Interactive Humanoid Robot

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Abstract: Humanoid robots have been on the frontier of robotic science for several decades, where human alike capabilities have been replicated into electromechanical units. Humanoid robots hold promises in the field of rescue, quarantine, hazardous conditions, radiation leakage, medical trials, etc. Building a humanoid robot is very complicated as it has to deal with locomotion, power, drive train, sensors and computing at the real time. With the development of Singleboard computers (SBC), the cost of computers has drastically fallen in last 2 decades. At the same time the computation power (GF/Sec) has also increased exponentially. Similarly, MEMS and sensors have also become industrially available with micro sized, robust and reliable. The power source used by robots has also advanced from dry cell to Li-Ion batteries with 5 to 8 times more energy density, resulting in higher operation time. The objective of this paper is to propose a low-cost Humanoid platform comprising a computational platform, sensors, power unit and drive train to deliver basic human alike functions like speech, visual signs, and navigation.

The proposed humanoid robot uses a single board computer (ESP-32) capable of executing C&C++-based AI frameworks combined with Ultrasonic sensors, Li-ion battery and DC motor drives. A top mounted OLED screen is used for display of visual signs. This human robot is a mid-sized model, which can talk with people, walk along with us, shows gestures as well, and displays the visual signs as per the situation. This humanoid robot adds an aesthetical value to the various upcoming models

Keywords: Frameworks, ESP-32,

I. INTRODUCTION

A humanoid robot is a robot resembling the human body in shape. The design may be for functional purposes, such as interacting with human tools and environment, for experimental purposes, such as the study of bipedal locomotion, or for other purposes. They are professional service robots built to mimic human motion and interaction. Like all service robots, they provide value by automating tasks in a way that leads to cost-savings and productivity. Humanoid robots are a relatively new form of professional service robot. When asked to envision a “robot” most people will tell you they imagine a piece of machinery that resembles a human form. A humanoid robot can be defined as “a robot with its overall 2 appearance based on that of the human body. In general humanoid robots have a torso with a head, two arms, and two legs (although some forms of humanoid robots may model only part of the body). A humanoid robot is an autonomous robot because it can adapt to changes in its environment or itself and continue to reach its goal”. The torso of a humanoid robot serves two major functions. The first is that is typically houses the central computer for the robot as well as the power, in most cases batteries. Secondly, the torso is where the centre of mass is located. This will prove to be crucial when we are determining the placement of the power and computer in the robot. Attached to the torso are a head, arms, and legs. Robots can have arms for many purposes. When designing a robot whose Primary objective is walking, arms are likely not going to be needed to perform assigned Tasks. The arms instead have the potential to be used to balance the robot. If a robot is turning, its centre of gravity can be thrown off centre and cause it to start to lean. The arms can be used in order to help it regain balance. The cameras and/or sensors used to discern objects in front of the robot are located in the robot’s head. As with humans, robots have the capability of having their heads be able to turn around a certain pivot point, i.e., a spine. Having the ability to discern objects around it and not just in front of the robot will allow it to better adapt to its surroundings. Some robots are also given the capability of showing emotions when given extra sensors and programs to help it recognize the emotions of people it is interacting with. The mechanical aspects of the robot are a major part in defining it as a humanoid robot. However, the software is also unique. Humanoid robots are also known for being able to interact with humans and adapt to their surroundings.

II. EXISTING SYSTEM

The studies are made in Humanoid Robots. There are several Robot that has been developed and integrated towork in real time.

Until 1970s, Japanese robotics technologies have led the field.[1] Waseda University launched the WABOT program in 1967 and developed the first electronic, massive-scale humanoid smart robot, WABOT-1 in 1972.[2]Its joint control system enabled it to walk with the lower limbs and grasp and hand-held artifacts utilizing tactile detectors [3].

KITECH has examined and established in South Korea EveR-1[4], the android model of effective communication that can mimic human emotional expression using facial "musculature" and can express in fundamentals with a 400-word vocabulary. The advanced computer processing power of EveR-1 enables vocal recognition and synthesis when processing lip synchronization and visual recognition through micro-CCD cameras with face recognition technology

EveR-2, later called EveR-2 Muse [5] performed at Robot World 2006 in Seoul [6]. Vision and emotional expressiveness as well as several other improvements have been developed. [7] In 2008 EveR-2, together with 100 gestures, may convey the facial representation of joy, sorrow, fear, surprise, anger and disgust. [8]

It was the first model of the EveR series to be mobile with locomotive wheels and equipped in long rows to hide spokes. EveR-3[9] was the successor to EveR-2, demonstrated in 2009.

EveR-4, it is modular in construction, 64 degrees of freedom with 33 in its head (30 in its face and 3 in its neck), and 5 in its base (3 on its legs and 2 in its base wheel).[10] It has a modular design, which also has a design called EveR-4M,[10] it also has a modular design with 64 degrees of freedom which is expensive but our humanoid robot gives 3 degrees of freedom, interspersing the main body, enabling a 2 degree of freedom camera making it cost effective.

