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Humanoid Robot: A Review

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Abstract: Technology is ever evolving regardless of the current conditions. Emerging technologies have capability to change the world. Innovation is everywhere we look. One of the technologies that is emerging is Humanoid Robotics. This paper gives a review about influence of Humanoid Robot in human life also discuss the appearance of various robots. Artists, engineers and scientists have all been inspired by the human body and intellect. Humanoid Robotics is focused with the creation of robots that are inspired directly by human abilities. A humanoid robot is the one with a body that is designed to look like a human. Humanoid Robots imitate characteristics of human form and behaviour selectively. The robot could be used for practical purposes, such as interacting with human equipment and environments or for research purposes, such as investigating biped walking.
Keywords: Biped Robot, Degrees of Freedom, Humanoid Robot, Human-Robot Interaction.

I. INTRODUCTION

Humanoid robots have a head, two arms, and two legs in general, but some types of humanoid robots only imitate a part of the body including the waist up [1]. A few other humanoid robots have faces with human-like features such as eye and mouth. Humanoid comes in a number of different forms, ranging from full sized legged robots to robotic minds with human like appearance.

Humanoid robotics is a relatively new research field with big opportunity for advanced technology and human success. Humanoid machines are programmed to look and act like humans [2]. They could be used to gain a better understanding of the human body's workings. In industrial and health care applications, for example, human effort is needed. Humanoid robot eases the human's working circumstances and increases productivity. Another application for humanoid robots is the partial or complete replacement of humans in hazardous situations such as disasters or space missions. Humanoid robots are now used as analytical tools in a wide variety of technical disciplines. Studies examine the human physical structure and behaviour in order to build humanoid robots.

II. HUMANOID ROBOTS

Humanoid Robots have been assisting humans in a variety of ways. Humanoid robots are widely used in medical care, industry, educational institutions and entertainment. In addition, humanoid robots were already interacting socially and assisting people in positions such as friend, teacher, helper, and remote healthcare provider. The following section provides a brief overview of Humanoid robots and their applications in a range of areas.

A. Humanoid Robot for basic task: Honda P2

Honda began developing humanoid robots around 1980s, Honda's P series of humanoid robot prototypes is a progressive evolution. Honda declared the development of P2, a humanoid robot with two arms and two legs, in December 1996, and Honda began technological development of this humanoid robot in 1986 [3]. The primary goal of developing this robot was to create a robot that can co-exist and work collaboratively with humans, as well as execute tasks that humans could not perform.

The robot which is used for household purpose it is essential that the robot should be able to keep moving all around house, which contains numerous obstructions such as the entryway, a stairway, walls, and appliances. According to Honda, the most functional and acceptable configuration is a robot with human-like hands and feet. As a result, Honda set out to create a new type of robot capable of meeting consumer demands.

Kazuo Hirai et al. [3], investigated the features of a human actions and movements, started experiments on some humans, created the preliminary robot requirements and compared the location of the ligaments, their angles of motion, dimensions, and centre of gravity to human legs [3]. The number of leg joints was reduced to the absolute bare minimum for walk. It was set to three hip joints, one knee joint, and two ankle joints. The rotation angles were chosen to match the angles observed during the walking studies. Taking into consideration of all the experiments Honda has developed several robots that look like a human. And also Honda did research in speeding of the walk when the robot carrying the heavy objects [3]. A sophisticated robot can walk at a top speed of 4.7 kilometres per hour.

The Honda team went on to construct humanoid robots as the next phase. The development of the Honda humanoid robot began with basic research.
The following are the workable requirements of Honda P2 humanoid robot given by Kazuo Hirai et al. [3]

1) The robot should be able to execute some tasks automatically in a defined place also robot should be able to execute some task in unknown place with the help of operator.
2) Kazuo Hirai et al. [3], calculated the width of the robot using the measurements of a pretty standard door wherein the robot will cross, and based on some tests determined the length of the leg link so that the robot can freely move on the stairs.
3) The number of arm ligaments has been decreased to a minimum level in quite the same way that the amount of leg joints was. It was programmed to have three joints for the shoulder, one for the elbow, and three for the wrist.
4) Honda designed the arm's length so that the robot could even collect any item which is upon on surface.
5) The robot's hands were intended for basic tasks such as removing obstructions from the robot's path.
6) Video cameras were placed inside the robot to process sight, approximate target position, and investigate chemical factory devices.

