, that will be indeed taken into consideration for the betterment of this research and further development.

E. Thai Dance Selection

As there are many varieties of Thai dances, it is vital that a careful selection of the one to be used in this research is done with a proper consultation from a professional in the area of Thai classical dance. Thai dance can range from a simple movement to a complex movement that if an inappropriate one is chosen, the robot might not be able to perform due to its physical limitation as mentioned earlier. This will form another integral phase of the study with consultation from experts in this discipline.

VI. CONCLUSION

Having explored the advancement in robotic technology and other relevant research work being done and reported, the paper has implicitly exhibited the feasible development of the project towards its objectives and its further development. At this stage, the direction of this research is being defined and further study will be done as the research progresses into subsequent phases of development. These include an investigation of the Thai dance movements to be implemented in the Robot. This will be followed by study and research on the acceptance and effectiveness of using such robots for a low cost teaching and learning tools in order to encourage motivation and enhance the student's learning experience.

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