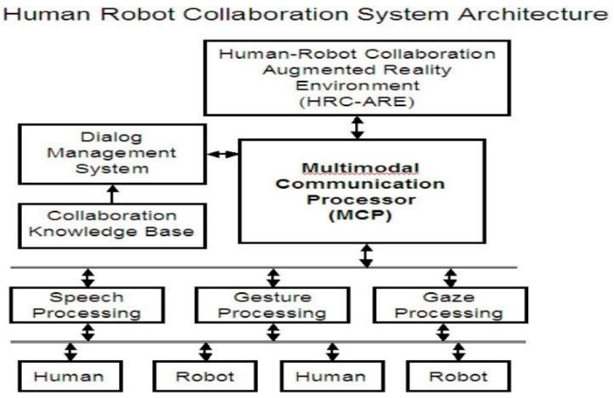
The Albert Einstein android portrait was developed by the Texas-based Hanson Robotics Inc. and by KAIST using the Hanson android facial technology mounted onto the life-sized KAIST bipedal robot body. The Einstein android is the first complete-body android in history, which was also known as "albert hubo" [11]. Federal Institute of Technology, Hanson Robotics [12]

III. PROPOSED SYSTEM

The key of this venture is to build up an in-field human UI accessible for every individual. This humanoid is intended to be worked in an outdoor environment. Modern investigations into humanoid robot development have led to the desire to create a robot that can not only walk from one destination to another, but also discern Objects in front of it and be able to compensate for that by moving around them. This was where the current project came into play. The purpose of this project was to design and build a humanoid robot that was capable of walking smoothly. Due to constant advances in technology, humanoid robots of the future will be capable of helping mankind by accomplishing tasks that may too dangerous, dirty, dull or even physically impossible, such as exploring other planets. Though there is still room for improvement for the locomotion of these robots to become more and more similar to that of a human, the future looks bright for the development of the next generation of Humanoid robots. Solidworks is computer-aided design (CAD) software owned by Dassault Systemes. It uses the principle of parametric design and generates three kinds of interconnected files: the part, the assembly, and the drawing. Therefore, any modification to one of these three files will be reflected in the other two. Solidworks helps you perform 2D and 3D modelling, and this CAD software is known for its ease-of-use and intuitiveness. Various parts of the Humanoid Robot are designed using the Solidworks software. Different parts are first designed with the standard dimensions in the “part modelling section”. After completing design of all the parts and the required sub-assemblies, the final assembly is done in the “Assembly section” of the Solidworks software. During the Assembly, proper mating is given. Various parts like robot foot, thighs, servo holder etc. are designed in the part modelling section and all these parts are assembled in the Assembly section and obtained the Final Assembly.

IV. ARCHITECTURE

The below figure 1, architecture of the humanoid robot is broadly categorized into 3 modules.



Architecture of Humanoid Robot.

V. COMPONENTS USEDS

A. MG995 SERVO MOTOR

MG995 Metal Gear Servo Motor is a high-speed standard servo can rotate approximately 180 degrees (60 in each direction) used for airplane, helicopter, RC-cars and many RC model. Provides 10kg/cm at 4.8V, and 12kgcm at 6V. It is a Digital Servo Motor which receives and processes PWM signal faster and better. It equips sophisticated internal circuitry that provides good torque, holding power, and faster updates in response to external forces. They are packed within a tight sturdy plastic case which makes them water and dust resistant which is a very useful feature in RC planes, Boats, and RC Monster Trucks etc. It equips 3-wire JR servo plug which is compatible with Futaba connectors too.

B. ESP-32

ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth. The ESP32 series employs either a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations, Xtensa LX7 dual-core microprocessor or a single-core RISC-V microprocessor and includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. ESP32 is created and developed by Espressif Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40 nm process.[2] It is a successor to the ESP8266 microcontroller. Features of the ESP32 include the following:[3]

- Processors:
  - CPU: Xtensa dual-core (or single-core) 32-bit LX6 microprocessor, operating at 160 or 240 MHz and performing at up to 600 DMIPS
  - Ultra low power (ULP) co-processor
- Memory: 320 KiB RAM, 448 KiB ROM
- Wireless connectivity:
  - Wi-Fi: 802.11 b/g/n
  - Bluetooth: v4.2 BR/EDR and BLE (shares the radio with Wi-Fi)