B. Advanced Step in Innovative Mobility (ASIMO)

Honda invented ASIMO in 2000, a humanoid robot. It is available to view in Tokyo, Japan's Miraikan Museum. ASIMO is a humanoid that can navigate in obstacles filled environment by itself. The capacity to choose foot placement locations autonomously while walking to avoid obstacles is a critical step toward greater navigation autonomy for humanoids. Fig. 1 shows ASIMO uses footstep plan to detect collision on the floor [4].
Joel Chestnutt et al. [4], demonstrated a foot-step planning for the Honda ASIMO humanoid robot that prepares a series of foot-step locations to traverse to a final destination. The robot's present state determines the robot's future foot placement positions. Joel Chestnutt et al. [4], also described scientific findings that shows the robot navigating both static or in dynamic recognized surroundings with obstructions moving on stable paths.
Home appliances, staircases, doorways, and unidentified obstructions on the ground are instances of indoor areas, while the ability to control difficult terrain, uneven paths is an instance of open areas. Joel Chestnutt et al. [4] approach the problem of calculating navigational techniques for legged humanoids as an elaborated distinct search over a set of legitimate leg positions. The findings produced a number of foot-step placements with minimizing the risk.

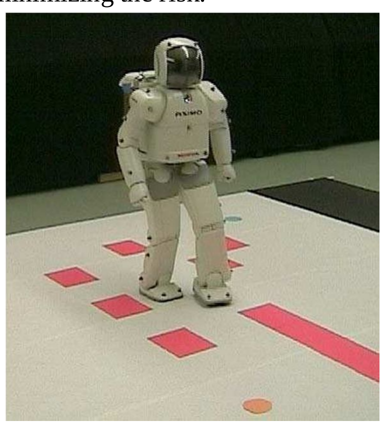

Fig.1 ASIMO [4]

Studies were conducted out on the Honda ASIMO robot. The tests were carried out on a strong level ground measuring three meters by three meters per each edge. The terrain was represented using cells with a side length of 0.025 meters. The planner was given the environments as well as the start and target locations, and the robot followed the planner's instructions. The tests were carried out in static and as well as in dynamic obstruction surroundings.
On above the strong level ground, a static obstruction surrounding was created. Every static obstacle is symbolized by a colored rectangular shape. The robot's start and goal locations are represented by the circles in the environment. Joel Chestnutt et al. [4], tested different scenarios and changed the beginning and ending goal locations. In each case the planner has some instructions, allowing the robot to travel from the beginning to the ending location with avoiding the obstacles.

In dynamically changing surroundings, two rows of colored rectangular shaped represents the moving hazards. Each row of obstacles is linked by threads to an electric motor. The threads are also used to represent locations where the robot is unable to walk in the surroundings. Two motors, one on each side, pull the threads to one side to move the obstacles. There are two rows of the obstacles which is regularly spaced between the blocks, even though the spacing is different for every row. The first row moves at a rate of 0.1 metres per second, while the second row moves at a rate of 0.18 metres per second. The ability of the robot to move over the threads connecting the blocks enables it to achieve the target location. The robot efficiently navigates the dynamic obstacles.For a two legged robot, beginning positions and the ending positions, and an obstacle contained surroundings, all the steps which are taken by the robot must be carefully chosen. Joel Chestnutt et al. [5] wish to find best methodology where the robot can easily walk to the end location without colliding with obstacles or placing leg into any unsafe surroundings [5]. Two legged robots have the special ability to walk without stepping onto the obstacles or any step onto or over barriers or dangerous locations, while the wheeled mobile robot would be unable to traverse. To solve this problem, Joel Chestnutt et al. [5], utilized a high-level planner that works from a characterization of the robot's abilities and neglects as many of the underlying information of body movement and projected path formation as possible. It plans at the level of steps and returns a list of footing that the robot can meet as it travels from the starting point to the destination.

To allow the robot to walk in unfamiliar surroundings also being able to respond to the new state of the world, Joel Chestnutt et al. [5], implemented an off board vision system to give the robot a real and actual data about the position, structure of the obstacle and the final destination of the robot [5]. With the help of this system the robot is able to re-plan its walking direction in every step that it takes, also this makes the robot to adapt any unfamiliar changes in the placement of obstacles and the final destination. As a result of Honda's work with ASIMO, more research into walking aid devices was conducted.

C. Waseda Bipedal Humanoid - No.2 (WABIAN-2)

A new two legged humanoid robot WABIAN-2 the first fully actuated robot that is capable of simulating human motion was developed around 1995 from Waseda University. This robot was created to assist the elderly who suffer from impairments and problems in their lower body, which increased the amount for welfare equipment development. As an outcome, the need for a human walking model that can be used in therapeutic medical treatment is growing.

The human body mechanism is made up of bones that operate as stiff linkages, cartilages that act as joints, ligaments and joints direct each body part [6]. It is hard to match the entire musculoskeletal system with mechanical systems that are currently available. As a result, the primary goal of mechanical systems should be to create a robot that can perform equivalent human motion. The primary goal of the mechanical system ought to be the creation of a robot that can perform equivalent movements. Humans have more repetitive Degrees Of Freedom (DOF) than biped humanoid robots, allowing them to perform a variety of motions. As a result, one of the most critical issues in the advancement of a humanoid robot is the hypothesis of a DOF arrangement that is required to replicate such movements.

