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Humanoid Robot, What is missing?

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Abstract: A humanoid robot is now a reality, which has been very developed. It can do almost all tasks that either the human can do or not as well as the dangerous tasks. The researchers recently develop robots, which can see, smell, smile, speak, touch, walk and talk using the more advanced technological tools such as computer aided design. However, these humanoid robots cannot react as human, so what is missing?, what is about the spirit? Does robot have the spirit? This paper answers these questions and presents imperfection of humanoid robot.

Keywords: Humanoid robot specifications, different robot platforms, graphic robot design, humanoid robot limitations.

1. INTRODUCTION

A decade ago, robots have been limited in their functions to repetitive tasks generally found in automation field. Today, robots become intelligent machines which have been integrated in our domestic and industrial life. Robots are now a reality. There exists deferent types of robots, but the type of our interest is the general public which can walk, talk, dance, and perform household tasks. In other words, it is a robot that can be anthropomorphized by some people.

According to the literature, different parts and mechanisms like human have been realized in order to allow the humanoid robot to work properly. But, it still cannot react as a human, there is something missing, what is it? In the following sections we try to answer this question.

In the next section, some of the most advanced humanoid robots are presented. Then, it is followed by the discussion of the use of Computer Aided Design and its contribution in developing humanoid robot design. In the third section, the ability of human being to create a humanoid robot with a spirit is discussed. Finally, we end up with conclusion.

2. STATE OF THE ART

The iCub is an open-source robotic platform with dimensions comparable to a three and a half year-old child (about 104cm tall), with 53 degrees of freedom (DOF) distributed on the head, torso, arms, hands, and legs [1][2]. Software modules in the architecture are interconnected using YARP [3][4]. The torso has 3DOF (yaw, pitch, and roll). Each arm has 7DOF, three in shoulder, one in the elbow and three in the wrist. Each hand of the iCub has 5 fingers and 19 joints although with only 9 drive motors several of these joints are coupled as shown in Fig.1. An integrated approach allowing the humanoid robot iCub to learn the skill of archery has been presented in Ref. [5]. After being instructed how to hold the bow and release the arrow, the robot learns by itself to shoot the arrow in such a way that it hits the center of the target. For learning this particular skill, a local regression algorithm called ARCHER has been proposed. The iCub has been also used for experimental purpose [6] to a novel minimum-jerk Cartesian controller.

H6 and H7 are humanoid robots constructed by university of Tokyo[7]. The construction of the first prototype was completed in June 2000 by Aircraft and Mechanical Systems Division of Kawada Industries, Inc. H6 is 1370mm height and 590mm width respectively, and has a total of 35DOF: 6 for each leg, 1 for each foot (toe joint), 7 for each arm, 1 for each gripper, 2 for the neck, and 3 for the eyes (see Fig. 2). All major joints are driven by DC motors and Harmonic drive gears. Its weight is 55kg including 4kg of batteries, since aircraft technologies were applied to the body frame, which led to a strong and light structure. An onboard PC equipped with dual PentiumIII-750MHz processors running RT-Linux is used for real-time servo and balance compensation, as well as coordinating high-level 3D vision and motion planning component software modules. The system is connected to the network via wireless

Ethernet. Thus, the robot is fully self- contained (it can be operated without any external cables). Thus, H6 and H7 can walk up and down 25cm high steps and can also recognize pre-entered human faces.

Fig 1. H6 humanoid robot.

JOHNNE is an anthropomorphic autonomous biped robot constructed by Technical University of Munich for realization of dynamically three-dimensional walking and jogging motion [8]. JOHNNE with 17DOF is about 1800mm height and about 40kg weight respectively, while the operating power is supplied by external sources. Currently, a stable walking could be realized with up to 2.0km/h[9].

SDR-3X (Sony Dream Robot-3X) is a compact size humanoid robot [10]. Its specifications are 500mm height, 220mm width, 5kg weight, and 24 DOF. The reason Sony made SDR-3X as small as possible is for lowering the cost. In 2003, the latest SDR: SDR-4XII (580mm height, 270mm width, 7kg weight with 38 DOF), which is the enhanced version of SDR-4X [11], was announced. Presently its name was changed into QRIO (Quest for cuRIOsity). QRIO can more than just walk around such as squatting, getting up, and doing synchronized choreography. As an entertainment robot that lives with you, makes life fun, and makes you happy. QRIO would be on the market in the near future. SDR-3X and QRIO are shown in Fig.3 respectively.

In December 1996, Honda announced the development of a humanoid robot with two arms and two legs called P2 [12]. Research and development of this humanoid robot was initiated in 1986. The desired goal was to develop a robot able to coexist and collaborate with humans, and to perform tasks that humans cannot. P2 is a self-contained humanoid robot with two arms and two legs (as shown in Fig.4a), and may be operated via wireless communication.

