Low-Cost 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 Single board 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 (SBC) capable of executing python-based AI frameworks combined with Ultrasonic sensors, Li-ion battery and DC motor drives. A top mounted touch screen is used for human machine interface (HMI). This human robotics used in a mid-size campus to guide people to their respective destination, display brief information to new users and navigate to different locations. The humanoid robot adds an aesthetical value to the campus.

Keywords: AI Frameworks, Convolutional Neural Network, SLAM, Natural Language Processing, Raspberry Pi.

I. INTRODUCTION

A Humanoid robot is essentially a robot with its body shaped to take after the human body. The structure might be for utilitarian purposes, for example, interfacing with humans and situations, for trial purposes, or for different purposes. As a rule, humanoid robots have a middle, a head, two arms, and two legs. In spite of the fact that a few types of humanoid robots may demonstrate just a piece of the body; for instance, from the midriff up. Some humanoid robots additionally have made a beeline for reproducing human facial highlights, for example, eyes and mouths. Androids are humanoid robots worked to take after a male human, and Gynoids are humanoid robots worked to take after a human female.

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Humanoid robot are currently utilized as a research devices in a few logical regions Other than the research, humanoid robots hold guarantees in the field of salvage, isolate, unsafe conditions, radiation spillage, clinical preliminaries and also humanoid robots are being created to perform human errands like individual help, through which they ought to have the option to help the sick and elderly, and messy or risky employments.

Humanoids are likewise reasonable for some procedurally-based occupations, for example, front counter heads and car fabricating line laborers. In essence, since they can utilize instruments and work gear and vehicles intended for the human structure, humanoids could hypothetically play out any undertaking an individual can, inasmuch as they have the correct programming. Notwithstanding, the multifaceted nature of doing so is gigantic. Building a humanoid robot is confounded as it needs to manage velocity, power, drive train, sensors and registering at continuous.

II. EXISTING SYSTEM

The studies are made in Humanoid Robots. There are several Robot that has been developed and integrated to work 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,

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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 school grounds. This humanoid is intended to be worked in an outdoor environment.

It will have the ability to move around the grounds and explore its clients to their goal of the grounds itself using differential drive system.

The interactive part of Humanoid robot is achieved with the help of Natural Language Processing (NLP). Since it is being created at an extremely less cost makes it more stand apart from different humanoids created and making it increasingly helpful and moderate for any association.

With the expanding use of robots to supplant the human efforts and perspective in any industry, we can have a humanoid in a school like grounds playing out a wide scope of errands for the school advantage.

The most significant perspective to review a robot is its dependability. In spite of being in an open-air setting guaranteed security is being given and ensured.

Security is an imperative angle and is dealt with caution.

Humanoid utilizes 3D mapping approach in which topological maps hold the fundamental end.

Topological maps are a strategy for condition portrayal which catch the availability (i.e., topology) of the earth as opposed to making a geometrically exact guide using SLAM.

Simultaneous Localization and Mapping (SLAM) is the computational issue of developing or refreshing a guide of an obscure domain while at the same time monitoring a specialist's area inside it.

It is vigorously used in navigation, robotic mapping, and odometry for virtual reality or augmented reality. SLAM algorithms are tailored to the available resources, hence not aimed at perfection, but at operational compliance. Published approaches are employed in self-driving cars, unmanned aerial vehicles, autonomous underwater vehicles, planetary rovers, newer domestic robots and even inside the human body.

IV. ARCHITECTURE

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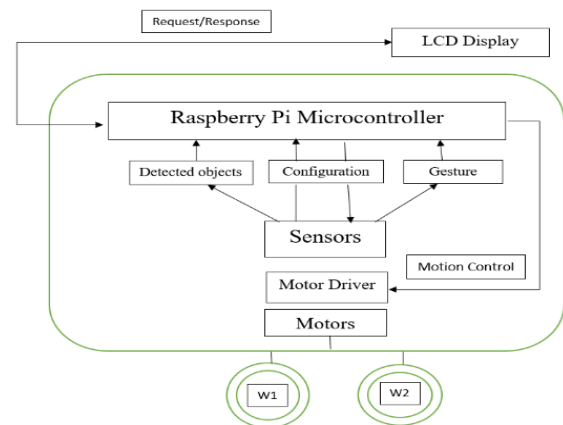

Figure 1: Architecture of Humanoid Robot.

A.   Mechanical module –

We have a motor driver with the usefulness to change over low force signal into a high force signal that drives the motor associated with it. The motor driver has four pins, two for pulse and two direction which are fed to motor left and motor right. Two wheels are precisely associated with the engines to prompt the development of the humanoid. Later, an encoder is used to translate rotary or linear motion into digital signal that monitors and controls the motion parameters such as speed, rate, position and direction. The encoder is a sensor joined to a pivoting object, (for example, a wheel or engine) to quantify revolution. By estimating revolution your robot can do things, for example, decide dislodging, speed, increasing speed, or the point of a turning sensor.

B. Electrical module

We have used few equipment, for example, Camera, Ultrasonic sensor, Infrared sensor, LCD touch panel, Accelerator, Magnetometer and Raspberry Pi. The sensors which is utilized to identify the human face, to gauge the separation of item, to distinguish the movement and convey different movements and gestures. We are utilizing LCD screen as an interface to visually communicate with human which will activate on human presence. We have utilized the microcontroller Raspberry Pi, that comes with the features of 1.5 GHz quad-core, 64-bit Arm Cortex A72-based, quad-core processor, up to 4GB RAM, a Video Core VI capable of 4K video playback, 802.11ac Wi-Fi, and Gigabit Ethernet, and two USB 2.0 and two USB 3.0 ports.
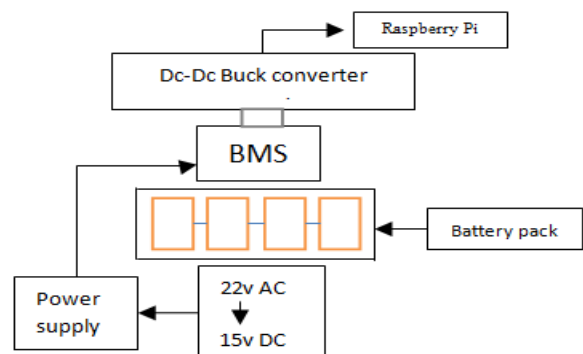

Figure 2: Li/ion Battery.