WABIAN-2R was created having a height of 1.5 meters and a weight of 64.5 kilograms with batteries [6], to be able to mimic human-like motions, it have two 7-DOF legs, a 2-DOF waist, a 2-DOF trunk, and two 7-DOF arms. First, a DOF arrangement is explained, which is based on clinical medical research and then the robots methodologies and control system are demonstrated. During the advancement of the robot, new design approach for a robot is established that it is able to use a walk assist device is set as main goal of the research. Experiments on walking have proved the usefulness of this created humanoid robot.

WABIAN-2's trunk is shaped to allow rotation as well as forward, backward, and sideways movement. Furthermore, when pushing a walk assist device, the robots arms are build in such a way that it holds its entire weight. It can also use trunk movement to depend on a walk assist device via upper arm influence. WABIAN-2 basic walking trials are performed with or without help of a walk-assist device.

WABIAN-2 has been monitored by a PC placed on its trunk, which is made up of a Peripheral Component Interconnect (PCI) CPU board, a Pentium M which is of 1.26 GHz processing unit, a PCI backplane board, 3 HRP Interaction boards, and a 6 axis sensor receiver board [6]. The HRP Interaction board includes a 16-channel digital to analog (D/A), 16-channel counters, and a 16-channel Programmed Input Output (PIO). As the real time operating system, the QNX is Not Unix (QNX) Real time Platform was chosen. The WABIAN-2's motion and movement are controlled and monitored by the computer mounted on its back. This biped humanoid robot can perform exercises with humans, and test rehab equipment under development instead of a human. The Wabian-2 runs on Li-on batteries.

Yu Ogura et al. [6], collated the pelvis and knee movement of eight people were mapped in the stable walking phase and observed in both the front and transverse planes. A humanoid robot that can walk like a human should also be capable of moving its hips in the roll and yaw axes, according to this. These hip motions must be autonomous of the situation of the trunk. WABIAN-2's frameworks are primarily made of aluminium alloy. A DC motor, a harmonic drive gear, a lug belt, and two pulleys make up each actuator system of the joint. The high reduction ratio and disconnection of a joint axis from the motor axis are provided by the double speed reduction method. This method generates designs for a human like joint methodology. Yu Ogura et al. [6], mainly focused on the development of the waist, trunk, and arms. The height of the robot is 1.53 meters and weight of the robot is about 64.5 kilograms with batteries [6].

Walking experiments were conducted on WABIAN-2 with two walking methods on a horizontal flat framework to test the efficacy of the humanoid robot's forearm method of control and components:

1) A traditional walking pattern characterized by a steady shoulder height and constant knee flexing.
2) A stretch walking pattern was produced using a stretch walking style with a human-like knee joint pattern that included stretch out knee phases.

D. Humanoid Robot for Industrial Environments: ANTHROPOMORPHIC MULTI-ARM ROBOT (ARMAR-6)

ARMAR is designed that is designed to help workers in manufacturing industries. Its humanoid system allows it to collaborate with humans and use human tool-kits like drilling tool and hatchets to perform a wide range of complex repairs in industry applications. Aside from looking and manipulating objects, the robot is designed to recognize when a human worker s in need of assistance and help immediately. ARMAR can pick up on a person's behaviour by watching and mimicking them [7]. ARMAR can pick up on a person's behaviour by watching and mimicking them.

The robot was created as part of the German Research Foundation-funded Collaborative Research Center on Humanoid Robots. The study focuses on developing and deploying adaptable robots that can perform tasks in human-centered environments, gain knowledge from human, and communicate with people in a natural manner. The first ARMAR robot ARMAR-I was created in the year 2000. ARMAR-II, ARMAR-IIIa, and ARMAR-IIIb were first introduced in 2004, 2006, and 2007, respectively. Tamim Asfour et al. [7], described the robot's internal equipment, technology and methodology used, as well as its capabilities. The capabilities are the recognition of the need for human assistance, the execution of maintenance plans, compliant manual modification, trying to capturing the vision, item handing, identifying the human tasks, normal conversation, route planning, and others [7].

The functional requirements were first evaluated using a set of routine works, and then translated into technological specifications that were considered during the development process. The highest payload that the robot should hold, the higher and lower height that the robot should indeed attain, and the sensor systems for understanding the human intelligence are among these requirements [7].

E. Torque Controlled Humanoid Robot (TORO)

TORO is a torque controlled humanoid robot that is a designed at Deutsches Zentrum für Luft-und Raumfahrt (DLR) German Aerospace Center [8]. It's a cutting-edge humanoid robot that's being used as a study of research for two legged walking and fully independent behavior patterns that incorporate modification and loco-motion.