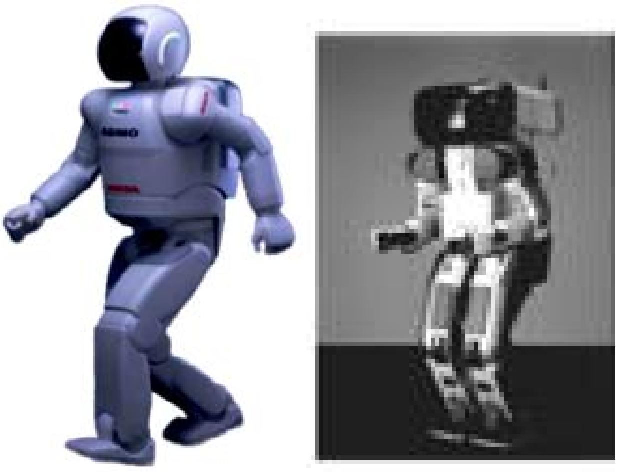
The overall height is 1820mm, the width is 600mm, and the weight is 210kg. It has 12 DOF in two legs and 14 DOF in two arms. The hand is similar to a two fingered with 2 DOF. It is able to open and close between its thumb and the other fingers, which form a single moveable digit. Furthermore, by rotating the position of the thumb, it is able to grasp an object in other ways. This robot has the ability to move forward and backward, sideways to the right or the left, as well as diagonally. In addition, the robot can turn in any direction, walk up and down stairs continuously. In the year 2000,

(a) (b)

Fig.2 Sony humanoid robot.
(a) Sony Dream Robot-3X (SDR-3X). (b) Quest for curiosity (QRIO).

downsizing P2 and P3 [13], ASIMO (1200mm height, 450mm width, 52kg weight with 26 DOF as shown in Fig. 3) appeared with a new walking technology (i-WALK) [14]. The introduction of i-WALK technology allowed ASIMO to walk continuously while changing directions, and gave the robot even greater stability in response to sudden movements. The newest impression of HONDA humanoids is that ASIMO Type-R, which is a Research Model of ASIMO and is children-size as well as a normal ASIMO, demonstrated 3.0 km/h walk at the robot exhibition: ROBODEX2003. The great success of HONDA humanoid robot makes the current research on the worlds humanoid robot to become very active area.

HRP-2 is humanoid robotics platform (shown in Fig. 5), which is developed in phase two of HRP. HRP was a humanoid robotic project, which had run by the Ministry of Economy, Trade and Industry (METI) of Japan from 1998FY to 2002FY for five years. The ability of the biped locomotion of HRP-2 is improved so that HRP-2 can cope with uneven surface, can walk at two third level of human speed, and can walk on a narrow path. The ability of whole body motion of HRP-2 is also improved so that HRP-2 lies down and can get up by a humanoid robot’s own self if HRP-2 tips over safety. The design concepts of HRP-2 are light, compact, but performable for application tasks like cooperative works[15]. HRP-2 is designed to have the human feminine size, its dimensions are summarized in table 1. An enhanced version of humanoid robot HRP-2, called HRP2-DHRC, was developed [16]. It was equipped with three DOF hands, three DOF wrists, one DOF toes, higher resolution stereo cameras and laser range fingers. The autonomy embedded on the robot includes a footstep planning with mixed reality with an online motion capture system, a vision guided footstep planning, an object localization from a depth matching, a navigation from 3D localization, and that among movable obstacles. HRP2-DHRC should be one of most advanced humanoid robots from the viewpoint of autonomy.



(a) (b)

Fig.3 Honda humanoid robot.
(a) P2. (b) Asimo[8].

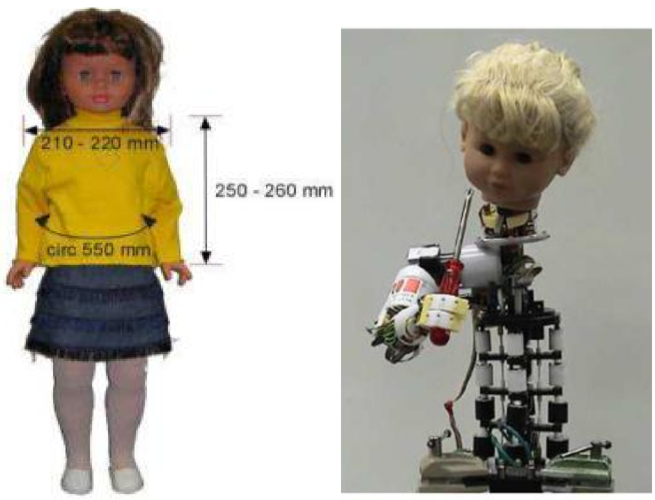
TABLE 1. SPECIFICATION OF SOME HUMANOID ROBOTS

Name	Asimo	QRIO	H7	HRP-2P	Silf-H2	Johnnie
Manuf-acturer	Honda	Sony	Univ. Tokyo	AIST/Kawada	K. Ito	TU München
size	130cm	58cm	147cm	154cm	25cm	180cm
weight	54kg	7kg	58kg	58kg	730kg	40kg
Speed	0.69-0.83 m/s	0.33m/s	0.5m/s	0.55m/s	0.1m/s	0.61m/s
DOF	34	28	30	30	20	19
Leg	6	6	7	6	6	6
Arm	7+2	5+Fingers	7	7	3	2
Trunk	1	-	-	2	1	1
Head	3	4	2	2	1	2

