The Economical Humanoid - Ellie

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Abstract: In the current scenario of the technologies, Robotics is acting as the backbone to majority of innovations. One such innovation are the human-like robots or "Humanoids". These are advance machines which tends to imitate most actions of a human in the real-world premises. Achieving this feat requires tremendous amount of human efforts, knowledge of high-level technologies as well as a monetary support. The basic working of a humanoid outside an industrial dome must be similar to that of a human, and this indeed lists out usage of several high-end devices for accurate operations like higher resolution cameras, efficient motors and high-level programming. This results in higher rate of such machines on market. Our project deals with taking utmost measures in reducing the cost of the Humanoids without reducing its features by a maximal margin and developing a humanoid which can interact effortlessly in the human world. Furthermore, our project contents can be modified as per the general requirement of its utilization.

Keywords: Economical humanoid, Humanoid robot, Economical humanoid Ellie, Raspberry-pi based Humanoid, Arduino interfacing with Raspberry pi, Face detection using OpenCV, Chatbot using Google and Sphinx API, Real-time Chatbot using Python, NRF wireless movement control, Bluetooth speech movement control.

I.   INTRODUCTION

Humans have been occupying the Earth for centuries now. They always have tried to ease their workload by discovering new ideas and implementing them into reality. For instance, humans have introduced the world with various useful innovations, whether be it the wheel, lever, train, and so on. As seen, the mankind invented machines of alternative shapes and sizes. To develop and operate these machines, there was a huge requirement of human resources which led to the vices of human slavery, wars, exploitation of natural resources and many more concerns.

Today, majority of industries have replaced the human arm with the mechanical ones to carry out various repetitive tasks without much efforts involved. These arms when attached to a mechanical body builds an identity similar to humans. We call these robots as Humanoids. With the development of technology, seeing these machineries in an industry is common. However, with the name being close to human, their application outside the industries are limited for now. There are a few social robots that can interact with humans but they have their own restrictions, may it be the features or the cost.

Basically, when we hear about humanoids, its features and look are the ones that develops a plethora of questions in everyone's mind. Will it be able to hear me? Can it speak like we do? These are few of the questions that we all want to be answered and see in a humanoid. As the technology is progressing, all these questions are receiving an answer to it and soon in the near future, these human-like machines will tentatively replace us.

Considering the development stages of the humanoid evolution, we have seen such high transformation both in the design as well as in the software. Previously known systems used to be bulky and gigantic in structures which is surely reduced into a compact human like structures. In addition, there has been numerous human characteristics attempted to be installed in these machines whether it may be identifying human faces with their respective information or picking up objects and performing suitable tasks with them. All these in recent times will eventually be easier than in recent times.

In the current statistics of technologies, robotics has surely advanced its wings to a greater extends providing the world with inventions like Sophia – the very first A.I humanoid. However, it cannot be called an exact replica of humans. Furthermore, Humanoids are also developed specifically for certain scenarios. For instance, at places of providing education, humanoids can be very beneficial. Another great example is the Humanoid named Erica, which is developed in Japan and it is utilized as the news anchor.

It can be clearly seen that robots are switching sides with humans and thereby converting the world more into an advanced arena of robots where every individual activity is performed by robots.

Sphinx API, Real-time Chatbot using Python, NRF wireless movement control, Bluetooth speech movement control.