TORO described by Bernd Henze et al. [8], has a total of thirty nine degrees of freedom, and It has the ability to regulate both position and torque. The motor position and torque sensors, as well as two Inertial Measurement Units (IMU) in the trunk and head, can all these be used to assess the robot's hidden representation [8]. Stereo cameras and RGB-D (Red Green Blue-Depth) sensor are inserted in the head of the robot to study the independent movement of the robot and force or torque sensors at the ankles provide observations in order to analyse the robot's reliability. The Divergent Component of Motion (DCM) [2], also known as Detection Point, is used to control walk. To walk on the small platform robot's feet should be small, so the TORO's foots are made small which allow it to walk and keep standing on the platform but sometimes it is very challenging to control the balance of the TORO. There are several subcategories within the area of torque control Impedance control is one viable alternative, and because of its passivity characteristics, it is a successful approach for human and robot communication and interactive with an unknown environment. Another methodology is inverse dynamics control, which offers useful track abilities while remaining compliant in the case of disturbances.

TORO is made by directly accessible Light Weight Robot (LWR) unit. So it has some of the limitations in the real time activities like fast walk, running getting on the high level of steps. It weighs approximately 76.4 kilogram’s and stands approximately 174 centimetres tall [2]. TORO will be extremely useful in the development of future humanoid robots.

F. An Internet of Things Humanoid Robot

The Internet of Things (IoT) is a network of physical objects or things that are equipped with sensors and software. IoT is a system of connected smart devices, mechanical equipments and objects provided with unique identifiers to transfer data over the network without human communication [1]. In comparison to humanoid robots, the usage of IoT in industrial robots is becoming increasingly common. There were some attempts to incorporate IoT and humanoid robots, but they all have low efficiency, less functionality, with Network Address Translation (NAT) or without NAT.

The system proposed by Georgios Angelopoulos et al. [1], consists of Humanoid Robot, Android Application and Server. The user could see what the robot is seeing and relocate it using the android application software. In order to regulate the humanoid robot it has an android application. This android application is accessible by anyone. This system also has the capability of providing consistent audio via the application. It has a text-to-speech and speech-to-text feature, with the help of this feature humanoid robot gives an audio to people with speech impairments.

This system [1] makes the end user easier to remotely control a humanoid robot by using an Android mobile application on an Android device, even in limited internal networks with the help of NAT (Network Address Translation). This system also supports video and audio streaming, as well as text-to-speech and speech-to-text services.

The system given by Georgios Angelopoulos et al. [1], consists of Humanoid Robot, Android Application and Server.

1) *Humanoid Robot:* The Humanoid Robot used in this system is NAO robot from Aldebaran Robotics. Aldebaran Robotics, a French robotics firm based in Paris, developed NAO robot, an autonomous, programmable humanoid robot. NAO runs Open NAO OS, a Gentoo-based GNU/Linux distribution. It can connect via wired IEEE 802.3 and wireless IEEE 802.11 a or b or g or n. This has a lithium battery that can last up to 90 minutes (active use). NAO robot is equipped with two ultrasonic sensors which allow it to assess the distance to obstacles in its environment. In addition, two equal video cameras are located in the forehead, offering a resolution of close to 1280x960 at 30 frames per second. As an outcome, when its person attempts to initiate an interaction with people or objects nearby the robot, NAO can be a very excellent method for tele-robotics. A user of this system [1] can control the robot using an Android smart phone while watching the robot's surroundings on a video feed displayed on the smart phone's screen. The technology that runs on robot is in the type of Python and Bash shell script files are required for the full range of our programmed activities. A decimal arithmetic protocol is used to communicate between the robot and the bridge server [1].
2) *Android Application:* The humanoid robot is controlled by an android mobile application. The user does have complete control over the robot, including the ability to move forward, make a left, and so on [1]. Besides from these simple commands, this system can convert speech to text, text to speech, and stream video and audio. It provided a new form of communication between a blind user and a speech-impaired user with these features. The humanoid robot is the best approach to such interaction, speaking out loud for blind user and typing the messages for speech impaired user. This system can be used to keep people safe. For example when a father is not at home, he can monitor what his kid has been doing. There is a button on the first screen of the application that is used to connect the application to the server. By clicking the settings button, the user can also modify the configuration settings. The home screen contains a number of buttons which are used to regulate the NAO robot. When a user presses a feature, the Android device sends a Hypertext Transfer Protocol (HTTP) response message to the bridge server, which the server adds to an activity waiting line. The database or web server transfers the task to the top of the waiting line (queue) whenever the humanoid robot polls for a new task. Additionally, video or photographs recorded by NAO robot are displayed on top of the screen. Android Studio was used to develop the application. Java and extensible markup language (XML) were the primary programming languages used [1].
3) *Server:* Server in this system is a FreeBSD (Berkeley Software Distribution) web server that runs Hypertext Pre-processor (PHP) scripts to form a communication between humanoid and the Android phone is mobile and can be accessed remotely from any location. Between the android phone and the humanoid robot, the web server serves as a bridge. It receives all of the instructions from the android phone, encrypts them in decimal format, and transmits them to the humanoid robot for execution.

