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Small in Size…Yet Big at Work- Role of Microrobot in health care context

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ABSTRACT

Medical robots assist with daily work by relieving doctors from more urgent duties and making medical procedures simpler and less cost-effective for patients. We can also execute tiny places specific surgery and also to transport dangerous substances.

Keywords— *Microrobot, Robotics technology, Medical robots, Robot operating system (ROS), Micro Electro Mechanical Systems, (MEMS), photoacoustic computed tomography (PACT), laser-guided imagery, jet-powered microrobot*

1. INTRODUCTION

Microrobots have shown tremendous ability to take out micro-scale activities, such as the delivery of drugs, cell handling, micro assembling, and bio-sensing. Drops go into the itchy eyes. A ruptured arm goes into a cast. Yet what affects us most is not easily attainable within the body. A treatment such as surgery or chemical therapy may be needed in these cases. A couple of researchers in the Engineering and Applied Science Division of Caltech are creating a new kind of treatment — microrobots that can deliver drugs to exact spots within the body however being controlled and monitored as of the outside the body.

1.1 Types of robots used in healthcare

1.1.1 Surgical Robots

Large manufacturers boost research and development activities in robotic surgical systems. Intuitive Surgical is still leading the overall market, but the landscape is changing rapidly. The entry in the trade of Medtech surgical robotics is enhanced through key manufacturers comprising Johnson & Johnson and Medtronic.

Different product lines for minimally invasive robotic surgery are available from all companies focused on individual therapy areas. Such as, the Vinci Program, is a general operating robot based on a variety of urology, bariatric, and gynecology operations. Also, the Stryker MAKO Program specialized in orthopedic service, in the specific partial and complete replacement of the knee.
Product diversity is the secret to market dominance as every business wants to highlight its own characteristics. Different firms, such as Intuitive Surgical, have strikingly different operating procedures relative to TransEnterix. Both companies offer system-specific robotic operating systems, but Intuitive does not have embedded chips to evaluate the usage of its components, and the attachments of TransEnterix are reusable.

The procedure volumes for robotic surgical operations in the health sector also expand rapidly. The rise in the acceptance rates of robotic surgical systems world-wide is due to this development. As an industry leader, Intuitive Surgical 's global procedures have risen by 32% between 2017 and 2018.

1.1.2 Exoskeletons

Robots can assist with healing and surgery. Cyberdyne's Hybrid Assistive Limb (HAL), for instance, is designed to help patients heal from conditions leading to lower limb disabilities, including spinal cord injuries and strokes, using sensors that are mounted on the skin to detect tiny electrical signals in the body of the patient and respond with joint movements.

Such devices are not inexpensive – the monthly rent for the HAL suit is estimated to be $1,000 and the price will drop as production scales up and components cost of products, including sensors, electronics, and electrical equipment are reduced.

One of the fastest-growing segments of robotics is the exoskeleton market. This requires the lumbar support of bio input for airport and warehouse staff, which is already a popular sight in Japan. Progress in the functionality of the brain system would affect the creation of exoskeletons. Cyberdyne, ReWalk Robotics, and Ekso Bionics are the leading companies in the field.

1.1.3 Care Robots

The number of robots adopted to provide care and support to elderly people and people with disabilities is handled and assisted is currently very small, but is expected to dramatically increase in the coming decade, particularly in countries such as Japan, where the number of caregivers available is projected to be limited. Initial uses of these items are fairly simple, for example by helping people get into and out of bed, but more and more complex research is needed, ranging from reminding patients to take medicine, to manage and engage emotions for those without daily human relationships.

One example of a use for nursing robots is to assist nurses with the multiple tasks they perform every hour. Many of these activities are easy, but important, such as taking blood, temperature monitoring, and hygiene improvements. If robots could perform such basic routine activities, nurses will have more time to concentrate on individualized patient care and schedule treatment. Patients and nurses also obtain assistance in Japan from products such as Robear Japanese developed by RIKEN Research Institute and Sumitomo Riko.

In last years, human support robots (HSRs) have been made by Toyota and Honda. A project of five years was launched in 2016, under the leadership of Gill Pratt, the former Defense Advanced Projects Projects Agency (DARPA), to open and operate two AI/robotics laboratories in Palo Alto in California, USA. The plants were aimed at the HSR division as well as its operation of automotive in Toyota. Honda does anything like that, but the project is Tokyo based.