A high-quality battery Li/ion is connected to battery management system (BMS) in above figure 2, to get the proper protection from external factors as battery plays a big role in running a robot or any other devices. It has to provide sufficient amount of power and backup for robot to operate. The BMS receives input of 15v from the Power Supply which in turn/ijitee is fed from the AC-DC converter. BMS is deployed over a Battery pack consisting of stack of 4 Batteries. This battery pack gets an input from the BMS. This discharges from 14v to 9v as the functions take place. The BMS is also connected to DC-DC buck converter also known as stepdown converter. The converter converts from 12v to 5v that powers the Raspberry Pi.

C. Computing Module

The processor utilized is Raspberry Pi which is low cost, credit card sized computer that is provided with slots for storage purpose. The computing is faster and efficient. We will have an ubuntu operating system deployed on Raspberry Pi. The figuring is quicker and proficient. We will have a ubuntu working framework deployed on Raspberry Pi. This incorporates installed programming, Python AI frameworks, control frameworks, mechanized dynamic, and force gadgets. This includes embedded programming, control systems, automated decision making, and power electronics. These disciplines must work together in order to infuse the ability to sense, think, and act (the core properties of the humanoid). This module proficiently touches concepts like computer vision, artificial intelligence, robotic dynamics, and human-robot interaction.

V. DESIGN
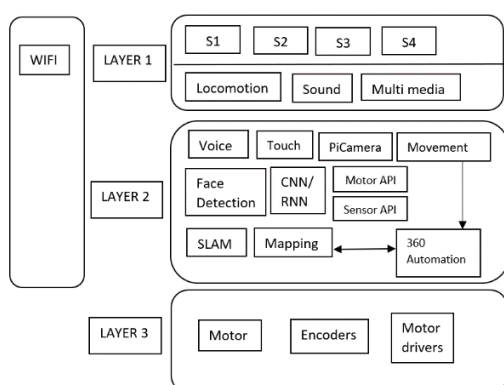
Figure 3: Layered design of humanoid robot.

As shown in the figure above, the design has 3 layers.

Layer 1 is the UI/UX layer of the humanoid. User interface (UI) design is the process of making interfaces in software or computerized devices with a focus on looks or style. We have various screens which represent various actions of the humanoid like locomotion, interaction with sound and handle the multimedia aspect of the screen.

Layer 2 is the API and Drivers layer. It handles the perception, computation, actuation in the humanoid. Perception is understood as a system that endows the robot with the ability to perceive, comprehend, and reason about the surrounding environment. With the help of sensors and devices perception is achieved. Computation handles localization answering to the question, where am I? Navigation answering the question, where to go? Driving

answering the question, how to go? These can be achieved through SLAM which helps in the computational problem of constructing or updating a map of an unknown environment while simultaneously keeping track of an agent's location within it. This works hand in hand with movement of the humanoid and 360-degree automation. Inclusion of CNN (Convolutional neural network) have three parts, convolution layers, pooling layers, and fully-connected layers. It usually takes a 2D (sometimes more dimensions) matrix and outputs a result. and RNN (recurrent neural network) RNNs (recurrent neural networks) are made up of one node. It is fed data then outputs a result back into itself, and continues to do this. Breakthroughs like LSTM (long short-term memory) make it smart at remembering things that have happened in the past and finding patterns across time to make its next guesses make sense. This also includes real time face detection which can be defined as a computer technology being used in a variety of applications that identifies human faces in digital images. APIs which a coupled with libraries to expose the various hardware capabilities of the humanoid.

Layer3 is the electromechanical hardware layer, which holds the motors, encoders and device drivers. This forms the electromechanical hardware base. The motors are controlled by the incremental encoder. The drivers are bidirectional and a controlled by PWM. Motors and actuators are the devices which make the robot movable. Motors and actuators convert electrical energy into physical motion.

VI. RESULTS
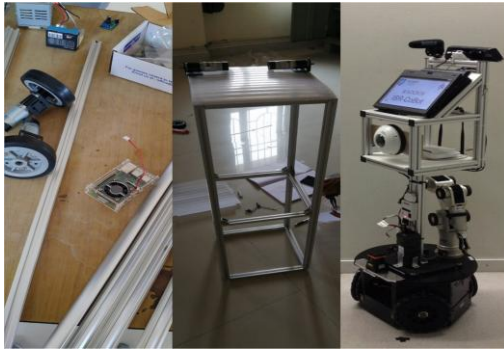

Fig 4: Amplifier, Ultrasonic sensor, Gyro sensor

In the above figure, the signal power is amplified using an amplifier and the ultrasonic

sensor is used during locomotion. The gyro sensor is used for corner speed, adjusting the rotational angle by unit time.

Fig 5: Raspberry PI

Fig 6: Chassis and final product

VII. CONCLUSION

The low-cost humanoid robot is implemented to save the time of people navigating the entire campus at a minimum cost. It is made for crowd control and interfacing at a key junction. This human machine interface (HMI) is widely used for interacting with visitors.

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