G. Soccer Robot

A soccer robot is a personalized autonomous and movable robot that is used to explore multiple soccer games. Annually, championships such as the Federation of International Robot-soccer Association (FIRA) and the Robo-Cup are held. Presently, there are several soccer competitions in the Robo-Cup competition, including modelling of tiny, medium and robot with 4 legs. The Robo-Cup Association has been arranging robotic soccer tournaments in the international level from the year 1997, inspired by its chess performance. Same types of tournaments are conducted by the FIRA [9].

The RoboCup Federation's long-term goal is to create a team of humanoid soccer robots capable of defeating FIFA world champions by the year 2050 [9]. The RoboCup championships have grown to become the most prominent robotic tournament in the world. Sven Behnke et al. [9] described the electromechanical designs of the robots they built for the Robo-Cup 2006 competition held in Bremen, Germany. The robot which is in the size of small kid took first place in the penalty kick contest and second position in the over-all best humanoid robot contest. [9].

Soccer robots described by the Sven Behnke et al. [9], were fully self-contained, and are activated by lithium polymer battery which have the ability to charge and installed in the hips of the robot. The Kid Size robot is powered by four Kokam 910milliampere per hour batteries. Robotinho is powered by 4 kokam 3200miliampere per hour batteries. The batteries are good for around 1500secs of use. The Recommended standard 485 differential half duplex interface were used by the Dynamixel actuators. Every robotic machine has a card-s12 micro controller chip that manages all of the Dynamixels complete interaction [9].

It has four kilo bytes of Random Access Memory, sixty four kilo bytes of flash memory, 2 serial connectors, a controller area network bus, eight timers, eight PWM passage ways or channel, and sixteen Analog to Digital techniques. Dynamixel actuators feature an adaptable interface. Target or final positions, but also control loop parameters like compliance, are supplied to the actuators. In the reverse direction, existing locations, velocity, load, temperature levels, and voltage levels are read. Each robot also has an attitude sensor in the trunk, in addition to the joint sensors. The micro - controller chip communicates with the Dynamixels over RS 485 at one mega baud and a main computer at the rate of 115 kilo baud over RS 232 serial line. Main system sends goal locations to the HCS-board which is at every twelve milliseconds and then sends that to the actuators. The microcontroller sends the pre-processed sensor readings back. This allows the main system to keep track of the robot’s condition. Sven Behnke et al. [9], used a pocket personal computer as main system, which is located in upper part of the robot. The FSC Pocket Loox 720, including the battery, weighs only 170 grams. It contains a five twenty mega hertz’s of XScale Processor, 128 mega bytes of random access memory, sixty four mega bytes of flash, a VGA-resolution touch screen display, blue-tooth, wireless LAN, an RS 232 serial interface, and 1.3 mega pixel of camera [9].

Robo-Cup's authorized server and physics simulation tool is sim-spark. For Robotic Soccer, it gives a detailed mapping of interactivity. Robo-Viz is the authorized Robo-Cup graphics platform. It was used to display all of the learning outcomes [10]. Soccer game with the humanoid robots is a challenging one and the research is started. Till now, the Humanoid League has made remarkable developing, progressing from remotely controlled robots to completely autonomous humanoids in just a few years [9].

H. Humanoid Robot: Humanoid Robotics Project-2 (HRP 2)

HRP-2 is a famous humanoid robot with an innovative appearance. It can assist human beings in carrying heavy loads, and it can walk on tapered roads, rough terrain, and at a speed of two-thirds that of humans typically around 2.5 kilometres per hour [11], If it falls over, it can lie down and even get up on its own [28]. HRP-2 employs a variety of mechanisms, including a cantilever-like configuration in the hips and a technique in the waist joint. Kenji KANEKO et al. [11], introduced the appearance model, methodologies, electrical equipment and requirements that have been improved over the prototype.

Fig. 2 Humanoid Robot HRP-2

Kenji KANEKO et al. [11], presented a creation of humanoid robot HRP-2 shown in Fig. 2 HRP-2's design concepts are light and compact, but capable of performing application tasks such as cooperative outdoor work. As an outcome, HRP-2 is made to be womanly sized [11]. HRP-2 inherits a machine-like configuration. The distinctive configuration is that the hip joint of HRP-2 has a cantilever-like structure and HRP-2 has a waist with 2 DOF. A mechanical animation designer created the outside appearance to make HRP-2 feel nice to humans. Leg actuators with built-in cooling systems allow for increased continuous walking endurance. Feet have been altered to provide a high level of stiffness. To enhance walk movements and overall efficiency, links and axial stiffness have been greatly improved.

Numerous attempts have been made in the electrical system for HRP-2 to reduce weight and achieve a dense body. The computer system of HRP-2 it has two Central Processing Unit (CPU) boards based on Pentium III. One is used for actual whole-body movement control, while the other is used for non real time control and sound. For the electric system's robustness, many distortion removal efforts were implemented. Kenji KANEKO et al. [11], designed many circuit boards which occupy less wires. The wire which takes up the more space would produce more unanticipated distortion. In HRP-2, the wire which occupies more space and distortion issues were significantly reduced, and efficiency was significantly improved.

