

## Conceptual Design of COD-E Humanoid Robots

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### Abstract

The conceptualizing process plays an important role in assisting designers' creativity in form and styling development. It contributes to representing the cultural elements before product transformation, which has a limited investigation. This research aims to identify the metaphorical form element that conveys the brain impaired as factors of selection and defining form development of the humanoid robot embodiment. Design Protocol Analysis obtains into design linguistic interpretations and synthesizing design based on perceptual product experience. Findings have outlined the theory of metaphorical form element selection and identification that could represent brain impaired product in assisting humanoid robotic acceptance among autism.

Keywords: Design-Inspire; Humanoid Robot; Children with Autism; Design Protocol Analysis.

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### 1.0 Introduction

Assistive technology refers to a variety of devices for helping and assisting children with autism to work better within their daily context, education, environment and meet a higher quality of life and encompassing multiple resources which are providing different forms of practical supports that lead to behavioural and social benefits support for the end-users by reducing the negative impact of their disability conditions (Bauer, Elsaesser, & Arthanat, 2011; Shih, 2011). Assistive technology offers role scope, such as playing and exploring by being creative in a highly controllable environment without any verbal demands. It is throughout assistive technology, cognitive can be integrated within components that enable scaffold learning (Kamaruzaman, Nor & Azahari, 2016). Usually, children with autism process visual information easier than auditory information.

Meanwhile, design-inspire approaches can be critical when it comes to forming the development process (Anwar, Abidin, & Hassan, 2015a; Corremans, 2011). As an artefact that reveals something insightful, conceptual metaphors are normally used in relating the connotation of separate entities to be conveyed and comprehended, thus allowing creativity during the form development of a product (Cila, Hekkert, & Visch, 2014). When brain impaired specific information contributes to generating relevance to the product or design, it may deserve to be mentioned. However, it is often an issue of finding the right metaphor to design a humanoid robot. These days, Human-Robot Interaction (HRI) is a widespread activity that can be determined as an emerging research domain especially here in Malaysia. It is, however, before scientific investigation; incremental validity and research justification can be very challenging. In recent years, more and more robots are being used as assistive devices in the intervention as well as habilitation for

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children with a special need, and this also comprises children with autism (Stokes, 2000). Autism is a developmental disorder caused by abnormal development of the brain (Kamaruzaman, Noor, Hanapiah & Azahari, 2016). The deficits in social and communication skills and behaviour stereotypes characterized the abnormal development. As autism is a lifelong challenge, intervention in the early years serves the purpose to cut the deficits of autism and to instil independent living abilities which could foster the children with autism quality of life (Kamaruzaman, Rahman, Abdullah, Anwar, 2013).

The robotic intervention has been recognized as one of the methods that are producing emboldening outcomes in the rehabilitation of children with autism. Robot-based solutions are desirable as they are inspiring, motivating, detailed, and repetitive. Reflecting Ho, MacDorman, and Pramono (2008), Mashahiro Mori, a Japanese robot was created to look identical to humans. The humanoid robots have the physical look similar to humans because they are divided into four sets of joints relating to the limb which is the legs and arms (Sian, Yokoi, Kajita, & Tanie, 2003). Therefore, it can be simple when applying human gestures to the robotic form and produce a few motions and gestures. Gestures and postures are non-verbal communication because it is translated through human's physical gestures and not through oral communication. This research focuses on creating a variety of human gestures and postures that are applied to a robotic form.

## 2.0 Humanoid Robot Design for Autism

Based on the literature study, there is a lot of experiment including clinical research investigated between humanoid robots and children with autism engagement. Acknowledging this fact, metaphors are one of the mechanisms that let the well-known mental imagery of subjective experiences and judgments based on regular experiences which could be neutrally linked (Lakoff & Johnson, 1999). These days, Human-Robot Interaction (HRI) is an emergent research domain here in Malaysia. Hence, it requires further study to prove its incremental validity and research justification that goes beyond scientific investigation. In recent years, more and more robots are being used as assistive devices in the intervention as well as habilitation for children with a special need, and this also comprises of children with autism. Autism is a developmental disorder caused by abnormal development of the brain. Deficits in social and communication skills and behaviour stereotypes characterized the abnormal disorder. As autism is a lifelong challenge, intervention in the early years serves the purpose to cut the deficits of autism and to instil independent living abilities which could foster the children with autism quality of life. The robotic intervention is one of the methods which are producing emboldening outcomes rehabilitate of children with autism. Table 1 has summarized a sample of robot-based solutions are desirable as they are inspiring, motivating, detailed, and repetitive.

