Understanding the Importance and Challenges of Animatronic Humanoid Prototypes Production in the Robotic Field in the United of States of America: Policy Implications

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Abstract
This study analyzes the importance and challenges of animatronic humanoid prototypes production within the robotic field in the United States of America to influence Artificial Intelligence (AI) policy. In fact, animatronic humanoid prototype has greatly inspired more designers and developers' interest in the study of human and robot interaction in both scientists and enthusiast alike to aid in robotic production. The study adopted a narrative literature review and Boolean search technique to identify 22 researches and review articles that are related to applications, challenges and importance of animatronic humanoid robotics production and applications. As part of the findings for the study utilized for the article, many scholars made specific inferences to the robotic applications in firms, businesses, and nations. Out of the twenty-two articles, five of the researchers, thus 22%, underscored and also perceived that robots and machines with biped locomotion is one of the achievements of humanoid robotic production. Researchers of 4 articles—thus 18% -- explicitly stated in their research that one of the achievements of humanoid robotic production is "learning capabilities in robots". The study further revealed that some of the evidenced-based research applications for humanoid robotic products include the following: Mitsuo Kawato of ATR Japan proposed using humanoid robots to study human behavior; In Europe- EU-funded projects, which include the large-scale NEUROBOTICS project; RobotCub project; Human Brain Project; Atlas humanoid robot by Boston Dynamics; and Wisdom of the robot Sophia in engaging in conversations, etc. Above all, this study revealed that complex environment, perception, human robot interaction, and collaboration in real life are some of the challenges identified in the literature. Therefore, in order to overcome such challenges—for the body of a robot, designers need to rethink the materials that robots are made of and leverage morphological computation to intrinsically balance and compensate for motion and dynamic behavior. Also, investors, policymakers, and public officials should invest more in innovative robotic production in order to promote businesses, bring about efficiency in operations, and to increase productivity.
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INTRODUCTION

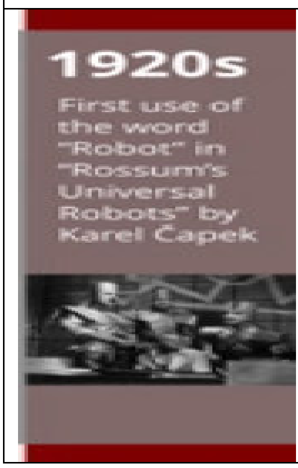
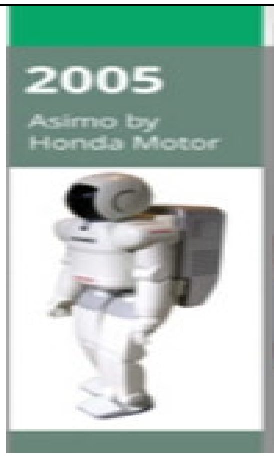
Throughout recorded history, human ingenuity can be attributed to some of the most incredible inventions in existence. In perusing the literature, some of the incredible inventions ranges from airplanes to cellphones, automobiles, television sets, and kitchen mixers. Of all the inventions so far, none have fascinated people more like humanoid robots (Goodrich and Schultz, 2007). According to Goodrich and Schultz (2007), humanoid robots are mobile electronic machines which can be programed or taught to carry out specific tasks or commands. In the past few decades, scientists have been highly interested in the development of life-like humanoid robots. Robots were first developed in the 1920's and were only taken as a novelty at the time as they had very limited features and abilities (see Figure A for more details). Further development led to the creation of programmable mobile robots. These robots were used mostly in transporting heavy objects to accessing regions that were unreachable by humans. Towards the late 80's and into the 1990's, engineers and scientists shifted their interest to the development of humanoid robots (Simon, 2020). These types of robots were able to stand, walk, and even pick up objects with mechanical hands. The introduction of humanoid robots greatly increased the interests of ordinary people in humanoid robots in particular (Simon, 2020). However, according to Simon (2020), with the interest in these robots came the issue of communication. During this period, majority of these robots have little or no recognizable facial features and would have to communicate with an external user by the use of audible sounds or visual symbols. This issue brought up the idea of creating robots that have recognizable facial features and are capable of carrying a conversation with humans through the help of animated prototypes.