The fundamental experiments were carried out to see if HRP-2 could take up many movements. These include whether HRP-2 could stand and run on small platform, coping with uneven surface, walk with a speed of 2.5 kilometres per hour, as well as cooperative work with humans [11].

I. Humanoid Robot HRP-4C, Robot Movement based on Motion Capture Data

In 2009 an initial public demonstration was held in that demonstration HRP-4C feminine-looking humanoid robot looks like 19 to 29 year old Japanese woman [12]. It is 158 centimetres tall and weighs 43 kilogram's with the batteries. The main objective of this robot is entertainment. The HRP-4C could be used in the media world or as a human simulation model for device analysis.

Kanako Miura et al. [12], created HRP-4C robot based on the motion capture data. The process of recording the mobility of objects or people is known as motion capture data. Explicitly obtaining the variables from the motion capture data, a robot motion pattern can be generated. All of the motions in their study were created using vicon motion systems 3 dimensional optical motion capture technology. The performer is a professional fashion model. Motion capture technology captured the several patterns with varying running pace, step, and attempting to turn angle.

HRP-4C was shown at the Combined Exhibition of Advanced Technologies (CEATEC) JAPAN-2009 Festival in June 2009, and its speaking and singing capabilities were displayed. HRP-4C was made by imitating a walking pattern of a model and movement of the human being. Fig. 3 shows the HRP-4C [12].

Fig. 3 HRP-4C [12]

Kanako Miura et al. [12], used a traditional pattern generator to add single toe support, modified the robot's waist length to flex the knees as feasible, and created a swing leg motion which was more human-like. The produced swinging motions are filtered to create a pattern that is practicable.

J. Humanoid Robot: Robovie

Robovie is a humanoid robot with special methodologies for interacting with human beings. Robovie appears to be human-like and it is designed to communicate with humans [13], it has various sensors like sense of touch and vision. The robot can do collaborative behavioural patterns by using human-like torso and sensor systems. Robovie's typical characteristics include greetings, handshaking, playing the paper stone and scissors game, workout, and social interaction, as well as idling behaviours such as rubbing the head, folding the arms, etc.

An interactive robot must have certain capabilities. Firstly, the robot must be independent. It should be able to communicate verbally and non - verbally on its own, even if its processors, data management systems, and sensory systems are external to its body [14]. It must have the ability to make movement without cables whenever it is making conversation, the capability of haptic communication is the second capability to consider. The third capability is the movement mechanics, which can cause unintentional movements. Human motion can be classified into two type's intentional and unintentional motion or movements. Intentional motions are a series of actions performed with the goal of achieving a specific purpose or activity. Heading to a specific location, extending an arm for a handshake, making a greeting vocalisation, etc. unintentional motions, on the other hand, are a series of unintentional movements that occur in reaction to physical cues, such as feedback control. Human recognition is the fourth capability. Human beings expect that a robot should able to locate as well as recognize them. All of these conditions apply to the communication robot [14].

The battery life is also an essential aspect of the design of robot. Robovie can work for 4 hours and charge the battery by searching for charging stations on its own. The robot can generate enough behaviour for conversation with humans using the actuators and sensors. For encoding sensing information and producing behavioural patterns, Robovie has a Pentium III PC on chip. Linux is used as the working platform. The Pentium III PC is sufficient for Robovie. It has communicative sensorimotor unit in order to recognise the sensing action and make interaction with human beings [13]. Robovie produces human being type behavioural patterns using human like actuator system, as well as optical and audio system [15].

K. Human Robot head

Ciprian Lapusan et al. [16], described the creation of a humanoid robot which will be utilized in socialization studies. This research evaluates a range of answers for replicating human head movement as well as a portion of sensory abilities. A series of MATLAB applications were created to implement the robot control and computer vision functionalities and obtained experimental results. Human-Robot Interaction (HRI) has grown in importance as a field of study. HRI is a branch of robotics research devoted to greater grasping, developing, and analysing robotics for use by or alongside humans.

Ciprian Lapusan et al. [16], described The mechanical and electronic methodology can be used to integrate all robot elements. Electrical, mechanical, and control systems all must be integrated during the development process, as well as appropriate interface systems for all robot subsystems. The analysis of human head movements and their kinematic features was the starting point for this robot's design. The integration of these activities that allows demonstrating human reactions, such as happiness, sadness, surprise, and so on, was also examined at this stage.

Depending on these findings, a number of innovative suggestions for systems that can simulate these activities were provided and analysed. Then, in solid works, the remedies that meet the enforced standards were incorporated. Aside from the machine systems, the sensor and motion elements are incorporated in the robot structure have been considered. The procured Computer Aided Design (CAD) models were made used to verify the suggested ideas and assess the originality of the replicated gestures. Based on these results a model of the robot head was developed. Neck motions, eye movements, mandible movements, and eyebrow movements all are reproduced by the structure. After this the main design of the robot were displayed. The robot was designed by experimenting in neck orientation mechanism, eyes orientation mechanism and mandible mechanism [16].