Table 1. Humanoid robots tested to be interacted by child with autism

Humanoid Robot	Description
	<p>NAO 2-feet-tall humanoid robot from Aldebaran Robotics. Because of its success in the classroom, ASK (Autism Solutions for Kids) Nao Program was launched.</p>
	<p>MILO 2-feet-tall humanoid robot. Proven to be effective at reaching autistic children who have difficulty interacting with humans. Research shows that children working with a therapist and Milo are engaged 70-80% of the time compared to traditional approaches which comes to 3-10%.</p>
	<p>BUDDY Created by Blue Frog Robotics. Is a personal robot. Its creator is working with Auticiel to integrate apps that will help children with autism and other special needs learn to communicate, interact with others, and be more autonomous.</p>

(Source: NAO <https://www.softbankrobotics.com/emea/en/nao>; MILO <https://robots4autism.com/milo>; BUDDY <https://buddytherobot.com/en/about-us/>)

## 3.0 A Complexity of Integrated Humanoid Robot Development in Design Process

Product interactions could be achieved by their product perceptual experience (Warell, 2008). A framework of perceptual product experience, which outlined dimensions of 'presentation' and 'representation' bounded by a core mode categorized as 'experience.' The representation dimension involved in the 'meaning-making' of product. 'Meaning' constitutes recognition, comprehension, and association with a particular product. In a product meaning association, metaphors recognize to express the characteristics and symbolic significance of the product. The framework of product experience (Desmet & Hekkert, 2007) outlines the recognition. At some point, metaphors also benefitted the users as a medium of 'communication' to help them understand a product based on the inspiration which, captures from the appearance and attributes (Anwar, 2016). In replicating physical form close to human, it needs

close human affection encounter whilst designer awareness throughout designing principal for the humanoid is mandatory. Design awareness in designing provides a designer with the ability to forecast product hindrances that may intrude on the users. It is also designed to outline limits dangers and the unfavourable results of coincidental or unintended activities. A protocol experiment has to put into practice in collecting important data of product performances and appearances that verifying users' experience that associates design with human affection. In return, the data can provide a bridge that potentially helps a designer in making sense of the user feedback drawn from using the product (Anwar, Abidin & Hassan, 2016). Through experiences, user gauge cognitions of perception shaped by many factors. The process of perceiving understands and remembering explains the significant time constraint of knowledge building that involves input transfer within user-artefacts designer (see Fig. 1). User product experienced in a lab protocol environment amplifies critical both conscious and unconscious user patterns. Prevailing the answer to why it is necessary, what do they think and how do they behave from the task that sets in achieving the directed goal (Vermol, Anwar, Hassan, & Abidin, 2015).

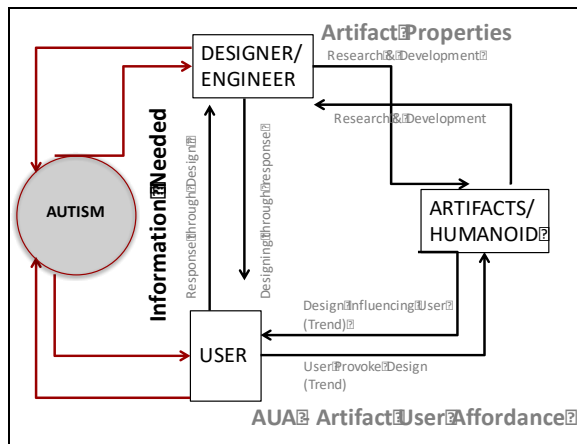


Fig. 1: AU-DA-Model. Reference for developing new concept of humanoid robot (Source: Vermol, Anwar, Hassan & Abidin, 2015)