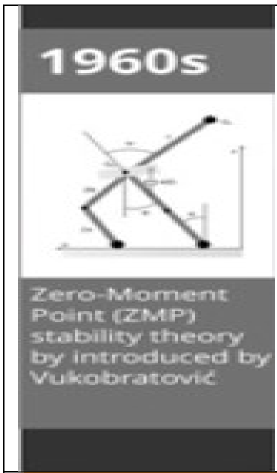
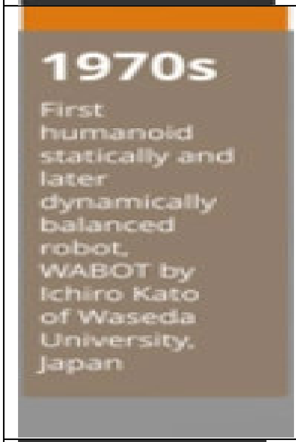
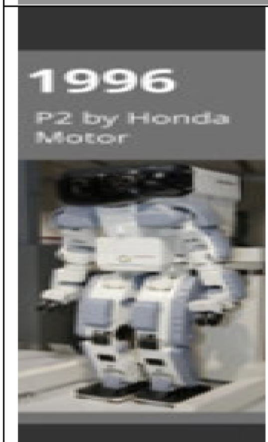
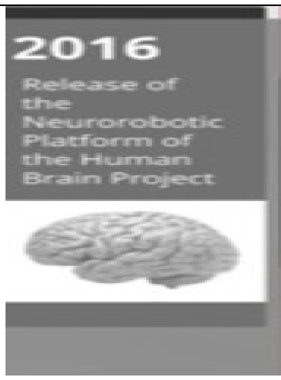
Very importantly, animatronic humanoid scholars such as Toshio Fukuda, Paolo Dario, and Guang-Zhong Yang, have always been fascinated by what it means to be human; for which the theme has been extensively explored in the sciences as well as the arts (such as literature and film) (Fukuda, Dario & Yang, 2017). *Rossum's Universal Robots* (by Czech writer Karel Čapek in the 1920s) introduced the word "robot" to describe creatures that look human but used only for tedious labor. The work has had an extensive influence on modern societies, inspiring the development of machines (humanoids) that not only resemble humans but also are intelligent and can act, reason, and interact like human beings (Fukuda, Dario & Yang, 2017). This ultimate dream has led to many robotic embodiments in recognizably anthropomorphic forms integrating motion, perception, and interaction to recreate the physical, cognitive, and social functions of humans (Fukuda, Dario & Yang, 2017).

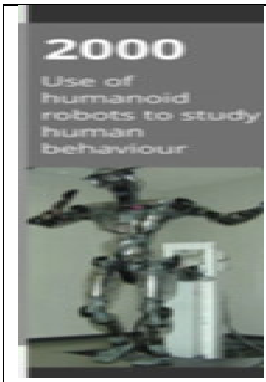
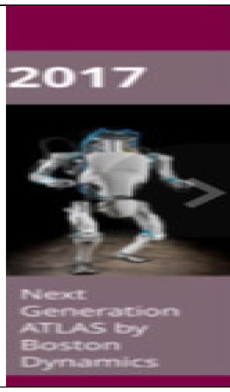
According to Fukuda, Dario and Yang (2017), humanoid robotics is an important branch of biomimetic robotics and is not only associated with science and engineering disciplines but also deeply connected to social, legal, and ethical domains. Surprisingly, the early attempts to the creation of humanoid robotics significantly underestimated the challenges associated; nevertheless, new theory and technologies have now come to fruition in realizing humanoid robots beside the classic Automata and Karakuri robots (Fukuda, Dario & Yang, 2017). Additionally, Fukuda, Dario and Yang (2017) further argued in the literature that one important contribution to humanoid robotics was the zero-moment point (ZMP) stability theory introduced by Miomir Vukobratović in the 1960s. Additionally, the first humanoid statically and later dynamically balanced robot, WABOT, by Ichiro Kato of Waseda University, Japan, was developed around the same time (Fukuda, Dario & Yang, 2017). For such achievements, these scientists must be recognized as pioneers of humanoid robotics. Since then, many scientists and engineers have been working on this topic (Fukuda, Dario & Yang, 2017). In 1997, Honda Motor revealed the Humanoid P2 at the 1997 IEEE International Conference on Intelligent Robots and Systems (IROS) in Grenoble, France. Subsequent development led to the ASIMO robot announced in 2000 (Fukuda, Dario & Yang, 2017). The impact was felt beyond the robotics community: The general public was excited by its human-like android shape, natural gait walks, automatic slope balance, ability to climb up and down stairways, and human interactions. An increasing number of researchers have since been challenged to further develop humanoid robots (Fukuda, Dario & Yang, 2017).

Guizzo and Ackerman (2015) also argued that after the Fukushima nuclear power plant disaster, the 2015 Defense Advanced Research Projects Agency (DARPA) Robotics Challenge demonstrated marked progresses in many ongoing humanoid projects. However, they still fell below researchers' expectations. This shortcoming in the humanoid robot literature clearly calls for the needs for more research and development not only in mechanical design and control but also in perception and recognition capabilities. As a result, several researchers, robotic designers and developers, after all, are still at the beginning of a long journey of creating a humanoid robot that is intelligent and can act, reason, and interact like a human being in real-world scenarios (see Figure A to view some key milestones towards the development of humanoid robotics since 1920s up to date).

Figure A: Some key milestones and major platforms in the development of humanoid robots.

Time Period	**Development of Humanoid Robotics**	**Time Period**	**Development of Humanoid Robotics**
	First use of the word « Robot » in « Rossum's Universal Robts » by Karel Capek		Asimo by Honda Motor

	Zero-Moment Point (ZMP) stability theory introduced by Vukobratovic		First Release of the iCub Robot for Cognitive Science Research
	First humanoid statically and later dynamically balanced robot, WABOT by Ichiro Kato of Waseda University, Japan.		NASA Robonaut 2- HRP-4 Bipedal Humanoid
	P2 by Honda Motor		**2013:** DRC-ATLAS used by 6 Teams for the DARPA Challenge 2015: South Korea DRC-HUBO Robot wins the DARPA Robotics Challenge
	P3 by Honda Motor		Release of the Neurorobotic Platform of the Human Brain Project

	Use of Humanoid Robots to Study Human Behavior		Next Generation ATLAS by Boston Dynamics

Source: Author's modification of Robert Merrifield and Lin Zhang/Imperial College figure of Some key milestones and major platforms in the development of humanoid robots.

