Styling and Design of New ASIMO

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ABSTRACT

The new ASIMO has been developed to enhance the robot's ability to function autonomously in real-life environments (offices, etc.) and its physical capability. The design concept for the new model is "Advanced functions for increased usefulness." The orientation of the development was decided while comparing different prototypes constructed to focus on "advancement" and "friendliness" respectively with the current ASIMO. Designers and engineers collaborated from the initial stages of development in design work using three-dimensional data. The fine-tuning ASIMO's dynamic status using computer graphics (CG), and the robot's presence using mockups in actual spaces, have enabled the achievement of a superb "harmony" between design and mechanical features. The resulting design enables the incorporation of new functions while retaining ASIMO's "friendly" image.

1. Introduction

Honda has long engaged in research on humanoid robots, which present new values by functioning usefully in society through coexistence and cooperation with people, in its attempt to innovate forms of mobility. The result of this effort was the arrival of ASIMO in late October 2000[1, 2], and since then Honda has provided venues for people in Japan and worldwide to interact with this robot through various activities.

The new ASIMO, announced in 2005, was developed to enhance the robot's ability to work autonomously in real-life environments, such as offices, and to enhance its physical capabilities[3]. The new ASIMO contains sensors in its lower torso, waist, the front and back of the head, and its ears to recognize its surrounding environment and the positions of people. New joints have been added in its waist, wrists, thumbs, and neck to enhance its physical capabilities and expressiveness, and the elbows have a larger range of motion. In addition to these new mechanisms, designers were asked to make its form more beautiful by reconciling major changes such as increasing the height of the robot to enhance its presence in real-life environments. This article introduces the new ASIMO's design concept and process.

2. ASIMO Design Concept

A humanoid robot, one with a human-like form, is unlikely to receive sympathy from people if its design is too radical. It is also unlikely to gain acceptance on the basis of familiar looks alone. Ideally, the robot should strike a fine balance between the qualities of being "advanced" and "friendly," and it should keep "a comfortable distance" from the human form, not being too close or too far. Accordingly, the basic concept of ASIMO's design is to harmonize its "advanced" and "friendly" qualities.

The design of the earlier ASIMO was based on the concept of being "more familiar," so that humanoid robots could start to come out of the laboratory, step into the world, and be accepted as a new industrial product by many people.

If the new ASIMO design were to change this image, people would miss the previous ASIMO. This is the issue in changing a humanoid robot model.

The new ASIMO was designed for realizing new functions on the concept of "advancing functions that make the robot more useful around people" while retaining the image of the previous ASIMO.

Figure 1 shows an overview of ASIMO's evolution and design.

