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Humanoid Robot: ASIMO

[1]Vipul Dalal
Department of Computer Science & Engineering,
GITAM Kablana(Jhajjar), India

[2]Upasna Setia
Department of Computer Science & Engineering,
GITAM Kablana (Jhajjar), India

Abstract:Today we find most robots working for people in industries, factories, warehouses, and laboratories. Robots are useful in many ways. For instance, it boosts economy because businesses need to be efficient to keep up with the industry competition. Therefore, having robots helps business owners to be competitive, because robots can do jobs better and faster than humans can, e.g. robot can built, assemble a car. Yet robots cannot perform every job; today robots roles include assisting research and industry. Finally, as the technology improves, there will be new ways to use robots which will bring new hopes and new potentials.

Index Terms--Humanoid robots, ASIMO, Honda.

I. INTRODUCTION

A HUMANOID ROBOT is a robot with its body shape built to resemble of the human body. A humanoid design might be for functional purposes, such as interacting with human tools and environments, for experimental purposes, such as the study of bipedal locomotion, or for other purposes. In general, humanoid robots have a torso, a head, two arms, and two legs; though some forms of humanoid robots may model only part of the body, for example, from the waist up. Some humanoid robots may also have heads designed to replicate human facial features such as eyes and mouths. Androids are humanoid robots built to aesthetically resemble humans.

Humanoid robots are used as a research tool in several scientific areas.

Researchers need to understand the human body structure and behaviour (biomechanics) to build and study humanoid robots. On the other side, the attempt to the simulation of the human body leads to a better understanding of it.

Human cognition is a field of study which is focused on how humans learn from sensory information in order to acquire perceptual and motor skills. This knowledge is used to develop computational models of human behaviour and it has been improving over time.

It has been suggested that very advanced robotics will facilitate the enhancement of ordinary humans.

Although the initial aim of humanoid research was to build better orthotics and prosthesis for human beings, knowledge has been transferred between both disciplines. A few examples are: powered leg prosthesis for neuromuscular impaired, ankle-foot orthotics, biological realistic leg prosthesis and forearm prosthesis.

Besides the research, humanoid robots are being developed to perform human tasks like personal assistance, where they should be able to assist the sick and elderly, and dirty or dangerous jobs. Regular jobs like being a receptionist or a worker of an automotive manufacturing line are also suitable for humanoids. In essence, since they can use tools and operate equipment and vehicles designed for the human form, humanoids could theoretically perform any task a human being can, so long as they have the proper software. However, the complexity of doing so is deceptively great.

They are becoming increasingly popular for providing entertainment too. For example, Ursula, a female robot, sings, play music, dances, and speaks to her audiences at Universal Studios. Several Disney attractions employ the use of animatrons, robots that look, move, and speak much like human beings, in some of their theme park shows. These animatrons look so realistic that it can be hard to decipher from a distance whether or not they are actually human. Although they have a realistic look, they have no cognition or physical autonomy. Various humanoid robots and their possible applications in daily life are featured in an independent documentary film called *Plug & Pray*, which was released in 2010.

Humanoid robots, especially with artificial intelligence algorithms, could be useful for future dangerous and/or distant space exploration missions, without having the need to turn back around again and return to Earth once the mission is completed.

II. SENSORS IN HUMANOIDS

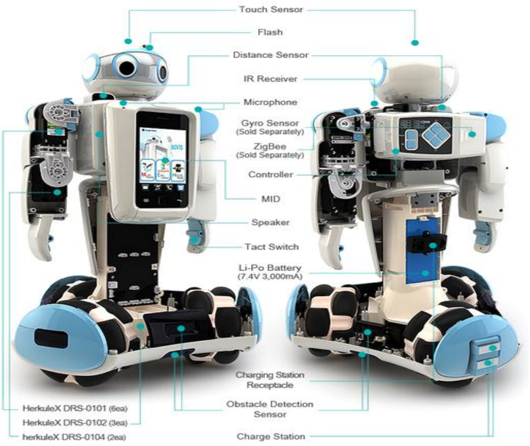
A sensor is a device that measures some attribute of the world. As being one of the three primitives of robotics (besides planning and control), sensing plays an important role in robotic paradigms.