Notwithstanding, it is observed from the literature that motion designers, such as UX (user experience) and UI (user interface) designers, animators, and web designers can all benefit from using this animated prototype tool in their development process. For instance, Hanson and Sophia developed by Hanson Robotics are some of the best examples of this technology. Both robots are capable of replicating several human emotions including joy, sadness, and even confusion. They were developed using a special type of artificial skin or prototype created by Hanson Robotics called Frubber (Wu et al., 2009). Therefore, this current study tends to model and investigate the importance and challenges of animatronic humanoid prototypes production within the robotic space in the United States of America to influence Artificial Intelligence (AI) policy.

LITERATURE REVIEW

Concept of Prototype

A prototype is a test or preliminary model of an idea, design, process, interface, technology, product, service or creative work (Spacey, 2016). They are used to support business processes such as requirements gathering, development and strategy planning. The following are common types of prototype. *Architectural Animation*: A movie that walks through the proposed 3D space of a building or structure. *Concept Art:* Illustrations that capture an aspect of design such as an idea, layout, form, aesthetic, architecture or sequence (Spacey, 2016). *Demo:* A short, unpolished version of a work such as a song, film, visual design, game or business application. *Evolutionary Prototype:* A prototype that is extended over a considerable period of time that represents a future version of something. For example, a concept car that is developed as a potential future production model (Spacey, 2016).

Form Study: An object or animation that explores size, shape, form, and appearance. *Functional Prototype:* A prototype that is close to the end result in functionality. For example, a user interface that works with test data but isn't properly developed as an well designed and integrated system. *Horizontal Prototype*: A prototype that shows a complete user interface without the ability to drill down. *Low Fidelity*: A prototype that is less detailed or lower quality than the intended end result (Spacey, 2016). *Minimum Viable Product*: A product that's complete enough to put in front of customers as tool of market research or as a beta release. *Mockup*: A broad category of prototype that looks like the finished product but is completely lacking functionality. For example, a webpage depicted as an image or a car without an engine for use in wind tunnel testing (Spacey, 2016).

Paper Prototype: Illustrations and primitive cardboard models of design ideas. *Proof of Concept*: An implementation of a method or design to prove that it can work. *Proof of Principle*: A test of a foundational idea (Spacey, 2016). *Rapid Prototyping*: Techniques such as 3D printing that produce a physical object from a computer aided design. *Scale Model*: A smaller, typically non-functional, model. Commonly used for large things such as buildings, automobiles or aircraft. *Simulations*: Software visualizations of physical things. *Sports Prototype*: An advanced automobile that is only used for racing. Often used as a prototype for advanced technologies that may be used in future production models (Spacey, 2016).

Static Prototype: A prototype that appears to be functional but is in fact hardcoded. For example, software that fakes its data as opposed to integrating with data repositories. *Storyboard*: A series of graphics that visualize a sequence such as a user interaction or a scene in a film. *Throwaway Prototype*: A low cost prototype that is quickly developed with limited quality and functionality (Spacey, 2016). Essentially the opposite of an evolutionary prototype that represents a state-of-the-art design. *Vertical Prototype*: A user interface mockup with drill down capabilities. *Wireframes:* An illustration of a skeletal framework that serves as a blueprint for a design. *Business Experiments*: This is the complete list of articles we have written about business experiments (Spacey, 2016).

Concept of Animatronics and Its Formation

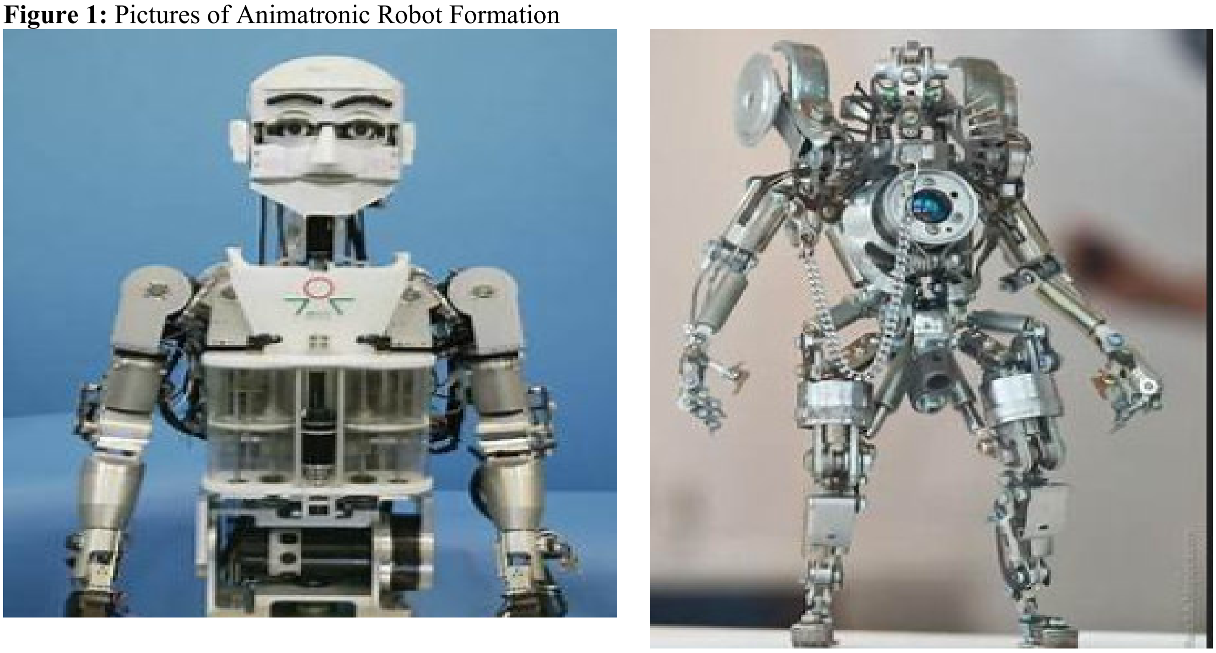
According to Janorkor (2021), animatronics is a combination of animation and electronics. What exactly is an animatronic? Basically, an animatronic is a mechanized puppet. It may be preprogrammed or remotely controlled. The animatronic may only perform a limited range of movements or it may be incredibly versatile (Jarnorkor, 2021; Tyson, n.d.). The scare created by the Great White coming out of the water in "Jaws" and the tender otherworldliness of "E.T." are cinematic effects that will not be easily forgotten. Later animatronics was used together with digital effects (Janorkor, 2021; Tyson, n.d.). Through the precision, ingenuity and dedication of their creators, animatronic creatures often seem as real to us as their flesh-and- blood counterparts.

