INVESTIGATION AND DEVELOPMENT OF LIFE SAVING RESEARCH ROBOTS

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This paper investigates life saving and time saving research robots which are installed in industry, military, space, hospital, medical, surgical, home, echo friendly, inspection, public and security system for performing labour and life saving jobs. At present, new types of robots are being developed in laboratories and much of the researches on robotics are focuses not on specific industrial tasks, but on investigations into new types of robots. And also focuses the alternative ways to think about the design of robots and its manufacturing process. The main goals of Research robots such as nano-robots/soft-robots/super-robots/swarm-robots/hap-tic-Interface-robots are as small as viruses, to cure the cancer and protect other sophisticated parts of the human body. The physical structures of these robots are like amoeba, which can move/roll/jump and change its configuration such as assembling and disassembling of its components, which depends on its requirement. It is very difficult to operate accurately therefore increasing the mobility, stability and precision, several smart materials, smart actuators and sensors are to be used to sense and react to the effect of environmental inputs, and to stimulate the devices. It is expected that these new type of robots will be able to solve real world problems when they are finally realized.

Keywords: Nano-robots, Soft-robots, Super-robots, Swarm-robots, Hap-tic-interface robots, Smart actuators/sensors/materials

INTRODUCTION

In this paper life and time saving research robots are discussed. The dynamic response of the control structure of these robots depends on the formation of torque, friction, inertia couple, displacement, velocity, acceleration, coriolis acceleration, external force, centripetal force, effect of gravity, buoyancy force in submerged system, trajectory planning for a given task and precision space input. Nano-robots should be able to sense the obstacles and modify its path to avoid obstacles by (Siegwart and Nourbakhsh, 2004) are finding applications. The wise variety electronic

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devices such as smart actuators, smart sensors, and controllers are used for optimizing the performance of various mechanical components of the selected systems. The micro-controller unit is put together around a central processing unit as the sensors such as displacement, velocity and acceleration sensors are to be used for monitoring the selected system parameters. The signals from electronic smart sensors are to be amplified and converted into digital format by using interfacing electronic devices. There is a rapid growth in the use of smart materials, structures and systems in the current day engineering technology due to their advantages and intelligent features, because these materials that sense and react to the effect of environmental inputs and to stimulate the devices. Several smart materials such as shape memory alloys by (Molfino, 2007; Nagarajan, 2009; and Sait Usha, 2011) are finding increasing applications. The characteristic of these smart materials is that they have the ability to return to their original shape even after several deformations. The shape memory alloys are the metals that can be deformed and then returned to their original shape. The most effective and widely used alloys to improve its material properties such as ductility, high fatigue life and corrosion resistance, because NiTiNol by (Kim and Miyazaki, 1997; and Sreekumar, 2009) are discussed and these smart materials possess a peculiar and unique constitutive behaviour, which strongly depends on the effect of loading and operating conditions. It has the ability to remember its initial shape even after subjected to several deformations and these materials restores to its original condition. The applications of smart materials cover areas such as automobile components discussed by (Schilling and Jungius, 1996) telecommunications, aerospace, structures, space manipulators, planetary exploration control and medical field applications. The actuators developed from smart materials, such as shape memory alloy by (Muthuswamy and Zoppi, 2007) and electro-active polymers by (Sait Usha, 2011) are very much suitable for nano-robots. Haptic Interfaces for virtual environment, teleoperating systems, virtual reality and multimedia are discussed by (Magnenat-Thalmann and Bonanni, 2006; and Endo, 2009). When high frequency actuation is required in nano-robots, the response of shape memory alloy actuators such as piezoelectric material becomes very much suitable, but the strain produced is very low as compared to and electro-active polymers.

NANO-ROBOTS

The advanced technology of creating robots very near to the nanometre scale and constructed from the atomic molecular structure. The advanced researches on nano-robots/nano-bots/nanites have produced by the molecular structure of the complex system. The functioning nano-robot contains nano-sensors, nano-actuators, nano-synthetic molecular limbs, joints, bearings and motors. The nano-robots are as small as blood cells/ Bactria/viruses which would perform the tasks on a tiny scale to cure the cancer, heart, lever, flu, sinus, neurotic problems and release the medicine in a particular place of the human body such as nano surgery on the level of individual cells and utility fog. Some more applications of nano-robots are manufacturing weaponry and cleaning.
SOFT-ROBOTS

Soft-robots contain deformable soft silicon bodies such as air muscles which are made by electro-active polymers, flexible actuators which are made by Ferro-fluids and are capable of different behaviours such as roll and jump on a ground by the deformation of its deformable bodies which are controlled by using, fuzzy logic and neural network locomotion system.