#### 4.0 COD-E Humanoid Robot – Product Development

Developing a conceptual humanoid robot requires certain issues to be solved. However, throughout the introductory of Critical Optimized Design through Emotion (COD-E) Humanoid Robot concept, innovative features of a shell design that protects the electronic parts become the critical influence that targeted to attracts interaction within the emotion of the user. As to plan out a new product in lines, as a supplement to existing market addition of humanoid via Bio-loid design of sizing and scaling (Fig. 2) has been repositioned to actual Bio-loid. Through design staging, the elaboration of the design process defined in 4 levels which is [1] ideate; [2] prototype screening; [3] fixing and fittings and; [4] digital characterizing.

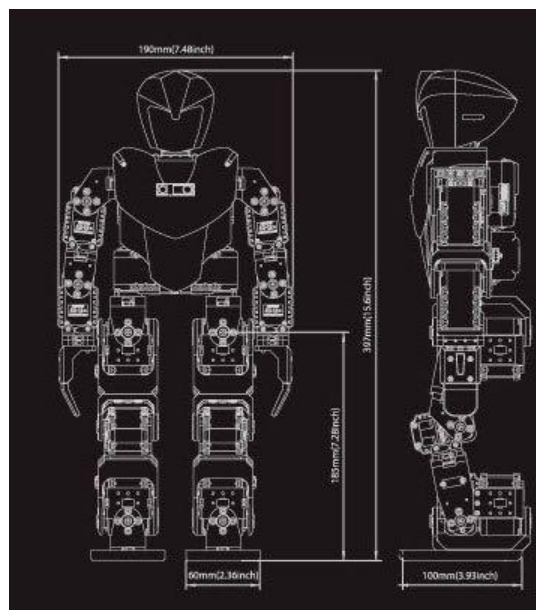


Fig. 2: Bioloid robot original structure (Source: <http://www.robotis.us/bioloid-1/>)

#### 4.1 Ideate

This research is to endow and developed a principle that will apply to any humanoid design for autism at any scale. The reasons for this hinge are to identify the relation between materials, shape, and the absolute dimension of design, its related accumulation, and the forces and deformations developed within it. The bigger an object gets, the more influential on form become structural issues. Ideating through a continuous, systematic search of new product sizing of attraction involves delineating sources of new ideas and methods based on principal design attributes. By taking into account the context in styling elaborations, the idea generated taking forms through design specification which, are fitted to compromise the partial aspect of Bio-loid original forms. Hence, the improvement made increases the humanoid appearance out of the original Bio-loid model. Fig. 3 shows a part of a design morphology based on the structural form of Bio-loid design. The investigations of the selection target area which revealed with poor ergonomic design, unsatisfactory, and quality problems. Ergonomics is a design-oriented discipline, ergonomists are just responsible for human-associated design function and do not design the whole systems. But the COD-E design structure requires to satisfy multiple functional requirements including ergonomics, production process, time, and cost.