FORMATION OF ANIMATRONICS

Step 1: Design Process: During the design process, the client and the company developing the animatronics decide what the character will be, its appearance, total number of moves, quality of moves, and what each specific move will be. Budgets, time lines and check points are established. Many years have been spent to ensure that this critical step is as simple as possible. Once this critically important stage is solidified and a time line is agreed upon, the project moves to the sculpting department (Janorkor, 2021).

Step 2: Sculpting: The sculpting department is responsible for converting two-dimensional ideas into three-dimensional forms. This team can work from photos, artwork, videos, models, statuettes and similar likenesses. Typically, the client is asked to approve the sculpting before it goes to the molding department. *Step 3: Mold-making*: The molding department takes the form created by the sculptor and creates the molds that will ultimately produce the character skins. Molds can be soft or hard, single or multiple pieces, and reusable or non-reusable. To get the sculptor's exact interpretation, mold making is both an art form and an elaborate technical process. The process can be very time- consuming and complicated. It can be so unnerving that some animation mold makers even refer to it as "black magic" (Janorkor, 2021). According to Janorkor (2021), after the mold is finished and cured, it is ready for skin making. Fiberglass shells are simultaneously being laid up to form the body and limb shapes. Some of these shapes are reusable stock pieces, but the majority of shells are custom made for each character (see Figure 1 for more details).

Figure 1: Pictures of Animatronic Robot Formation



(Source: https://www.brainlab.com)

Step 4: Armature Fabrication: Meanwhile, various body armatures are being created and are assembled in the welding metal-fabricating areas (Janorkor, 2021). Each of the robot's movements axis points must have an industrial-rated bearing to provide action and long life. Each individual part requires a custom design and fabrication. These artisans are combining both art and technology to achieve realistic, lifelike moves (Janorkor, 2021). As the armature takes shape, the actuators, valves, flow controls and hoses are installed by the animation department. The technicians select those components carefully in order to ensure the durability and long life. As it's assembled, each robotic move is individually tested and adjusted to get that perfect movement.

Step 5: Costuming: The costume, if there is one, is usually tailored to the character and its movements (Janorkor, 2021). Animation tailoring can be a very difficult tedious process considering the variables. The outfit has to allow for easy access to the character's operating mechanisms. It must also "look" normal after movement has taken place. The costume must be designed to provide hundreds of thousands of operations without wearing out and without causing the skin areas (i.e. around the necks or wrists) to breakdown as well (Janorkor, 2021).

Step 6: Programming: Finally, if it is an animated character the electronic wizard moves in to connect the control system into valve assembly in the preparation for programming. Programming is the final step, and for some animations it is the most rewarding. Programming can be done either at the manufacturing facility or at the final installation site. In programming, all the individual moves are coordinated into complex animated actions and nuances that bring the character to "life" (Janorkor, 2021).

Goal of Robotics and Its Proliferations

According to Fukuda, Dario and Yang (2017), humanoids represent one of the ultimate goals of robotics: to synthesize advances from many disciplines. These robots are inherently cross-disciplinary, involving advanced locomotion and manipulation, biomechanics, artificial intelligence, machine vision, perception, learning and cognitive development, as well as behavioral studies. For this special issue of humanoid robotics, we received a wide variety of papers in the field of the biomimetic design, stability and autonomous control, adaptive walking to rough terrain and natural gaiting, robust control for avoiding falling on the ground, adaptive behavior, robot machine learning capability, real-time visual recognition and understanding, multi-robot cooperation, human-robot coordination, human psychological aspects, and many others. Some of them are included here, and others may appear in future issues of *Science Robotics* after further revisions. The editors are grateful for all contributions submitted to this special issue, and we hope that this field will continue to grow and prosper in both research and development, targeting real-world applications as expected by the general public rather than restricted laboratory settings.