SUPER-ROBOTS

Some researchers have been investigating to creating super robots which can change their physical structure/ sophisticated shape to suit a particular task or situation like the unit of amoeba, which can move/roll/jump and change its configuration which depends on its requirement. That means these super-robots are self reconfigurable robots with variable morphology and that contain nano-autonomous kinematic mechanisms, nano-conventional actuators, nano-sensors, nano-controllers which are able to deliberately change their own shape by rearranging the connectivity of their parts and structure in order to adapt to new circumstances, perform new tasks and recover from facing problems. In these self reconfigurable robots the mechanism and its devices are capable of utilizing its own system of control such as with nano-actuators to change its overall structural shape by the process of set of modules can be added or removed to the system of super robot. The intent is finite nano-identical modules in a mesh of its nano-structure of self configurable super robot.

The self reconfigurable robots allow a robot or group of robots to assemble and disassemble the components of nano-robots to form new morphologies that are better suitable for new tasks such as changing from a legged robot to a snake robot, rolling robot and then to a flying robot. Since robot parts are interchangeable and self repair within a robot and between different robots and also replace faulty parts autonomously. The applications of these robots are envisioned space missions, space exploration and lunar colonization, rescue in mining, underwater exploration, self sustaining robotic ecology such as grow, heal of biological systems.

The challenge key steps in the design of hardware, control algorithms are often intertwined. The design factors which are govern the limits on interface between modules, strength, and precision of robot components, power consumption and its efficiency. The challenges of control algorithms that determine the optimal configuration, time to complete a given task.

SWARM-ROBOTS

The swarm-robots inspired by insects such as line follower of ants and bees which are exhibiting swarm intelligence and modelling the performance of behaviour task of tiny robots. The whole set of swarm robots can be considered as one single distributed system, which are finding something hidden, cleaning and spying. The swarms are like nanocentibots which are used for its collective behaviour and also more resistant to failure, a swarm can continue even if several robots fail and these swarm robots are suitable for space exploration missions.
HAP-TIC-INTERFACE ROBOTS

Hap-tic-interface robots are the specialized robots which are used in the design of virtual reality interfaces and allow touch enabled user interaction with real and virtual environments. These robots are simulating the mechanical and electrical properties of virtual objects which are used in robot rehabilitation process. Multi fingered hap-tic-interface robots are developed for the purpose of multipoint contact between users and a virtual environment, which have a higher potential and allow a user to make natural actions such as grasping, manipulation and exploration of virtual objects. A hap-tic-interface consisting of an arm, fingertips and exoskeleton system of the virtual object which are used in large workspace and the nano-mechanism is mounted on the back of the virtual objects.

LOCOMOTIVE LEGGED ROBOT

In locomotive legged robots set of point contacts are required between feet of robot and ground for sustaining the adaptability and manoeuvrability in rough terrain. The quality of the ground between those points and the robots are does not matter so long as the robot can maintain adequate ground clearance. The locomotive legged robots are potential to manipulate objects in the environment and capable of lifting and lowering the robots in several degrees of freedom. Locomotive legged robots focus on problems of traction and stability, manoeuvrability, and control velocity of the robot in desired cover space.

SPACE LUNAR MANIPULATOR

Space lunar manipulator system is mainly used for satellite development and construction of space stations at outside of the planetary exploration. There are challenging requirements for space lunar manipulators such as maintenance and repair of space stations, inspection of space vehicles, retrieve and exchange of equipment in space. The space shuttle of the planetary exploration is vacuum, extreme hot temperature or cold temperature or the operations are poorly known environment that mean dusty environment, radioactive materials and lower gravity.