AIST's Paro is known as a robot for therapy. Paro is a robotic baby harp seal covered in fluffy white fur that shows much of the same actions as a live pet do. It's programmed to be cute that elicit an emotional response in clinics and hospitals.

1.1.4 Hospital Robots

The drugs, laboratory tests, or other sensible material inside the hospital setting can be handled by Hospital Robots like the autonomous mobile robotic robot of Aethon. TUG has an integrated map and an onboard sensor array to navigate. This also has Wi-Fi connections to lifts, automatic doors, and fire alarms.
GE, McKesson, and Siemens also produce hospital robots among the largest medical equipment manufacturers. An outsider for industry, iRobot, is partnering with InTouch Health to develop a robot specifically built for hospital applications.

Robots were designed for disinfecting hospital equipment and appliances. Xenex, a robot maker that sterilizes with pulsed Xenon light also could disinfect the entire room of the patient in less than 20 minutes, is a promising company in this industry. Actually, Xenex partners with more than 400 hospitals.

2. THE ROLE OF MICROROBOT

2.1 Overcoming cardiovascular disease with a magnetically-Steerable Guidewire microrobot

When a surgeon manually controls a guide for a percutaneous operation that exposes obstructed blood vessels to adjust his or her course and position, the rate and speed of operation depended on the operator 's skill. The precise location and direction were hard to control because the surgeon had to manually set and manoeuvre the guide with bent ends through complicated vessels or junctions. Professor Choi 's team has applied a versatile and biocompatible polymer and a neodymium magnet to control the path and location with an external magnetic field, to overcome this constraint. The team built a 500um diameter and 4 mm length cylindrical microrobot and attached it to the end of the guiding thread. They also created a soft guidewire micro-robot to lead the guide to the direction desired by check with the external magnetic field and through a "master-slave" device to allow a straight linear step.

The robot can faster than previous techniques enter the target zone inside the complex blood vessel, which improves surgery performance and efficiency. It also decreases the exposure to radiation from the patient and surgeon, as well as damage to the blood vessel, as the affected site will enter the new system quicker than the current method.

2.2 Microrobots activated by laser pulses could deliver medicine to tumors

Microrobots research studies are jointly undertaken by Wang and Wei Gao, assistant professor of medical engineering, and are planned aimed at the treatment of digestive tract tumors.

2.3 Developing jet-powered microrobots

The micro-robots comprise of magnesium metal microscopic spheres, a material resistant to digestion coated with fine layers of gold and parylene. The layers left exposed to the circular section of the sphere, a type of porthole. The uncapped part of the magnesium responds to tiny bubbles with fluids under the digestive tract. The bubble stream acts similar to a rocket for moving the sphere through the surrounding tissue.

It may be interesting, but not especially useful, magnesium Spherical microrobots that can zoom around. Wang and Gao changed them to transform them from a novelty into a tool for the distribution of medication. Initially, an individual microsphere is sandwiched with its Parylene cover in a drug sheet. They are then covered in paraffin wax microcapsules to shield the microrobots against the harsh stomach environment.

2.4 Laser-guided delivery

A particular stage, the spheres can transport drugs but still do not have the critical capacity for their delivery to a preferred location. To that end, Wang and Gao practice photoacoustic computed tomography (PACT), a skilled technique Wang has developed with infrared laser light pulses. After the diffusion of infrared laser light in the tissues is then absorbed by the oxygen-carried haemoglobin molecules in red blood cells, which results in ultrasonic vibration. Sensors pressing against the skin detect these ultrasonic vibrations.

Data from the sensors are utilized to construct pictures of the body's internal structures. Before this, Wang showed that PACT variability can be used to classify breast tumors. The system has two tasks concerning micro-robots. The first one is photography. The researchers can identify tumors in the digestive tract using PACT and can also monitor the role of microbots, which are highly visible in the PACT pictures.

3. ARTIFICIAL BACTERIAL MICROROBOTS

This micro-robotics are swimming micro-robots that imitate the bacterial propulsion mechanisms using helical filament rotation to generate movement. The future applications for bacteria-inspired microbot systems range from in vivo diagnosis and treatment tasks for monitoring, study, and biological transport of micro-objects and fluid systems for laboratory-on-a-chip devices.