METHOD AND MATERIALS

This study follows a narrative literature review analysis. According to Petticrew and Roberts (2008), narrative literature review referred to as a systematic review that synthesizes the individual empirical studies—by systematically extracting, checking, and narratively summarizing information on their methods and results. In relation to narrative research studies, an in-depth search and inclusion criteria are explicitly explained and underscored. Narrative research inquiry is a group of approaches that rely on the written or spoken words or visual representation of individuals (Lichtman, 2013, p.95). These approaches emphasize the lives of individuals as told through stories. The emphasis, in these approaches, is on the story and often the epiphany. Narrative can be both a method and the phenomenon under study (Lichtman, 2013, p.95). These definitions are pertinent to this particular review study because "narrative methods of research consider, "real world measures" that are appropriate when "real life problems" are investigated" (Lieblich et al., 1998, p.5). In addition, narrative reviews are beneficial in providing conclusions for researchers who examine topics that do not have one optimal way of measuring outcomes (Baumeister, 2003). The narrative nature of this review allowed the researcher to examine and describe a wide range of outcomes of research designed to address the challenges, and importance of animatronic humanoid production within the robotic space.

Data Collection

Selection of articles. Based on the definition of animatronic humanoid prototypes, Humanoid Robotics, and Robotic prototypes, the researcher used the following criteria to select articles for the purposes of the review: (a) Study content included a focus on importance of animatronic humanoid prototypes to robotic production to assist businesses. (b) Study content included also focus on animatronic humanoid prototypes applications, challenges, and importance of animatronic humanoid prototypes, and humanoid robotics production within and outside United States of America. (c) Researcher reported findings from empirical research designs (i.e. qualitative, quantitative, survey, or mixed methods designs). (d) All humanoid robotics, animatronic humanoid prototypes, and human robotic facial expression related articles published in peer-reviewed journals. (e) Whole books, book chapters, dissertations, and theoretical manuscripts were excluded based on the lack of peer-review in such publications.

As part of the literature search, the data collection procedure took into account the first and second authors of the completed simultaneous electronic and ancestral searches for peer-reviewed articles by using the online database, IEEE Robotics & Automation Society, Navy Center for Applied Research in Artificial Intelligence (NCARAI), and seven databases from AI Advocacy Organizations Databases: Institute for Ethics and Emerging Technologies (IEET), Oracle Database Software (ODS), Animatronic Humanoid Production Databases, International Committee for Robot Arms Control (ICRAC), Robotic Search (Heritage Foundation), Killer Robots (Human Rights Watch), Journal *Data Mining and Knowledge Discovery (JDMKD)* as well as Google scholar and advanced Google scholar.

In fact, by using the Boolean indicators, "or", "and" and "not" the following search terms were entered into databases, Animatronic Humanoid, Humanoid Robotics, Robotic prototypes, Challenges associated with Animatronic Humanoid, Challenges associated with Robotic production, Challenges associated with Animatronic Prototypes, Challenges associated with Robotic production, Significance/Importance of Robotic prototypes, Significance/Importance of Animatronic Humanoid Prototypes, and Significance/Importance of Animatronic Humanoid for Robot Production. It is important to note that the initial search results yielded about 3,012 relevant articles on IEEE Robotics & Automation Society, Navy Center for Applied Research in Artificial Intelligence (NCARAI), and AI Database Management System (DBMS), 200 on International Committee for Robot Arms Control (ICRAC), and Oracle Database Software (ODS), 150 on Robotic Search (Heritage Foundation), and Killer Robots (Human Rights Watch), and 2,200 on both Google scholar and advanced Google scholar.

Based on the large number of authors using the terms like "Robot", "Animatronics", "Humanoid", and "Prototypes" in numerous ways, an abstract filter was also applied to the selection criteria. The study further widens the scope of the search to minimize the sampling of the selected articles by focusing on the challenges and importance of animatronic humanoid prototypes for robotic production. This particular search yielded about 150 articles through the help of abstract filters. After the abstract filtration to reduce the size of the articles' selections, the researcher uses the two concepts, "Robotic" and "Humanoid" to determine whether those remain articles meet the inclusion criteria, and 45 articles were chosen for inclusion. The researcher gave the 45 articles to two different AI experts, and IT professor with knowledge in animatronic humanoid robotic production at Southern University and A & M College to further review the 45 articles independently in order to ensure the reliability and validity of the analysis (or results). As a result of the three independent reviews by experts in the field, and a completed total of three ancestral searches resulted in 22 articles for final inclusion. Therefore, a total sample of 22 articles which met the inclusion criteria were used for the purposes of review analysis.

DATA ANALYSIS AND DISCUSSIONS

For the article, both deductive and inductive coding of the concepts were used for the search. In relation to the experts' views and readings of the 22 articles, deductive codes were developed but were later observed to be insufficient in capturing all the concepts relevant to the estimation of the results or the findings. In view of the gap in estimation, the researcher further develops an inductive coding to strengthen the analysis. The analysis is organized into challenges of robotic production in United States, importance of robotic production in United States, and some robotic applications across the globe.

