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Review Article

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Era of Robotics

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Abstract

This paper was originally presented as an invited presentation in the 6th International Conference and Exhibition of Mechanical and Aerospace Engineering in Atlanta, Georgia, USA. The purpose of this talk is to inform audience that this is the era of robotics and what we need to do in this era. However, it is much modified in this paper. Many anthropomorphic robots are proposed, such as robots for test pilots, for firemen, for police, for soldiers and for health services. Current statuses of robots are reviewed. Further products are discussed. Much information and references are added, that means my original statements are verified. And if readers like to get more details they can find from references. To lend the audience perspective regarding my background, my recent project in robotics is mentioned briefly. As robotic products are invented, many engineering jobs will be developed, so this is an exciting field.

Keywords: Robots, Robotics, Mechanical Engineering, Electro-Mechanical Design

Introduction

I feel that lots of people have a misconception that not much can be done in mechanical engineering. Actually mechanical engineering is a major branch of engineering. Many devices in the field of transportation, energy and appliances are associated with mechanical engineering. In the field of transportation, locomotives automobiles, airplanes and ships undergo constant improvement in both performance and efficiency. In energy production, power plants regardless of the source of energy, coal, oil, or nuclear, are designed and operated by mechanical engineers. Most importantly, automation in different manufacturing plants are designed and operated by mechanical engineers. So graduates from departments of mechanical engineering can always find jobs. As an example of the impressive rate of achievement in mechanical engineering, in the last century, airplanes barely got off the ground in the beginning of 20th century, but then our rockets went to the moon in 1969. Mechanical engineers performed a major role in this achievement, for which we mechanical engineers ought to be proud. But we should not rest on our laurels, as a new field, robotics, is just created and is ushering us into the 21st century. Following this introduction, sections in this paper are robots to be built, knowledge required, current status, my recent project in robotics and conclusion.

Robots to be Built

Science and technology are progressing constantly. Many repetitive jobs that require human effort, especially in manufacturing, are now done by robots. Similarly, we can predict that dangerous jobs can be done by robots in the near future. For example, a test pilot is a dangerous job, i.e. a very good pilot who tests newly designed airplanes to find the maximum limits of the airplane is in great danger when those limits are exceeded. It is possible to make a robot to do the job. Firefighting is a dangerous job. Buildings that are collapsed or burning can trap both first responders and other victims inside. Drones could be built to fly or to drive through small space to look for trapped people. Policemen are also at risk. Routine traffic stops, with the wide availability of guns in this country, can escalate to gunfire at any moment. To avoid these dangerous encounters, robots could be deployed by a police to do routine check-ups. In the recent wars, many military service men and women were injured or even killed because of ground mines. Robots could be deployed here before soldiers. Actually wars are always dangerous for humans to fight, it is possible to use robots to fight, and each soldier could control a robot to fight in front for him or her. In this way, the death rate will be greatly reduced. Seniors or disabled persons often need a maid or in-home health service on a daily basis. They also need a companion. A robot may help, and technology is slowly achieving societal expectations. At this moment, humanoid or anthropomorphic robots cannot replicate the skill and emotional support of a care-giver so this is still a challenge. These are just a few examples of ways in which robots may benefit human lives, but we expect many applications to surface with time.

Knowledge Required

A robot is a multidisciplinary product, including the following major disciplines: mechanical engineering electrical engineering, computer science, and medical science. Design requires the application of all the fundamental sciences. A good design considers the product from many different perspectives. To make an anthropomorphic robot we must consider the motions of arms, hands, legs etc. with respect to mechanical engineering principles such as dynamics, mechanics, materials, stress analysis, etc. Furthermore, because of limited space and motor speed, often planetary gear train and harmonic gear train are employed. A good mechanical engineer should have all of these in his or her background. In addition, the need for an intelligent brain in the robot should not be underestimated. The computer and proper

software needed to control the robot are becoming exceedingly complex. For these we need engineers in computer science and electrical engineering. Moreover, to make robots really humanistic, we must consider the human form as a model and we need input from medical scientists.