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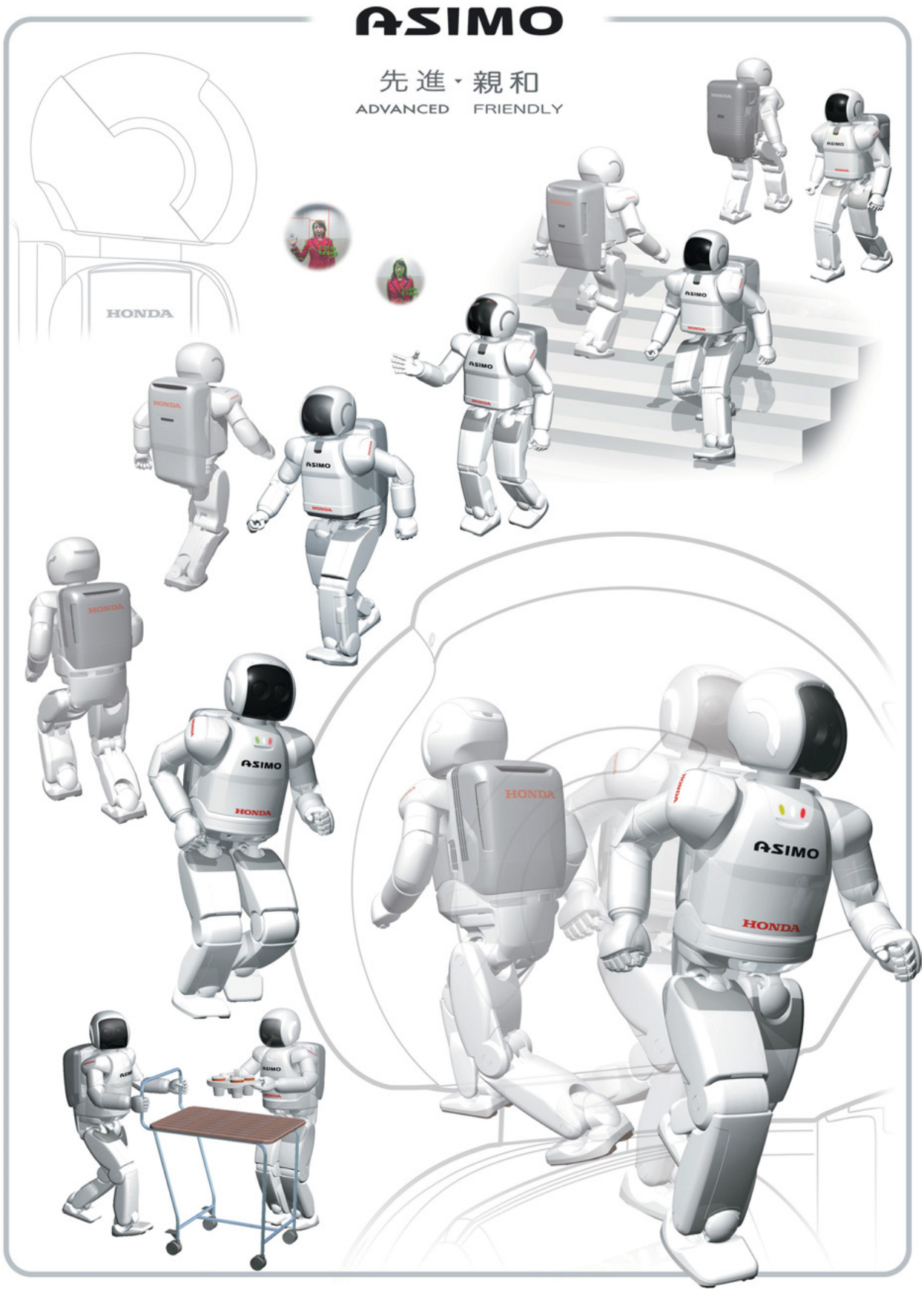

Fig. 1 Evolution of styling and design of ASIMO

3. Design Process

3.1. Design Techniques

Many unique humanoid issues are involved in achieving a humanoid robot, such as safety considerations in light of the many moving parts and avoidance of a sense of incongruity on appearance when the robot moves. Function is directly related to the form, a fact that necessitated the optimal placement of sensors and the addition of joints to increase the range of motion. Design plays a critical role in solving these issues, so designers and engineers worked closely together from the earliest stages of development and did design work with a common tool, 3D data.

Though there are conflicts between designers who seek aesthetic form and engineers who pursue innovative technology, the use of 3D data helped the two to share ideas concretely and mutually to enhance their work. In addition, because the designers were able to operate the 3D software directly, they could focus on the robot's aesthetics, not only in its static status but also its dynamic status, and could simultaneously work with each line and surface. Repeatedly making and unmaking the robot, the designers were able to create a sophisticated design. Designers ran highly precise simulations of the completed image through computer graphics (CG) rendering and animation (Fig. 2). The current computer technology, however, is still unable to test for the sense of presence a robot has when it is in the same room with people, so mockups were produced to make up for this. By putting a mockup in proximity to people, it can be checked how the robot will be viewed and sensed in these situations.

3.2. Goals of Design Study

Both CG and mockups were used to conduct design studies whose goal was to generate ideas for new design possibilities and new mechanism ideas such as equipping the robot with sensors and increasing the number of joints.