Sensors can be classified according to the physical process with which they work . In this case, the second approach was used.

➢ PROPRIOCEPTIVE SENSORS

Proprioceptive sensors sense the position, th orientation and the speed of the humanoid's body an joints.

In human beings the eoliths and semi-circular canals (in the inner ear) are used to maintain balance and orientation. In addition, humans use their own proprioceptive sensors to help with their orientation. Humanoid robots use accelerometers to measure the acceleration, from which velocity can be calculated by integration; tilt sensors to measure inclination; position sensors, that indicate the actual position of the robot (from which the velocity can be calculated by derivation) or even speed sensors.



➢ EXTEROCEPTIVE SENSORS

Exteroceptive sensors determine the measurements of objects relative to a robot's frame of reference. These sensors are categorized as a proximity sensors. These sensors keep the robot from colliding with other objects. They can also be used to measure distance from the robot to another object.

There are three main types of exteroceptive sensors.

- Contact Sensors: Contact sensors are typically simple mechanical switches that send a signal when physical contact is made. Contact sensors are used to detect the positive contact between two mating parts and/or to measure the interaction forces and torques which appear while the robot manipulator conducts part mating operations. Another type of contact sensors are tactile sensors. These measure a multitude of parameters of the touched object surface.
- Range Sensors: Range sensors measure the distance to objects in their operation area. A range sensor can also be a distance detection devices that provides a simple binary signal when a particular threshold is detected. Range sensors are used for robot navigation, obstacle avoidance, or to recover the third dimension for monocular vision. Range sensors are based on one of the two principles: time-of-flight and triangulation
- Vision Sensors: Robot vision is a complex sensing process. It involves extracting, characterizing and interpreting information from images in order to identify or describe objects in environment.
- Arrays of tactile can be used to provide data on what has been touched. The Shadow Hand uses an array of 34 tactile arranged beneath its polyurethane skin on each fingertip. Tactile sensors also provide information about forces and torques transferred between the robot and other objects.

Sound sensors allow humanoid robots to hear speech and environmental sounds, and perform as the ears of the human being. Microphones are usually used for this task.

III. ASIMO: A HUMANOID BY HONDA

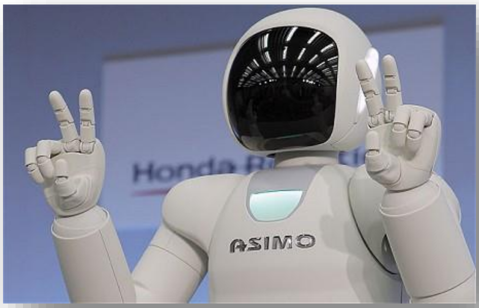
ASIMO, an acronym for Advanced Step in Innovative Mobility, is a humanoid robot designed and developed by Honda. Introduced on 21 October 2000, ASIMO was designed to be a multi-functional mobile assistant. With aspirations of helping those who lack full mobility, ASIMO is frequently used in demonstrations across the world to encourage the study of science and mathematics. At 130 cm (4 ft. 3 in) tall and 50 kg (110 lb.), ASIMO was designed to operate in real-world environments, with the ability to walk or run on two feet at speeds of up to 6 kilometers per hour (3.7 mph). In the USA, ASIMO is part of the sat traction at Disneyland and has been featured in a 15-minute show called "Say 'Hello' to Honda's ASIMO" since June 2005. The robot has made public appearances around the world, including the Consumer Electronics Show (CES), the Miraikan Museum and Honda Collection Hall in Japan, and the Ars Electronica festival in Austria.