- Peripheral interfaces:
  - 34 × programmable GPIOs
  - 12-bit SAR ADC up to 18 channels
  - 2 × 8-bit DACs
  - 10 × touch sensors (capacitive sensing GPIOs)
  - 4 × SPI
  - 2 × I²S interfaces
  - 2 × I²C interfaces
  - 3 × UART
  - SD/SDIO/CE-ATA/MMC/eMMC host controller
  - SDIO/SPI slave controller
  - Ethernet MAC interface with dedicated DMA and planned IEEE 1588 Precision Time Protocol support[4]
  - CAN bus 2.0
  - Infrared remote controller (TX/RX, up to 8 channels)
  - Pulse counter (capable of full quadrature decoding)
  - Motor PWM
  - LED PWM (up to 16 channels)
  - Ultra low power analog pre-amplifier
- Security:
  - IEEE 802.11 standard security features all supported, including WPA, WPA2, WPA3 (depending on version)[5] and WLAN Authentication and Privacy Infrastructure (WAPI)
  - Secure boot
  - Flash encryption
  - 1024-bit OTP, up to 768-bit for customers
  - Cryptographic hardware acceleration: AES, SHA-2, RSA, elliptic curve cryptography (ECC), random number generator (RNG)
- Power management:
  - Internal low-dropout regulator
  - Individual power domain for RTC
  - 5 µA deep sleep current
  - Wake up from GPIO interrupt, timer, ADC measurements, capacitive touch sensor interrupt

C. BREAD BOARD

1. A breadboard is a construction base for prototyping of electronics. Originally the word referred to a literal bread board, a polished piece of wood used when slicing bread.

2. A breadboard is used to make up temporary circuits for testing or to try out an idea. No soldering is required so it is easy to change connections and replace components. Parts are not damaged and can be re-used afterwards.

3. Almost all the Electronics Club website projects started life on a breadboard to check that the circuit worked as intended.

4. A breadboard allows for easy and quick creation of temporary electronic circuits or to carry out experiments with circuit design.

5. Breadboards enable developers to easily connect components or wires thanks to the rows and columns of internally connected spring clips underneath the perforated plastic enclosure

D. JUMPER WIRES

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed.

E. LM 2695

The LM2596 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. Requiring a minimum number of external components, these regulators are simple to use and include internal frequency compensation, and a fixedfrequency oscillator. The LM2596 series operates at a switching frequency of 150 kHz, thus allowing smaller sized filter components than what can be required with lower frequency switching regulators. Available in a standard 5-pin TO-220 package with several different lead bend options, and a 5-pin TO-263 surface mount package.

F. PCA9685

The PCA9685 is an I²C-bus controlled 16-channel LED controller optimized for Red/Green/Blue/Amber (RGBA) color backlighting applications. Each LED output has its own 12-bit resolution (4096 steps) fixed frequency individual PWM controller that operates at a programmable frequency from a typical of 24 Hz to 1526 Hz with a duty cycle that is adjustable from 0 % to 100 % to allow the LED to be set to a specific brightness value. All outputs are set to the same PWM frequency.

Each LED output can be off or on (no PWM control) or set at its individual PWM controller value. The LED output driver is programmed to be either open-drain with a 25 mA current sink capability at 5 V or totem pole with a 25 mA sink, 10 mA source capability at 5 V. The PCA9685 operates with a supply voltage range of 2.3 V to 5.5 V and the inputs and outputs are 5.5 V tolerant. LEDs can be directly connected to the LED output (up to 25 mA, 5.5 V) or controlled with external drivers and a minimum amount of discrete components for larger current or higher voltage LEDs.

The PCA9685 is in the new Fast-mode Plus (Fm+) family. Fm+ devices offer higher frequency (up to 1 MHz) and more densely populated bus operation (up to 4000 pF).

G. OLED

An **organic light-emitting diode** (**OLED**), also known as **organic electroluminescent** (**organic EL**) **diode**,[1][2] is a light-emitting diode (LED) in which the emissive electroluminescent layer is a film of organic compound that emits light in response to an electric current. This organic layer is situated between two electrodes; typically, at least one of these electrodes is transparent. OLEDs are used to create digital displays in devices such as television screens, computer monitors, and portable systems such as smartphones and handheld game consoles.

VI . ASSEMBLY OF PARTS

1. Filing is done on the parts to avoid the sharp edges as well as the to remove the unwanted material on the parts which are printed.