General Findings

Table 1: Humanoid Robotic Production Achievements

Humanoid Robotic Production Achievements	**Percentage (%)**	**Number (*n*)**
Robots and Machines with biped Locomotion	22	5
Learning Capabilities in Robots	18	4
Neuro-Inspired Control Feature in Robots	14	3
Predictive Architectures in Robots	14	3
Many more Bioinspired Functions in Robots	18	4
Making Robots more effective in real-life settings	14	3

Note: Twenty-two total articles.

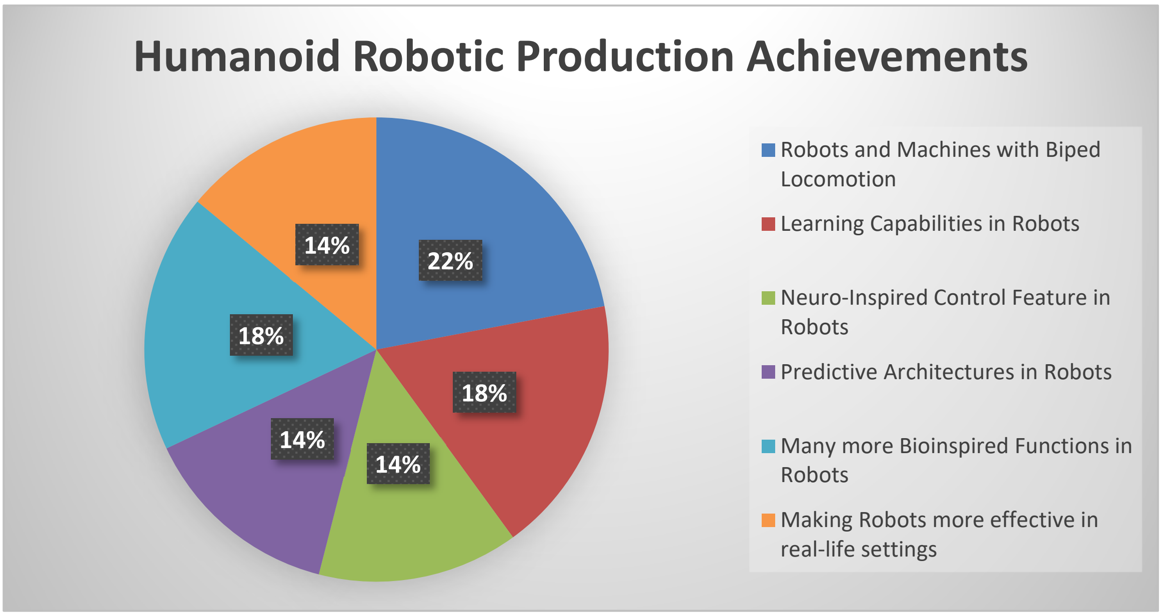


Figure 2: Humanoid Robotic Production Achievements

Researchers of 5 (22%) articles explicitly stated that robots and machines with biped locomotion is one of the achievements of humanoid robotic production. Four (18%) researchers (Ackerman, 2021; Hubicki, 2019; Arsenio, 2004a; Arsenio, 2004b) explained in their research that one of the achievements of humanoid robotic production is "learning capabilities". Additionally, three (14%) other research teams (Cheng et al., 2020; Cheng et al., 2009; Schaal, 2006) vividly stated that one of the achievements of humanoid robotic production is "neuro-inspired control features in robots". Also, three (14%) researchers (Guizzo & Ackerman, 2015; Kajita, Hirukawa, Harada, & Yokoi, 2010; Atkeson et al., 2000) arguably discussed that "robotic predictive architectures" is one of the achievements of humanoid robotic production. Again, four (18%) researchers (Atkeson et al., 2000; Guizzo & Ackerman, 2015; Wilson & Daugherty, 2022; Metta et al., 2010) provide detailed discussion in the literature about the fact that "many more bioinspired functions in robots" is one of the achievements of humanoid robotic production. Toward this end, three (14%) researchers (Fukuda, Dario, & Yang, 2017; Wilson & Daugherty, 2022; Goodrich & Schultz, 2007) provide a discussion about the prototypes of "making robots more effective in real-life settings" as one of the achievements of humanoid robotic production (see Table 1 and Figure 2 for more details).