II. METHODOLOGY
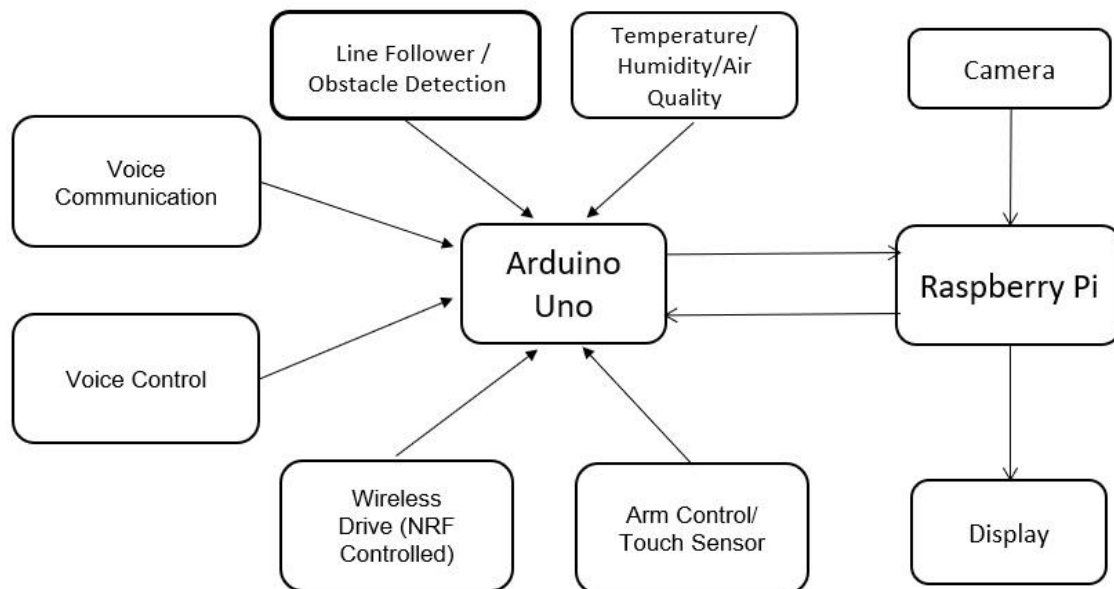
Figure 1: *Block diagram showing the working principle of humanoid*

The various units involved are as follows:
I. Processing units (Raspberry Pi 3b+, Arduino Uno R3)
II. Power supply units (12V Lead acid batteries (4))
III. Visual display units (16×2 I2C LCD, 15" LED)
IV. Motors (DC motors, Servo Motors)
V. Sensors (Touch Sensor, Temperature &Humidity sensor, Air Quality sensor)
VI. Modules (Memory Card module, Audio Amplifier module, Camera module, Relay module)
VII. Communication units (NRF module, Bluetooth module HC-05)

The main processing units of the humanoid are Raspberry Pi 3b+ single board computer and Arduino Uno R3 developmental board. All other equipment is directly or indirectly connected to them for data processing and giving commands. The sequence of operation of the humanoid is as follows
a) The camera gives real time data feed to the Raspberry Pi 3b+, which looks for the presence of any human face in the point of view of the humanoid.
b) Upon detection, humanoid greets the person present there and moves its arm ahead for a handshake.
c) When the person does the handshake, the person's touch is recorded using sensor and hence gives the signal to humanoid to take its armback to standby position.
d) The humanoid's LED screen lights up to display an informative video about itself.

There are two sensors used for environment monitoring i.e. DHT11 (for temperature and humidity levels) and MQ-135 (for air quality index values). The analog data provided by these sensors is processed by an Arduino Uno R3 and it is given to the 16×2 I2C LCD display module for displaying the temperature (in degrees C), humidity (percentage) and air quality index.

The movement of the bot is controlled with the help of 5V Relay Switching module. The data to trigger the switching the module can be provided in two modes i.e. using wireless remote (NRF module) and voice commands (using mobile phone as transmitter and HC-05 module as receiver). The NRF module is trans receiver module used at both at transmitter remote and receiving ends of the humanoid. Arduino Uno R3 is used at both ends to process data being transferred. The voice command requires an application on mobile phone which uses inbuilt Bluetooth for transmitting data and HC-05 module along with Arduino Nano. When a person says a particular keyword, that word is converted into a message which is sent to the receiving Nano. The Arduino Uno R3 upon receiving message processes the data and gives the output signal. Data pins to give signal

for relay to switch are passed through a switch so that only one mode gives signal for the motors to be operated at any given moment.