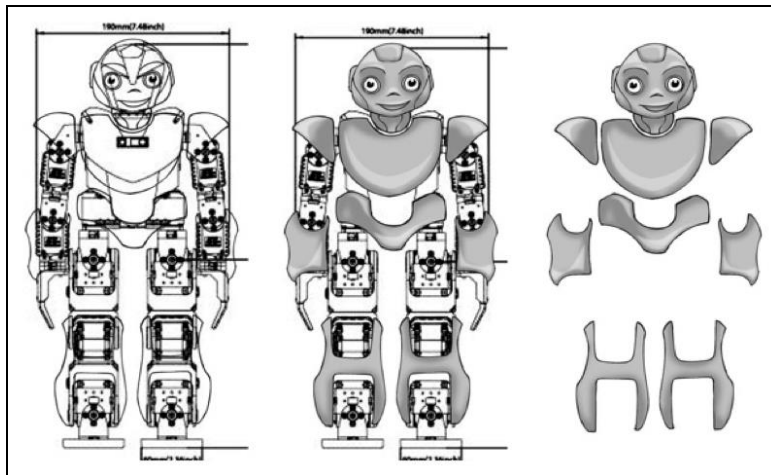


Fig. 3: Idea generation

#### 4.2 Prototype screening

According to Ching (2008), Mashahiro Mori, a Japanese robot was created to look identical to humans. The humanoid robots have the physical look similar to humans by fragmenting four sets of joints relating to the limb which are the legs and arms (Yokoi, Kajita and Tanie, 2003). Therefore, it's easier to apply human gestures on a robotic form and produces a few motions and gestures. Gestures and postures are non-verbal communication. It is translated through human's physical gestures and not through oral communication. This study focuses on creating a robotic form through a variety of human gestures and postures. Through the generated idea, the design is then sculpted, fabricated, and fitted as a prototype sample to be deliberated and discussed. Through this process, screening is made following the aspect of the Bio-loid movement by taking account 'the state of pause, walk, and rest'. Through idea screening, fitting problems arises can be reduced to support Bio-loid progressive movement. Fig. 4 shows the idea of screening through the state and condition of Bio-loid.

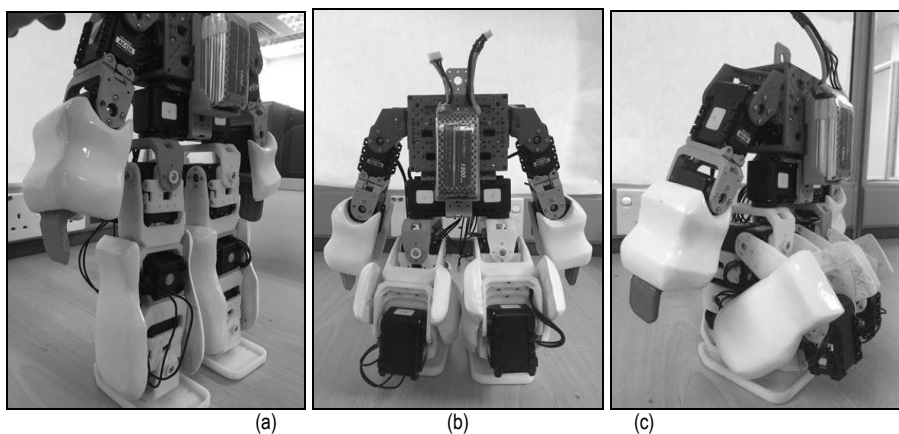


Fig. 4: (a) Side view through stand condition; (b) Front view through squat condition; (c) Side view through squat condition.

#### 4.3 Fixing and fitting

Re-sizing the original Bio-loid anatomy is critical to support its movements and balance. During the fabricating stage, the stability set to the original Bio-Loid size and structure. It is, however, the location of brackets for the mini-motors remains on its original.

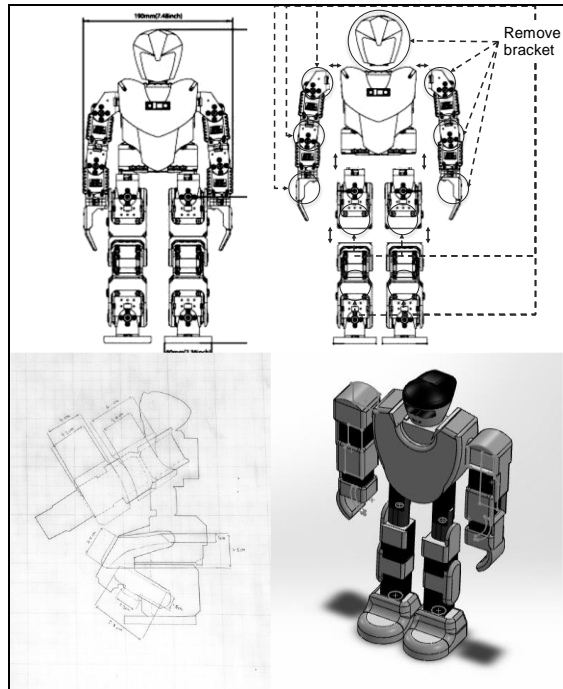


Fig. 5: Body concept development

#### 4.4 Digital characterizing

Through digital concept visual development, characterization of each

humanoid-Bio-loid head design provides a series of COD-E Conceptual Design into consideration and discussion.