2. The Sub-Assemblies are first made by applying the mixture of the Araldite gum on the required surfaces and the motors. Once the Sub-Assemblies are made, we need to proceed to the final assembly

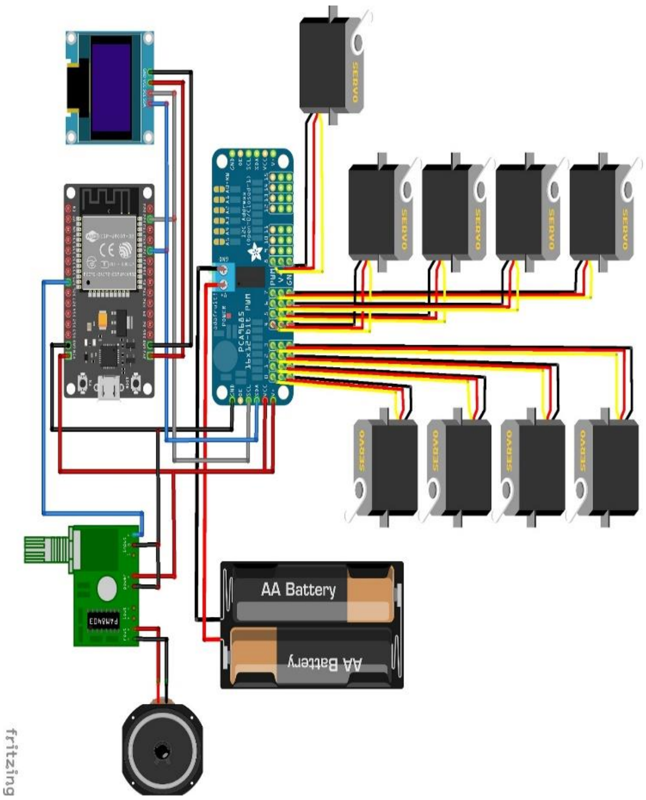
3. All the individual parts and the sub-assemblies are assembled together according to the design to get the Final Assembly

4. the complete assembly of the 'Humanoid Robot' is displayed

VII. WIRING AND PROGRAMMING

WIRING : All the wiring is done between the ESP 32, Power Source and Motors, and Initially all the Servo motors are fixed at 90 degrees for obtaining the flexible movement of motors.

PROGRAMMING : The Arduino platform can control the hardware only if it is programmed well. It is like a brain for the human body. As without proper brain, muscles and skeleton are malfunctional similarly without proper computer programming, actuators and mechanical framework will mal-function. The program is written in an Arduino IDE and then it is fed into the Arduino board through a USB connector from the computer.



WIRING AND ASSEMBLING

VIII. TESTING OF HUMANOID ROBOT

1. All the servos are connected to the ESP-32 and to the power source with the help of jumper wires.

2. The power supply is given to the bread board and the ground pins and power pins of the servos are arranged accordingly on the bread board.

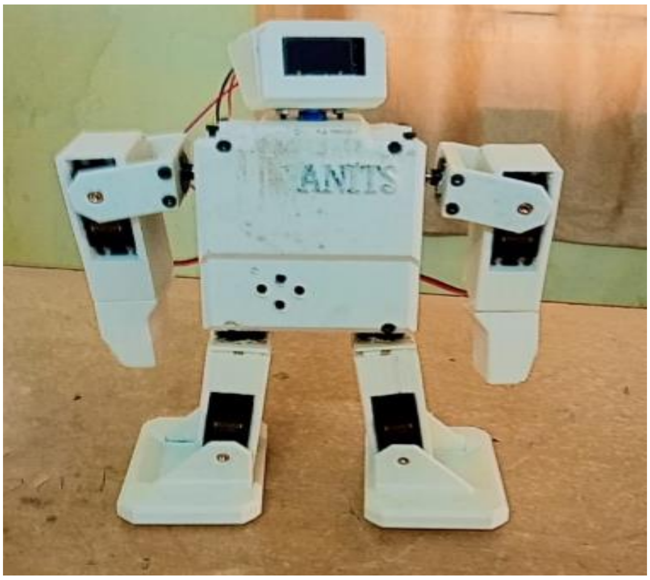
3. The signal pins of the servos are connected to Arduino board to which the input instructions are given.

4. Now with the help of Servo libraries in Arduino IDE, programming is done accordingly to operate the servos and is sent to Arduino board as input instructions.

5. The balancing and walking program is written by checking the servos at different angles.

IX. RESULTS AND DISCUSSIONS

The robot is given a set of code and it is made to walk. The program is written in such a way that the robot balances while walking. To make it balance, we need to find the centre of gravity of the legs and then we need to write the code accordingly. Trying with different angles of the servos, finally we have found the correct angles to the servos to make the robot leg balance. The code is written with the help of Servo libraries in Arduino IDE.



Finally, the Humanoid Robot could achieve the balancing and walking motion which is the desired output.

CONCLUSION

Wheeled robots cannot navigate well over obstacles, and this is the main drawback of this type, depending on the terrain, such as rocky terrain, sharp declines or areas with low friction, there are some situations where the wheels are not the best choice. So, Legs are the best ways to overcome these drawbacks. So, to overcome these drawbacks legged robots are necessary. In this project we have fabricated the Humanoid Robot which is a legged robot, and we could achieve the walking motion with the help of servo motors. So, we conclude that the walking motion to the robot can be obtained with the help of motors and thereby overcome the disadvantages of wheeled robots.

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