Robota project is part of a current trend of robotics research that develops educational and interactive The Robota project designs a series of biomimetic humanoid robots [17]. Since 1998, Robota has being used as part of studies with autistic children [18]. The Robota project is concerned with the design and construction of a series of multiple degrees of freedom (DOF) doll shaped humanoid robots, whose physical features resemble those of a human baby. The toys for children with disabilities. [19] designed and built prototypes of a 23 degrees of freedom upper body for Robota, including two 7 degrees of freedom (DOF) arm, a 3 DOFs pair of eyes, a 3 DOFs neck and a 3 DOFs spine. Robota has an average size of a 60 cm tall commercial doll, see Figure 6, and, the maximal weight of commercial toy robots, i.e. 4kg.

Figure 6 shows the doll shaped humanoid robots Robota. Figure 6.a illustrates Doll used as reference for setting the size of the new robot Robota. However, Current prototype of the new Robota is shown in Fig.6.b. In a latter stage, the prototype will be embedded in a plastic coating similar to that of commercial doll shown in Fig.6.a.

Fig. 4 HRP-2 Humanoid robot [15].



(a) (b)

Fig.5 The doll shaped humanoid robots Robota. (a) the size of the new robot Robota. (b) Current prototype of the new Robota.

3. COMPUTER GRAPHICS ROBOT DESIGNS

The concept and design of human-like automatons is not new. In 1495, Leonardo da Vinci designed a mechanical device that looked like an armored knight. It was designed to sit up, wave its arms, and move its head via a flexible neck while opening and closing its jaw. In 1921, the word robot was coined by Karel Capek in its theatre play: Rossum's Universal Robots (R.U.R.). The mechanical servant in the play had a humanoid appearance. The first humanoid robot to appear in the movies was Maria in the film Metropolis (Fritz Lang, 1926). Humanoid robots were not only part of the western culture. In 1952, Ozamu Tezuka created Astroboy, the first and one of the world's most popular Japanese scientific robots.

Recently Computer Aided Design (CAD) has been very developed, and it enables ones to create a real three-dimensional (3D) objects and environment. Thus, we have assembled an amazing collection of jaw-dropping computer graphic robot designs from various talented artists. With the help of powerful 3D rendering and illustration software, each artist presents their own creativity and skills in their masterpiece.

Computer aided design (CAD) was also used for dynamic and kinematic simulations of humanoid robot design, such as [20] which illustrates design and simulation results for a new low-cost humanoid robot that has been named as CALUMA (CAssino Low-cost hUMAnoid robot). A 3D-CAD model of CALUMA has been developed in order to check the design feasibility, possible component interferences and kinematic behaviour as well as, to realize a human-like shape [21]. A 3D arbitrary surface modeling has been used to design most of the robot's parts. Then, the 3D CAD data have been effectively converted to information that was suitable for CAE analyses. By using the structural CAE analysis, the design parameters that would ensure mechanical safety under given load conditions have been determined. The CAD enabled also the conducted kinematic simulation on various movements of the humanoid robot in order to estimate the required torque at each joint.

4. HUMANOID ROBOT WITH SPIRIT

4.1 What is spirit?

Spirit is the vital immaterial principal; it is an incorporeal substance and an intellectual activity which define the think principal.

Spirit is the God energy that imbues all living. It is our true nature...the part of us that never dies, that is eternal, infinite and limitless. It is in every one of us. It also gives life to our otherwise inanimate bodies. Even with these great developments in all fields, we cannot give an exact definition of spirit.

4.2 What does spirit do?

Spirit does not have to "do", but can only "be". It depends on what level of consciousness you are at and the world or plane you are reincarnated in. Spirit can be used to create form. Think of philosophy Homer's Socrates...what is a table? It is an idea that has taken on form. Without the idea there can be no form. Thought (the idea) always precedes the form. So, if the humanoid has a spirit, it will be able to create form, to create idea, then to recognize the world around it by itself and to take decision.

Norihiro Hagita, the director of the ATR Intelligent Robotics and Communication Laboratories near Kyoto in an often cited interview with the Washington Post, said "In Western countries, humanoid robots are still not very accepted, but they are in Japan, in Japanese [Shinto] religion, we believe that all things have gods within them. But in Western countries, most people believe in only one God. For us, however, a robot can have an energy all its own" [22]. In contrast, we think that, as spirit is something which is created by God, scientists cannot offer this for humanoid robot.

5. CONCLUSION

Humanoid robot is very important in the industry or the domestic use, and it has been dramatically developed in these recent years as the other types of robots. But, in our point of view, scientists can never create a humanoid robot with spirit because no one knows what spirit is really and the tendency to project human characteristics onto inanimate objects seems as universal as our most basic instincts. However, the interests in humanoid robotics can spread over various topics such as intelligence, interactions with humans and a tool of cognitive science.

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