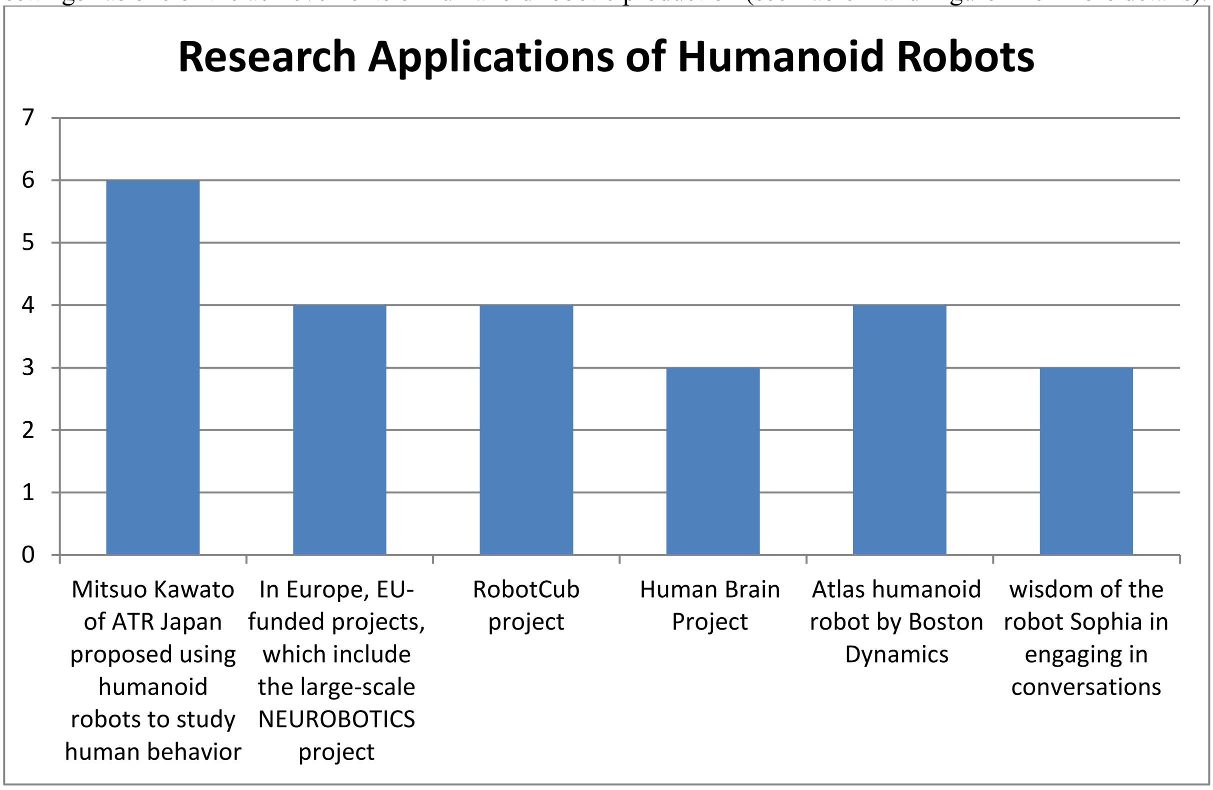


Figure 3: Research Applications of Humanoid Robots

Figure 3 discusses some evidenced-based research applications of humanoid robots across the globe. Figure 3 reveals that some of the evidenced-based research applications for humanoid robotic products include the following: Mitsuo Kawato of ATR Japan proposed using humanoid robots to study human behavior; In Europe-EU-funded projects, which include the large-scale NEUROBOTICS project; RobotCub project; Human Brain Project; Atlas humanoid robot by Boston Dynamics; and Wisdom of the robot Sophia in engaging in conversations, etc. Meanwhile, Fukuda, Dario and Yang (2017) also argued in the literature that humanoid robots can represent a research platform for studying not only robotics but also human beings. This is especially true for neuroscience, where human brain models can be implemented on humanoid robots. This can allow testing and validation of these models, in addition to providing humanoids with human-like sensorimotor functions. In fact, Mitsuo Kawato of ATR Japan proposed using humanoid robots to study human behavior at the beginning of this century (Atkeson, Hale, Pollick, Riley, Kotosaka, Schaul, Shibata, Tevatia, Ude, Vijayakumar, Kawato, & Kawato, 2000). In Europe, this approach has been pursued in a number of EU-funded projects, which include the large-scale NEUROBOTICS project across neuroscience and robotics and the RobotCub project, which led to the open iCub platform for the study of the development of cognitive capabilities (Metta, Natale, Nori, Sandini, Vernon, Fadiga, von Hofsten, Rosander, Lopes, Santos-Victor, Bernardino, & Montesano, 2010). Today, the Human Brain Project consists of a dedicated neurorobotics platform for the implementation of brain models (Falotico et al., 2017).