SMART NANO-ACTUATORS FOR MOBILE ROBOT

Smart nano-actuators are invisible actuators with nanometre in resolution to achieve the required controllable displacements. The active nano-actuators are nano-magnetostrictive actuators, whereas semi-nano-active actuators are electro rheological and magneto rheological actuators. The shape memory alloy, piezoelectric and electro-active polymers are very much suitable for actuation and simultaneous sensing, the ability of smart materials are return to some previously defined shape and size when subjected to shape memory effect. The properties of shape memory alloy and electro-active polymers are large recoverable strains, high tensile strength, good damping properties, high thermal conductivity, good resistance, less sensitiveness to magnetic resonance, crush recoverability and excellent push ability. The most common smart materials in shape memory alloy actuators are NiTinol. The important factors to be considered while designing a system actuated by shape memory alloy are the shape of the nano-actuator, bias force required for deforming the
actuator, type of fixing the actuator with the structure, type of control system to be adopted for actuation and nano-sensors being incorporated to measure the parameters like positions, velocity, acceleration, temperature, force and resistance. The selection of a particular form of the actuator for a specific task is based on strain, bias force, actuation force, torque and frequency of operation. The actuators are fabricated with many thin layers of dielectric electro-active polymer films that are coated with silver electrodes. The strain produced with these actuators based on elastic stiffness and dielectric constants of electro-active polymer materials. The smart actuators works on the principal that opposite charges attract and like charges repel each other. The smart dielectric material is basically sandwiched between two complaint electrodes. When power is applied to smart dielectric electro-active polymer material, then stress is induced by electrostatic attraction, and this stress causes smart material to get compressed in the thickness and its area increases. The typical electro-active polymer materials are conductive, conjugated, piezoelectric ferroelectric, polymers and dielectric electro-active polymers.

These devices are used in variety of fields such as aerospace for high cycle fatigue test system, high bandwidth in actuator movement of flight simulation, missile fin positioning in aerospace, high frequency servo valves, tuning laser and seeker antennas, astronomy, optics and precision mechanism of sub-nanometre fabrication. The magneto-strictive actuators are made by magneto-strictive materials such as Terfenol-d which is an alloy of terbium, rare-earth dysprosium and iron. These devices are high stiffness in actuation and exhibit good linearity and a moderate level of hysteresis and used in noise free operations, biocompatibility, compact and light weight, insensitive to wide variety of environmental conditions. Shape memory alloys provide greater strains, good linearity, simplicity and having high hysteresis and effective for low frequency vibrations. Lever arm nano-actuator contain flexure hinged amplification mechanism, the nano-actuator sandwich a piezo-ceramic stack and caps of shallow cavities with amplification mechanism to convert the motion generated by the stack to a usable output motion in the transverse direction. The displacement output of the nano-actuator greatly increases with cavity diameter and depth which are used for proof mass actuation, micro positioning, active and passive vibration control system.

SMART NANO-SENSORS FOR MOBILE ROBOT

Smart nano-sensors are smart emitters and smart detectors which are made by smart nano-materials and present on inner walls of slot. They are used to calculate the incremental and decremented change in position and orientation of a vehicle by measuring the number of rotational speed of each of its wheel. The inverse process of actuation makes the smart dielectric, electro-active polymer material to work as the smart sensor. When force or pressure is applied on smart dielectric electro-active polymer, it changes its role and act as a sensor. The input force or pressure on smart dielectric electro-active polymer material, make its capacitance vary and the corresponding effect produces an equivalent electrical output in terms of current or voltage. The smart sensor offers a solution by
integrating the sensor and necessary signal conditioning unit on a single package or on a single silicon wafer. The smart sensor is also posses signal processing capability and have a built in analog to digital converter, microcontroller and memory. Commonly used smart sensors are ultrasonic sensors, laser based sensors, infrared sensors, tactile sensors, vision based sensors and light based sensors which are called integrated smart sensors. These smart sensors emits high frequency sound signal and receives the echo signal from the obstacle for collision avoidance in mobile robots and used in design and development of circuits for distance measurement between a transmitter and receiver, and also used to determine the presence of target of an object rather than to measure the distance, these sensors works on the principle of flight of time.

CONCLUSION

An overview and working principle along with a few applications of smart materials, efficient smart nano-actuators, smart nano-sensors and their performance characteristics, scaling laws, advantages and limitations are discussed in this paper to improve its accuracy, operational speed and flexibility in operation. The characteristics of these smart materials are that they have the ability to return to their original shape even after several deformations. Smart materials have good mechanical properties such as ductility, high fatigue life, corrosion resistance, light weight and easy to activate. The nano-actuators have to be developed from smart materials, such as shape memory alloy and electro active polymers are very much suitable for the design of nano-robots/swarm-robots/haptic-interface robots and these sensors works on the principle of flight of time. These robots are as small as viruses, to cure the cancer and protect other sophisticated parts of the human body, used in nano-surgery. And also these research robots are suitable for space exploration missions, design of virtual reality interfaces and exoskeleton system of the virtual object, space exploration missions, aerospace for high cycle fatigue test system and satellite development and construction of space stations at outside of the planetary exploration.

REFERENCES