Current Status

A robot for test pilot is not yet available, but unmanned airplane exists; many different unmanned aircraft were developed in recent years. For example, one is designed for high altitude flight and powered by solar energy so it can fly for a long time without refuel [1]. Some can carry a bomb and is remotely controlled by a pilot as reported on TV. The unmanned plane or drone is low in speed and has a communication delay so that complex aerial maneuvers are not possible. Certainly, at this moment, a drone cannot function as well as a plane with an on-board pilot. There is a long way to go to reach the goal of robot test pilot. A robot to replace a firefighter is not available either. However, a remote-controlled rover and remote-controlled helicopter are available as described by Murphy [2]. They can carry a camera or use a claw to help firefighters to search for trapped people, but lack the functionality, durability, and reliability to replace a firefighter. A robot soldier is not available but mine detectors are available. These detectors are still in development and are not routinely used to clear mine fields. Remote-controlled weapons are also in development. They are frequently demonstrated in news but not used in the battlefield. Machine guns and rifles are mounted on a vehicle with a remote controller and can be fired when the controller sees the enemy in sight. So future wars fought by robots is possible. A real robot maid or care-giver does not exist, but many simple functions such as mechanical arm and hand are available. Robot-assisted living is a very interesting subject many people are working on it. The paper reported by Vieira et al. is a typical example in this area. Robot even is used in agriculture field as reported by Li et al. in China [3, 4].

Robot vision is another interesting subject to study; at this moment 3-d vision has been developed and actually applied to unmanned helicopter to detect the overhead power cable as a visual guide to fly [5]. Also 3-d stereo vision is used for nursing robot to take care of elderly [6]. From 3-d stereo vision of nose and mouth, the robot can easily recognize who is the elderly person to be served. Interactive robot is a very hot subject to pursue. Early stage development up to the year of 2015 in the interactive communication is well covered by Marvidis [7]. However, in view of recent development of software 'Dragon' computer can type words by voice commands. And iPhone 7 can accept voice commands to give out information. With a minor modification, robots can accept voice commands and carry out tasks as a real maid is possible in the near future. All of these projects mentioned above are in the developing stage, so there is lots of work waiting to be done. We have lots of work to do [8].

Recent Project

My recent project is entitled 'Gyroscope for Robot to Sense the Balance'. Since a humanoid robot will have structure similar to human, there are many joints in the body, such as neck, waist, hip, knees, and ankle; they can all be used to adjust the balance. It is proposed to use a gyroscope to sense the position of the robot but send the signal to the computer which serves as a brain for the robot just like the vestibular system in the human ears. It is a sensor but not doing the correction directly. Let the computer to decide what the best way to correct the position is. Because the gyroscope is used as a sensor, its weight must be small so its inertia will not affect the motion of robot. So it is proposed that the weight of gyro is within 1% of the total weight of the robot.

Two examples for the motions of gyroscope are studied. In view of these examples and gyroscope used in airplanes, the proposed gyroscope with three degrees of freedom and with a spinning axis in a vertical position perpendicular to the ground of Earth and it is powered by electric power. The rotating speed may be at 6000 rpm. The sensor for the detecting the deviation of the position from its neutral position is in the form of an electric condenser with one electrode on each gimbal and with three corresponding electrodes on the spherical housing of the gyroscope. At the neutral position the capacitance is maximum. Any change of relative position will reduce the capacitance. Each pair of electrodes will make an oscillation circuit, changing of the position of the housing relative to the rotor will change the value of the condenser, consequently will change the frequency of oscillation. The frequency is detected and sent to the computer for the action of correction.

Conclusion

Many jobs in robotics are challenging and exciting. My recent project is just one example in robotics. In general they are in electro-mechanical design. They require innovative thinking and problem-solving. However, those engineers do not develop new theories or new principles. If you hope to create new theories in mechanical engineering you may be disappointed in working on robotics. On the other hand, fundamental theories are not changed rapidly in mechanical engineering anyway. This means that all the science learned in mechanical engineering can be used throughout your life. In the era of robotics, many robots are in the developing state, many robots are to be developed so we have lots of work to do. We will be busy for many years in the future.

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