Selections of the ideation concept provide a closer step in bringing the final fabrication of the COD-E prototype into reality. The insight seeking and form element ordering during design episode has exposed the divergent-convergent of AFMA (Anwar, Abidin, & Hassan, 2015b) thinking among designer generates a significant visual surface shown in the form structure. Through the process, five conceptual designs of early COD-E were developed and to be re-coded. The result through circumstantial evidence adapted from AFMA approaches revealed that there is a consistent character arisen from the form-giving activities that relate to the human experience. Referring to the final concept of designers' impression design in Fig. 6 provides the overall improvement on appearance and sizing of Bio-loid new look. The success of form structure (body) has made possible the COD-E prototype design illustration complete as a whole (product gestalt) with any possible head design options.

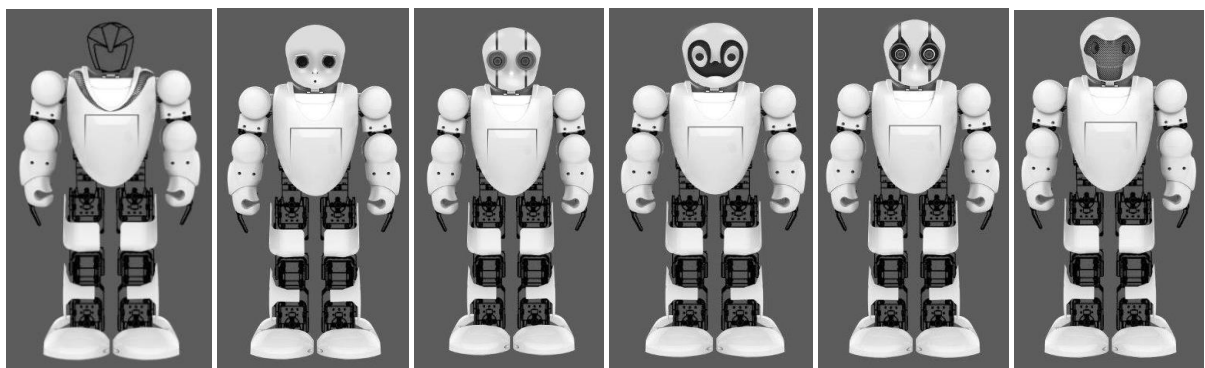


Fig. 6: Early concept of COD-E

#### 5.0 Conclusions and future works

The conceptual design process explained in this study features how

researchers observe primary users' experiences to reflect on the experiment trial. Mediating through four humanoid prototypes of the same types and design with multiple facial expressions. As for future works, the researcher will be observing and summarizing human experiences through video recording within the contextual inquiry for finding a significant pattern. The significance of this research underlines the design factors pattern draws out from the primary user representation that highlights pre-post performances. The results of the experiment generate the User-Designer consensus within the respondent's awareness. Makes invisible to the product designer enabling the researcher to look into gaps and articulate product performance according to the primary user perspective. COD-E design criteria demanded all materials and components that lead to long-term failure-free operation. Autism character on

children debated as fundamental in creating better humanoid robot design and development. Thus the discussion focus only on structural design aspects. There are also technical issues that are non-structural. It is useful to review some of these issues as a way to understand design structural issues differences. Explained explicitly and implicitly on these studies to cater design development of a humanoid design. It can accrue through an attempt to improve the technical performance of COD-E design of any scale. For future works, the primary concern has usually been the improvement of the design, structure, or material itself. The consideration of facial expression will also need explorations towards matching the abilities of the autism needs with the COD-E structure design requirements.

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