IV. DEVELOPMENT HISTORY OF ASIMO

Honda began developing humanoid robots in the 1980s, including several prototypes that preceded ASIMO. It was the company's goal to create a walking robot. E0 was the first bipedal (two-legged) model produced as part of the Honda E series, which was an early experimental line of humanoid robots created between 1986 and 1993. This was followed by the Honda P series of robots produced from 1993 through 1997, which included the first self-regulating, humanoid walking robot with wireless movements.

The research conducted on the E- and P-series led to the creation of ASIMO. Development began at Honda's Wako Fundamental Technical Research Centre in Japan in 1999 and ASIMO was unveiled in October 2000.

Differing from its predecessors, ASIMO was the first to incorporate predicted movement control, allowing for increased joint flexibility and a smoother, more human-like walking motion. Introduced in 2000, the first version of ASIMO was designed to function in a human environment, which would enable it to better assist people in real-world situations. Since then, several updated models have been produced to improve upon its original abilities of carrying out mobility assistance tasks. A new ASIMO was introduced in 2005, with an increased running speed to 3.7 mph, which is twice as fast as the original robot. ASIMO fell during an attempt to climb stairs at a presentation in Tokyo in December 2006, but then a month later, ASIMO demonstrated tasks such as kicking a football, running and walking up and down a set of steps at the Consumer Electronics Show in Las Vegas, Nevada.



In 2007, Honda updated ASIMO's intelligence technologies, enabling multiple ASIMO robots to work together in coordination. This version also introduced the ability to step aside when humans approach the robot and the ability to return to its charging unit upon sensing low battery levels.

V. FEATURES AND TECHNOLOGY USED

1) Form

ASIMO stands 130 cm (4 ft. 3 in) tall and weighs 54 kg (119 lb.). Research conducted by Honda found that the ideal height for a mobility assistant robot was between 120 cm and the height of an average adult, which is conducive to operating door knobs and light switches. ASIMO is powered by a rechargeable 51.8 V lithium-ion battery with an operating time of one hour. Switching from a nickel metal hydride in 2004 increased the amount of time ASIMO can operate before recharging. ASIMO has a three-dimensional computer processor that was created by Honda and consists of a three stacked die, a processor, a signal converter and memory. The computer that controls ASIMO's movement is housed in the robot's waist area and can be controlled by a PC, wireless controller, or voice commands.

2) Abilities

ASIMO has the ability to recognize moving objects, postures, gestures, its surrounding environment, sounds and faces, which enables it to interact with humans. The robot can detect the movements of multiple objects by using visual information captured by two camera "eyes" in its head and also determine distance and direction. This feature allows ASIMO to follow or face a person when approached. The robot interprets voice commands and human gestures, enabling it to recognize when a handshake is offered or when a person waves or points, and then respond accordingly. ASIMO's ability to distinguish between voices and other sounds allows it to identify its companions. ASIMO is able to respond to its name and recognizes sounds associated with a falling object or collision. This allows the robot to face a person when spoken to or look towards a sound. ASIMO responds to questions by nodding or providing a verbal answer in different languages and can recognize approximately 10 different faces and address them by name.

3) Mobility

ASIMO has a walking speed of 2.7 kilometers per hour (1.7 mph) and a running speed of 6 kilometers per hour (3.7 mph). Its movements are determined by floor reaction control and target Zero Moment Point control, which enables the robot to keep a firm stance and maintain position. ASIMO can adjust the length of its steps, body position, speed and the direction in which it is stepping. Its arms, hands, legs, waist and neck also have varying degrees of movement. The technology that allows the robot to maintain its balance was later used by Honda when it began the research and development project for its motorized unicycle, U3-X, in 2009. ASIMO has a total of 34 degrees of freedom. The neck, shoulder, wrist and hip joints each have three degrees of freedom, while each hand has four fingers and a thumb that have two degrees of freedom. Each ankle has two degrees of freedom, and the waist, knees and elbows each have one degree of freedom.