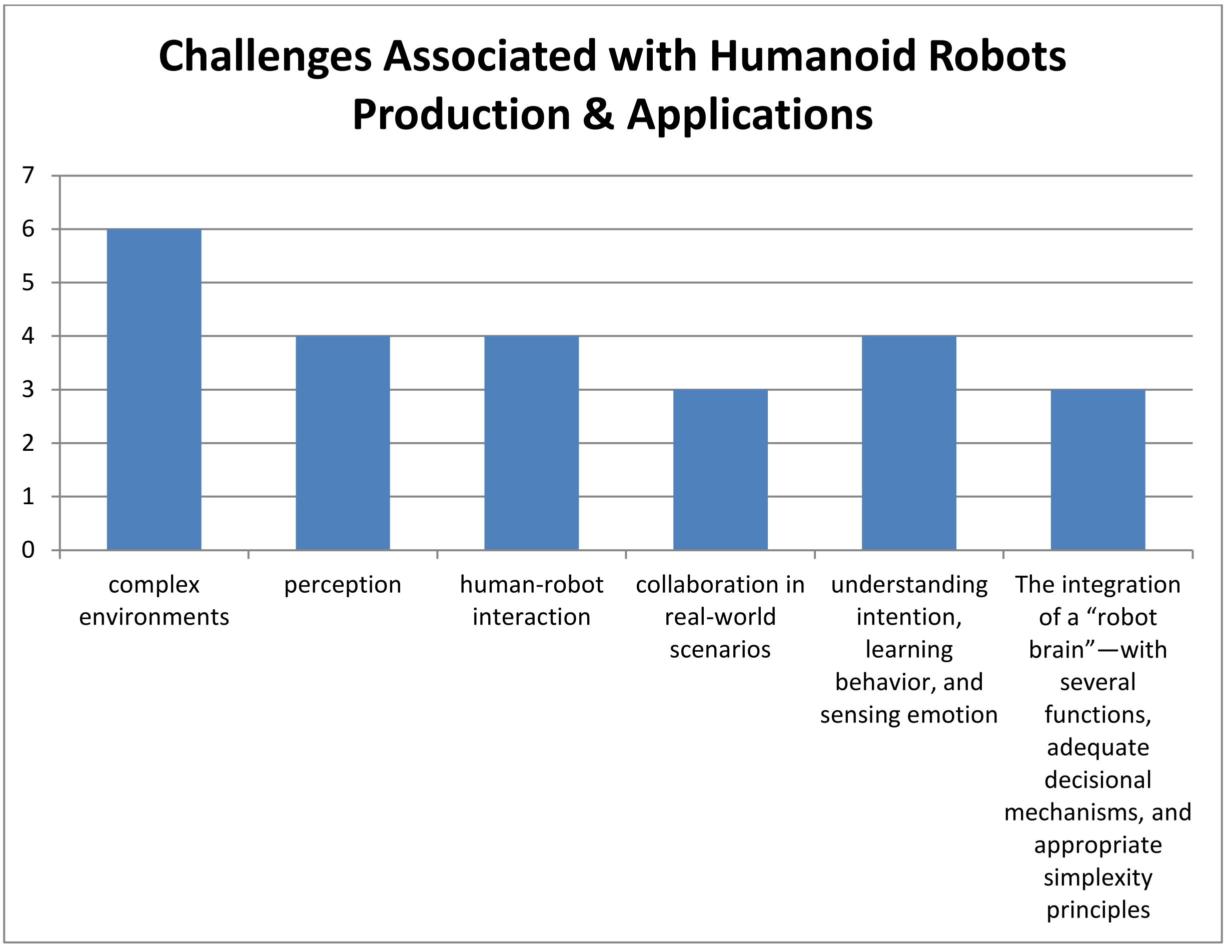


Figure 4: Challenges Associated with Humanoid Robots Production & Applications

Figure 4 presents the discussion the challenges associated with humanoid robotic production and applications. By inspection, Figure 4 revealed that complex environment, perception, human robot interaction, and collaboration in real life are some of the challenges identified in the literature. Clearly, Fukuda, Dario and Yang (2017) also argued in the literature that there remain many outstanding research issues in bipedal locomotion and dexterous manipulation for complex environments, perception, human-robot interaction, and collaboration in real-world scenarios, as well as understanding intention, learning behavior, and sensing emotion. They further argued that despite the initial implementation of a variety of brain models for specific sensorimotor behaviors, the integration of a "robot brain"—with several functions, adequate decisional mechanisms, and appropriate simplicity principles—represents an interesting challenge. Therefore, in order to overcome such as challenges—for the body, designers need to rethink the materials that robots are made of and leverage morphological computation to intrinsically balance and compensate for motion and dynamic behavior. In addition to these technical challenges, there are also allied social, legal, and ethical issues for seamless integration of humanoids into our societies (Fukuda, Dario &Yang, 2017).

CONCLUSION AND POLICY RECOMMENDATION

Based on the discussion of the systematic literature review, the study recommended the following:

- There should more investment in "Robots and Machines with biped Locomotion". This is because robot locomotion can assist many businesses or companies to transport heavy and bulky goods from one place to another. By inspection, it is observed that robot locomotion is a collective name for the various methods that robots use to transport themselves from place to place. That is, more Wheeled robots needs to be produced. Wheeled robots are typically quite energy efficient and simple to control. However, other forms of locomotion may be more appropriate for a number of reasons, for example traversing rough terrain, as well as moving and interacting in human environments. Furthermore, studying bipedal and insect-like robots may beneficially impact on biomechanics. A major goal in this field is in developing capabilities for robots to autonomously decide how, when, and where to move. However, coordinating numerous robot joints for even simple matters, like negotiating stairs, is difficult. Autonomous robot locomotion is a major technological obstacle for many areas of robotics, such as humanoids (like Honda's

Asimo).

- There should be more investment from both private and public sectors to support the production of animatronic robotic prototypes of "making robots more effective in real-life settings" and to also have human learning capabilities, and facial expression to businesses, and organizational operations. In perusing the literature, it was observed that both robots are capable of replicating several human emotions including joy, sadness, even confusion. They were developed using a special type of artificial skin created by Hanson Robotics called Frubber, which contains a bed of embedded electric wires within the layers of the silicone which actuates the artificial skin to create the expressions on the faces of the robots. Recently, the development of flexible artificial skins has given rise to more realistic kinds of humanoid robots which can recreate facial expressions with striking resemblance to that of an average human. Hanson and Sophia developed by Hanson Robotics are some of the best examples of this technology.
- Lastly, investors, policymakers, and public officials should invest in innovative robotic production in order to promote businesses, bring about efficiency in operations, and increase productivity. For instance, more investment should go into innovative robotic production such as: "neuro-inspired control features in robots", "robotic predictive architectures", and "many more bioinspired functions in robots" to facilitate operations and increase efficiency in production.

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