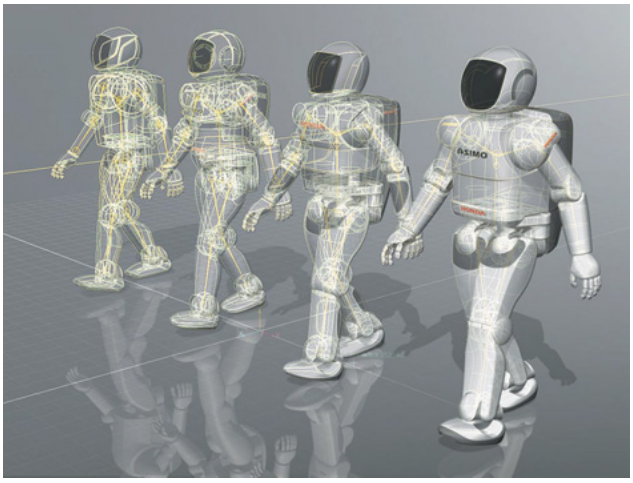

Fig. 2 Rendering and animation by computer graphics (CG)

Figure 3 illustrates the design studies in relation to the previous ASIMO. Taking the previous ASIMO with its "harmonization" of "advanced" and "friendly" qualities as the starting point, the balance was shifted and two design studies were conducted for comparison purposes: Design Study A, which focused on the "advanced" look (Fig. 3 (a)), and Design Study B, with an emphasis on the "friendly" look (Fig. 3 (b)).

The goals of each study were as follows.

(1) Goal of Design Study A

The goal was to express a humanoid robot with high functionality by focusing on an advanced image. The form of the head was based on a full face helmet, with sensors on the surface and illuminated ears and mouth. Joints were made spherical so that there would be little gap in the outer form during movement. Flexible material was used to enhance safety while maximizing the range of motion.

(2) Goal of Design Study B

The goal was to give the robot a face to focus on friendliness and enhance the sense of communication. Joints were added to the neck, elbows, wrists and waist to increase the angle of available motion, which enabled the robot to make various motions.

3.3. Design Clinic Results

Design clinics were held to obtain the opinions of non-designated subjects and thereby determine how well the goals of the two design proposals would be conveyed to people and how people would understand the relationship with the previous ASIMO. Mockups of the previous ASIMO (Fig. 4), Design Study A (Fig. 5), and Design Study B (Fig. 6) were presented, as were CG animations of each, and subjects responded in questionnaires and interviews as follows.

(1) The previous ASIMO

The previous ASIMO was likable, with a cute and friendly image. Subjects looked forward to seeing how this ASIMO would turn out in the future. They felt that it could be evolved by enhancing individual parts, such as the heavy-looking back.

(2) Design Study A

The impressions of the robot were that of a high performance robot that would get its work done steadily; that it seemed futuristic but not warm; and that it looked like a completely different humanoid robot, with little connection to the previous ASIMO. The new mechanisms seemed a little incongruous.

(3) Design Study B

This robot conveyed a higher sense of communication. However, its expression seemed rather simple. This robot could be teamed together with the previous ASIMO

Fig. 3 Relation of design studies with previous ASIMO [(a) : advanced design, (b) : friendly design]

Fig. 4 Previous ASIMO (Mockup)

Fig. 5 Design study A (Mockup)

Fig. 6 Design study B (Mockup)