There are sensors that assist in autonomous navigation. The two cameras inside the head are used as a visual sensor to detect obstacles. The lower portion of the torso has ground sensor which comprises one laser sensor and one infrared sensor. The laser sensor is used to detect ground surface. The infrared sensor with automatic shutter adjustment based on brightness is used to detect pairs of floor markings to confirm the

navigable paths of the planned map. The pre-loaded map and the detection of floor markings help the robot to precisely identify its present location and continuously adjusting its position. There are front and rear ultrasonic sensors to sense the obstacles. The front sensor is located at the lower portion of thetorso together with the ground sensor. The rear sensor is located at the bottom of the backpack.

VI. PUBLIC APPEARANCES

Since ASIMO was introduced in 2000, the robot has travelled around the world and performed in front of international audiences. ASIMO made its first public appearance in the U.S. in 2002 when it rang the bell to open trade sessions for the New York Stock Exchange. From January 2003 to March 2005, the robot toured the USA and Canada, demonstrating its abilities for more than 130,000 people. From 2003 to 2004, ASIMO was part of the North American educational tour, which visited top science and technology museums and academic institutions throughout North America. The goal of the tour was to encourage students to study science through a live show that highlighted ASIMO's abilities. Additionally, the robot visited top engineering and computer science colleges and universities across the USA as part of the ASIMO Technology Circuit Tour in an effort to encourage students to consider scientific careers. In 2004, ASIMO was inducted into the Carnegie Mellon Robot Hall of Fame. In March 2005, the robot walked the red carpet at the world premiere of the computer-animated film, Robots. In June 2005, ASIMO became a feature in a show called "Say 'Hello' to Honda's ASIMO" at Disneyland's Innovations attraction, which was a part of the Tomorrow land area of the park. This was the only permanent installation of ASIMO in North America until Innovations was closed in April 2015.

The robot first visited the United Kingdom in January 2004 for public demonstrations at the Science Museum in London. ASIMO continued on a world tour, making stops in countries such as Spain, the United Arab Emirates, Russia, South Africa and Australia. In October 2008, ASIMO greeted Prince Charles during a visit to the Miraikan Museum in Tokyo, where it performed a seven-minute step and dance routine.

In a demonstration at Honda's Tokyo headquarters in 2007, the company demonstrated new intelligence technologies that enabled multiple ASIMO robots to work together. The demonstration showed the robot's ability to identify and avoid oncoming people, work with another ASIMO, recognize when to recharge its battery and perform new tasks, such as carrying a tray and pushing a cart.

In 2008, ASIMO conducted the Detroit Symphony Orchestra in a performance of "The Impossible Dream" to bring attention to its partnership with the Orchestra and support the performing arts in Detroit. A 49-foot replica of ASIMO made with natural materials, such as lettuce seed, rice and carnations led the 120th Rose Parade in celebration of Honda's 50th year of operation in the USA. Later that year, the robot made an appearance in Italy at the Genoa Science Festival.

In January 2010, Honda debuted its "Living with Robots" documentary at the Sundance Film Festival in Park City, Utah. The film focuses on the experience of human interaction with robots like ASIMO. ASIMO attended the Ars Electronica festival in Linz, Austria in September 2010, which allowed Honda to study the results of human and robot interaction and use the results to guide development of future versions of the robot. In April 2011, ASIMO was demonstrated at the FIRST Championship in St. Louis, Missouri to encourage students to pursue studies in math, science and engineering.

ASIMO visited the Ontario Science Centre in Toronto in May 2011 and demonstrated its abilities to Canadian students. The robot later travelled to Ottawa for the unveiling of an exhibit at the Canadian Museum of Civilization 19 May through 22 May 2011.

ASIMO appeared as a guest on the British quiz show QI on 2 December 2011. After serving water to host Stephen Fry and dancing with comedienne Jo Brand, ASIMO won with 32 points.

ASIMO was also the inspiration behind 2012's film Robot & Frank, where a robot assists an aging man to commit his last job as a 'cat burglar'. The robot in the film, portrayed by an actor in costume, has the appearance of an ASIMO robot.

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