The humanoid also comes with a chatbot, which is an audio interaction with the humanoid. This is done with the help of voice recognition algorithm built in Python library. The person can say a particular keyword to get the bot into interaction. The bot will reply to predefined questions such as how are you, what's your name, where are you from and so on. The Chatbot uses two methods for voice recognition i.e. Google's online voice recognition algorithm and offline Pocket Sphinx voice recognition algorithm.

III. PERFORMANCE EVALUATION

The working of the humanoid can be distinguished into four sections:

Face detection in humanoid is done with help of a camera interfaced with Raspberry Pi 3b+ and Open CV software. When a person stands in the point of view of camera, the humanoid detects the person and moves arm ahead for a handshake gesture while greeting the person. When the person shakes hand, humanoid takes back the arm, and displays an informative video about itself.

The movement of the humanoid can be done using two ways i.e. wireless remote and voice command. The wireless remote is a joystick connected to Arduino Uno R3. The humanoid moves in direction pointed by the joystick. The voice command is given through an application on smartphone which uses the phone's Bluetooth for transmission of the data. The person speaks out a particular command in the application, which is sent to the receiving Arduino Nano connected to Bluetooth module HC-05. The receiving message is decoded and the command is executed.

The chatbot is an interaction of bot with a human being. It is speech based chatbot that understands the human speech and responds to it. The chatbot can be asked a variety of questions such as name, people who made it or even the weather around the world.

The humanoid is embedded with DHT11 and MQ-135 sensors. These are connected to Arduino Uno R3. These sensors provide temperature, humidity and air quality index data. This data is displayed through a 16×2 LCD display which is connected to the same Arduino Uno R3.

IV. RESULT

These functions are made possible at an economical cost with the help of simple coding and readily available electronic components in the market but provides high-end accuracy. The results obtained using the Economical humanoid are listed below:

- Accurate face detection.
- Gesture interaction through speech and handshake.
- Movement control using Bluetooth speech and wireless NRF module remote controller.
- Display of self-characteristics through the LED display connected.
- Display of environmental parameters such as temperature, humidity and air quality index.
- Speech Interaction using Chatbot technique.

Figure 2: Economical Humanoid Ellie   **Figure 3:Environment data displayed on LCD**

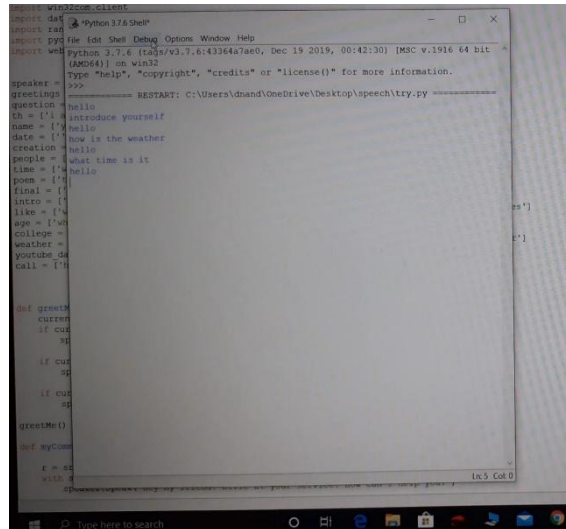**Figure 4: Face Detection**

Figure 5: Chatbot

V. CONCLUSION

As technology increases rapidly, we have witnessed humans and robots working in industries, factories, warehouses, and laboratories. However, a humanoid that is interactive from every aspect decreases the risk of putting individuals in industries and also boosts the economy effectively. Robotics is still in its developing phase and will surely offer immense benefits to humanity in the future. The humanoids can undertake tasks, which are considered dull, dirty, and dangerous and also reduces the threat to human life.

Our project goal and priorities also remain the same, i.e. causing minimal harm to humanity while providing the essential features economically. Therefore, the humanoid Ellie will be beneficial at locations of high features and minimal cost.

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