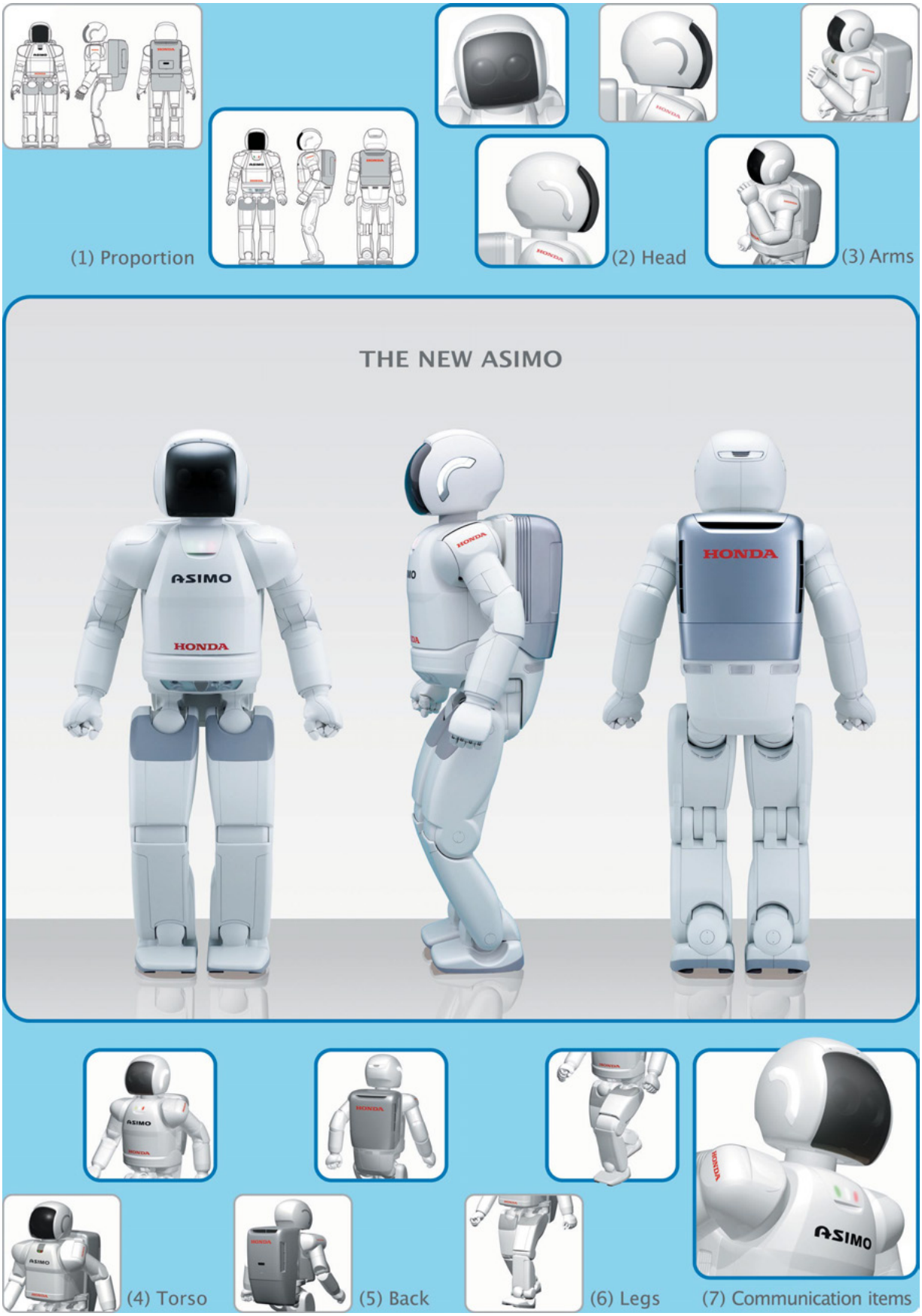

Fig. 7 Overall final design and design of parts (Blue frame : new ASIMO ; Gray frame : previous ASIMO)

without seeming out of place, but it seemed like just a variation of the original, e.g., like a brother. The new mechanisms did not seem incongruous.

In summary, the subjects' opinions indicate that they understood the designs as the designers intended, and that the functional simple design of the previous ASIMO had received the sympathy of the subjects.

3.4. Deciding on the Final Design

The new ASIMO was designed with respect to the following three perspectives by incorporating the new mechanisms investigated in the design studies while using the image of the previous ASIMO.

1. The new ASIMO would express "ease of communication" by using LEDs for illumination and integrating a head tilting motion into the design.
2. It would express "gentleness" with rounded surfaces and crisp lines basically.
3. It would express "good motion" with a functional and strong form.

Figure 7 shows a comparison of the previous ASIMO and the final design of the new ASIMO. Details are shown below.