4.THERMO-ELECTROMAGNETICALLY ACTUATED MICROROBOT FOR THE TARGETED TRANSPORT OF THERAPEUTIC AGENTS

This research suggests the targeted carriage of therapeutic agents through thermo-electromagnetically. This microrobot is reduced through UV polymerization in 2D also comprises of an electromagnetically actuated layer (polyethyleneglycol diacrylate dispersed with iron (II, III) oxide and a thermo-responsive layer (N-isopropyl acrylamide).

This robot displayed the capability to capture, deliver, and release anti-cancer medicines (docetaxel) encapsulating with a proper mouse mammalian Tumor cell line concentration in microbeads of about 300 mm of diameter (4T1). The findings of this work show that our thermal-powered micro-robotic motor is appropriate for biomedical use.

5. A NEW MICRO-ROBOT DELIVERS DRUGS IN CAPSULES.

New technology in the healthcare as well as in the medical devices industries has been rapidly emerging around the world and there is active work in the field of high-tech medical robotics, such as microbot drugs or cells that can supply the desired body areas which are actively underway. On the robotic surface a variety of approaches have been implemented until now in many cells and medication-delivery microrobots, they are made into a merge of biodegradable cell or drug material which is released by dismantling biodegradable material; magnetic particles are formed for cell and drug delivery. The drawbacks of given types of robots are that when in external environments robots are run inside the human body, the cells and drugs can be lost.

To resolve these constraints, the researchers created micro-robots of the form of a capsule, combining the structure of the cap that allows the movement of bacterial tails to be opened and closed in the microrobots head, along with encapsulating cells or drugs and a propulsion system. A three-dimensional polymer structure has been developed by the research team using a method of 3-D laser lithography, using techniques adopted by Micro Electro Mechanical System (MEMS). Furthermore, on the surface of capsule-style microrobots was deposited nickel (Ni), a magnetic material, and titanium (Ti), a bio-compatible material, to allow the activity of the external magnetic field.

Cells or drugs may be included in the capsule-type microrobots produced by the investigation team and released at either destination by using the fluid vortex so that cell or drug losses are reduced within the external environment, resulting in appropriate volumes. This result is in usage to treat diseases like as retinal degeneration through controlling low-flow fluids such as the eyes and the brain in the human body. Cells and drugs could be encapsulated at the right locations with the use of microrobots like capsules, avoiding cell loss, and denaturation because of the external environment.

5.1 Advantages

(a) Improving the accuracy
(b) Precise diagnosis
(c) Remote treatment
(d) Augmenting human abilities
(e) Supporting mental health and daily tasks
(f) Auxiliary robots

5.2 Limitations

(a) Malpractice issues.
(b) It's a big drawback in medical robotics that they are extremely costly, takes more time to execute, and is put in the stricter guidelines than other more common methods.
(c) Further, the research costs are quickly added to the study, supplies, training, and many more.

6. FUTURE OF MICROROBOT

6.1 Robotic nurses

Some of these robotic nurses actually easing overburdened nurses, who are the center of life in hospitals, ranging from filling up the automated paperwork to assessing critical symptoms and tracking the condition of the patient, etc. Actual and tactile protheses, bot endoscopy, micro-robot therapy targets, telepresence robot susceptibles, pharmaceuticals, AI diagnostics, robotic-assisted biopsy, AI epidemiologies, antibacterial nanorobots, and so on are only a few of the other developments in robot technology that has been encountered in medicine. When the human mind matures and technical experience increases, people definitely must aspire to create smarter and more competent surgical problems shortly.

6.2 Companion Bots

Companion robots are a blessing to solve all these problems in a single shot if people are subjected to persistent boredom and have little opportunity, such as the elderly, disabled, and others that need daily check-ups.

7. CONCLUSION

Robotics has officially joined a long roster of healthcare skills and career paths that are set for growth in the coming years. Some of the others include pharmacists, registered nurses, dental assistants, and laboratory technicians, among others. Altogether, between 2016 and 2026, healthcare is on track to add 2.4 million new jobs.

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