L. iCub Robot

iCub is a one-meter-tall humanoid robot test - bed for machine learning and involves human cognitive study. The system architecture, technology, and documentary evidence for the robot are all released under the General Public License (GPL) licence. The name cub stands for Cognitive Universal Body and is a partial acronym. Nicolas Sommer et al, [17] presented a research study in which the iCub humanoid robot uses perceptual skills to understand and to identify the face [17]. Through the use of its arms and legs, a child starts many reasoning function as it interacts with its surroundings and human beings. The robot was created to put these concepts into action by allowing a precise replica of a small child's perceptual system to act out intellectual learning environment and articulation, which enables iCub to communicate and interact in the manner of a child. Visually impaired person identify the faces with the help of sensation, in the same way the iCub also identifies the faces with the sensory movement. Sensors are installed in the fingers of the iCub which help to scan the faces of the humans. Fig. 4 shows movement of the iCub robots finger on the doll's face and takes a photo of the face with sensory analyses [17].

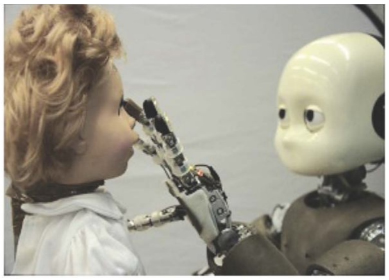

Fig. 4 Movement of the iCub robots finger on the doll's face and takes a photo of the face with sensory analyses [17]

iCub was designed by using the sensory fingernails, perceptual data and the location of the fingers throughout a movement to identify the face of human being [17]. The iCub robot has 53 actuated degrees of freedom distributed as follows: seven in each arm, nine in each hand, six in head, three in the upper body, and six in each leg. To achieve linear movement of the hand, seven arm joints were included, while one joint for each finger that is used to scan the face. Fig. 5 shows the sensors installed in the fingertips of the iCub [17].

Fig. 5 Sensors installed in the fingertips of the iCub [17]

The iCub's hand is guided in such a way that it follows the predetermined straight line starting for the upper part of the face to the lower part of the face, palm will be towards the scanned head. The movement starts from the fingers when it starts scanning the forehead and ended when the fingers hit the end part of the face. The index and middle fingers remain in touch with the face throughout the motion. The ring and little fingers are not used in the experiment because they are coupled and cannot be controlled independently. The distance in between fingers (adduction/abduction) is constant throughout the tests. During the test, the angle levels of the finger joints are measured. Every movement will take around seven and ten seconds, based on the size of the face. Ten recordings were used in the training stage. Information is gathered at a level of fifty hertz, which resulted in four hundred data-points. The ability of the iCub to perform the tasks has been illustrated in below.

1) The iCub is able to crawl on the floor with the help of the instructions with optically indicator device.
2) Completing the three-dimensional puzzles.
3) Mastering the art of hitting the target in the middle with the arrow.
4) Expressing the feelings.
5) iCub is able to grab the things like balls, bottles and other similar things

M. Design of Soft Fingertips for Humanoid Robot Hand

Antonio Sardo et al. [18], first described the logical methods to design soft fingers for humanoid robot hands. Antonio Sardo et al. [19], considered both functional aspects and reliability aspects, where the functional aspects related to the condition of being strong and in good condition and the reliability aspects related to wear - and - tear opposition, manufacture ability and systemic functionality. Antonio Sardo et al. [18], conducted many experiments on the fingertips, that is to verify the performance of biological tissues covering a skeleton, the fingertips have an internal stiff core enclosed by a softer material and also tested the effects of thickness of material under different load condition. Antonio Sardo et al. [18], choose the soft pad materials for the fingertips to cover the external surface of the robotic devices, and that must look like human with having skills and it should exhibit robustness, stability.

N. A Social Humanoid Robot: Sophia

David Hanson Jr. is a roboticist and the creator and CEO of Hanson Robotics in Hong Kong created Sophia, a social humanoid robot. Sophia is a robot with a beautiful feminine face that is only developed up to her waist. Her eyes are like cameras that can recognize faces and greet them. Frubber, a patented material invented by Hanson Robotics, is Sophia's skin. It's an elastomer, or elastic rubber, that has the same feel and flexibility as human skin. That allows her to make 62 different facial expressions (anger, joy, sadness, amazement, annoyance, fear, etc.). She uses an electronic synthetic voice system that enables her to speak and gesture while speaking [19]. Sophia grows more familiar with her communicator's cultures, customs, feelings, emotions, and linguistic styles. All these experience is accumulated in her memory. Cameras are embedded in Sophia's eyes that allow her to see [19]. She could even recognize faces of people, carry on a conversation. With the help of a natural language sub **-** system, she can process talk and speak intelligibly.