(1) Proportion

The height of the previous ASIMO was 120 cm, which was considered to be the minimum size to be useful when occupying space with a human, and it had a six head-length body proportion, similar to that of a child of about the same height. The new ASIMO is 130 cm tall and has an approximately 6.3 head-length body proportion to accommodate the new mechanisms and to enhance its presence. The new design also attempted to enhance the robot's posture by changing the locations of the axes of the neck and arms. It also expressed "gentleness" with rounded surfaces and crisp lines all over the body so that it could be active in proximity to people.

(2) Head

Because the head has a particularly strong impact on the overall image, several proposals were developed before the following design was finally chosen.

The size deemed appropriate at first on the 3D data appeared smaller than expected in the mockup form, resulting in an impression of less "friendliness." Therefore the size was determined after adjusting the balance.

The head was rounded overall to increase its "friendliness," and sensors were built into the front, back, and ear areas. A joint was added to the neck, enabling the robot to better express itself by tilting the head. To do this without touching the chest or back, the lower surface was rounded. To express the image of "running," the angle of the top of the head and lines on the sides were used to recall hair streaming in the wind.

The eyes are important in designing humanoid robots. A series of lenses were tested so that a modest amount of light would reflect, projecting "pupils" that would make the robot look friendlier.

(3) Arms

The shoulders were made compact and nearly spherical to minimize gaps in the outer form when the arms moved. Due to the increased angle of available motions of the elbows, a soft material was placed inside, and the outside was formed to reduce gaps during movement. Whereas the previous ASIMO had cylindrical wrists, the new model has spherical wrists to accommodate the increasing degrees of freedom. Each finger was modified rounder to give a gentle touch when shaking hands.

(4) Torso

The torso of the new ASIMO has a rotating mechanism to enhance its physical capabilities. As a result, an angular torso like that of the previous ASIMO would display an unevenness of angles when turning, so the rounded form studied in Design Study B, having little unevenness between the upper and lower parts when turning, was used as a basis. Sensors for recognizing the surrounding environment were arranged in the lower part to have a functional look to demonstrate this performance.

(5) Back

Due to the changes to the internal structure and a more compact battery, the back of the robot was modified smaller to enhance a sense of unity with the torso. Moreover, the structure was made to be a single piece with the changeable battery, and a handle for battery removal and installation and an operating switch panel were built into the upper lid for ease of use.

The waist was made into a separate component by making the back smaller and giving the torso a rotating mechanism. This is a part that is highly different from the previous ASIMO. Repeated studies were performed not to generate any sense of incongruity and the waist was designed to be functional with consideration given to the placement of sensors and insertion into the back of the legs.

(6) Legs

At first the legs were designed to be the same length as those of the previous ASIMO, and then the proportions were modified by making the thighs and shins longer so that the torso would not appear too long. The bumps of the knees were reduced to enhance safety, and the hem was flared to express strong legs that are ready to "run."

(7) Communication items

Humans associate lights and the way in which things are illuminated with a sense of life. To make effective use of this association, the new ASIMO's ears and chest are

illuminated. The ears clearly illuminate, but the chest was given an illumination design tested in Design Study A: when illuminated, the chest shines gently, projecting a sense of having a core, and when not illuminated, it reduces its sense of presence.

4. Conclusion

The process of developing a design for the new ASIMO was designed to achieve a new level of "harmony." This endeavor included design clinics with models focusing on, respectively, "advanced" and "friendly" qualities, and the process furthermore sought out points of agreement between designers and engineers, who shared 3D data from the beginning of the development and enhanced each other's ideas. At the same time, the design considered both the robot's static and dynamic status, and expressed "ease of communication," "gentleness," and "good motion." As a result, the robot was designed to present the concept, "advancing those functions that make the robot more useful around people" while retaining the "cute and friendly" image of the previous ASIMO. This design was intended to receive sympathy from people.

5. Closing

Humanoid robots continue to inspire hopes and interests among people. And the dream spreads endlessly. The drawings that children around the world send to Honda, and the fascination with which people look at ASIMO, are testament to this. While it is easy to dream up a robot in the imagination, actually building one has many challenging issues. However, with its goal of building a robot to coexist with humans, Honda is committed to achieving this goal one step at a time.

References

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