Sophia was powered on fourteenth of February in the year of 2016 and in the middle of the same year 2016 she made her first public debut in US, at the South by Southwest Festival (SXSW). Sophia was named the first ever Innovation Champion by the United Nations Development Programme, and she is the first non-human to receive any UN title. Sophia's main goal is to be a good friend to the old people in care homes and to assist audiences at major gatherings or playgrounds. Sophia is also a research and development platform for cutting-edge robotics and AI, with a focus on human and robot interactions as well as their utility and infotainment potential. In October 2017, Sophia has become the first humanoid robot to be given citizenship [20].

III.CONCLUSION

Humanoid robots have been broadly used in various fields such as Healthcare, Industries, Education and Entertainment. In recent years, there have been a lot of significant advancements in robotics, indicating a promising future. Nowadays Artificial Intelligence (AI) robots are becoming too smart and take over the world. Future humanoid robots have been given ambitious goals. They are expected to be human associates and assistance in everyday life, as well as ultimate savior in the event of natural crises. The RoboCup robot soccer association has also set a goal for a team of humanoid robot soccer players to compete and win against the most recent World Cup winner in 2050. This paper concludes that bipedal locomotion is considered one of the core technologies and also humanoid robotics is an emerging and challenging research field.

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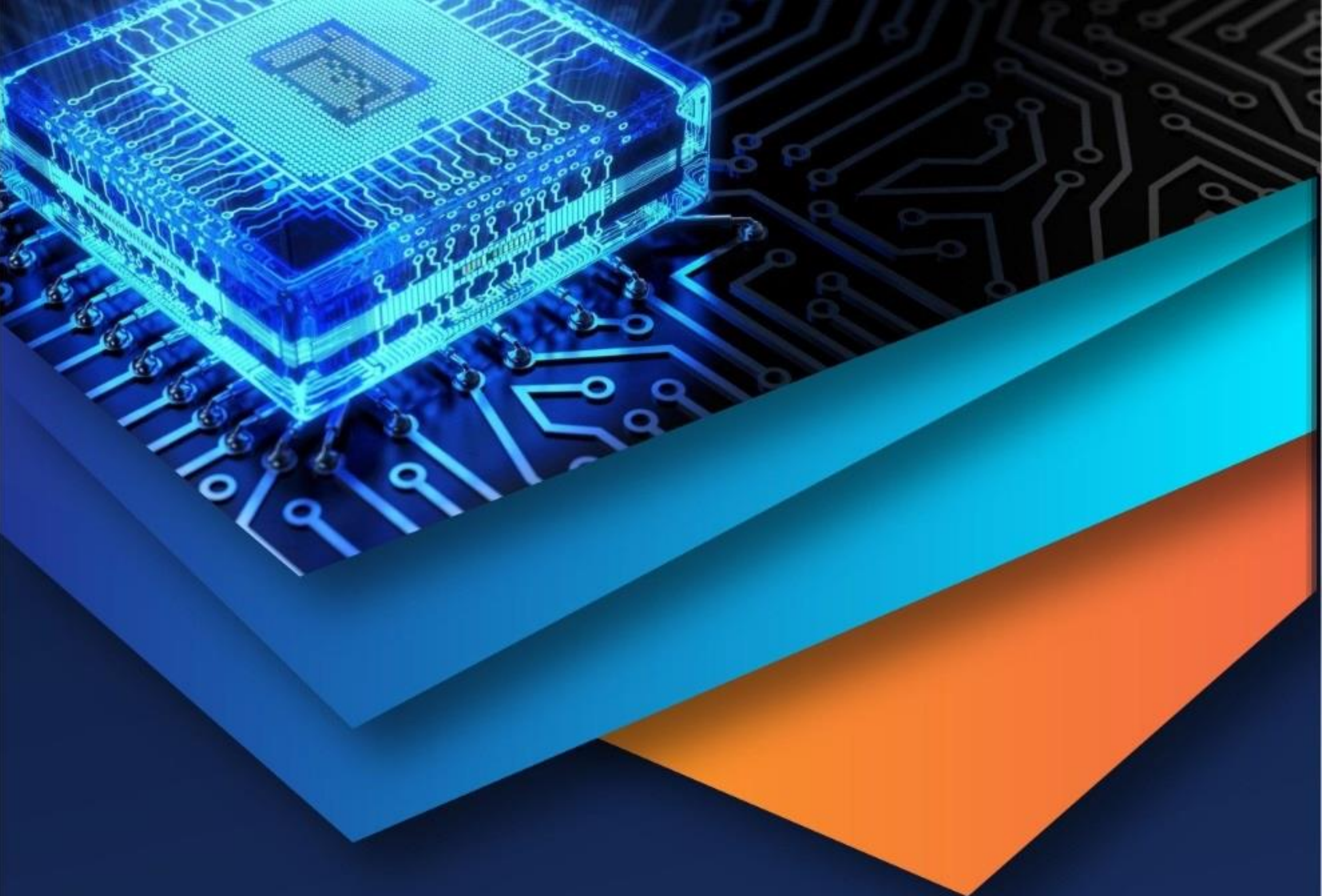

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