QUESTIONNAIRE 1 - Prof. ALÍCIA CASALS LECTURES

Computer Assisted Surgery and Medical Robotics

Submitted By

Fakrul Islam Tushar

Submitted To

Cufi Sole Xavier, PhD

xevi.cufi@gmail.com

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QUESTIONNAIRE

Q1. Concept of a rehabilitation robot based on hand held support. Indicate three types of therapy modes

Answer:

Robot-assisted therapy for rehabilitation is a kind of physical therapy, through which patients practice their paretic limb by resorting to or resisting the force offered by the robots. Robot-assisted therapy has been greatly developed over the past three decades with the advances in robotic technology such as the exoskeleton and bioengineering, which has become a significant supplement to traditional physical therapy. Hand rehabilitation robotics focus on the design of structure, actuator, method of control, and so forth to achieve a robotic hand that is more adaptive to the motion characteristics of bones and joints and meets the needs of rehabilitation more effectively [4].

Therapy modes: The movement therapy assisted by the robots can be classified as below

I. **Passive:** In passive therapy modality, the motion of the patient's hand totally depends on the force offered by the robots. According to the continuous passive motion (CPM) concept, the massive passive training would promote the motor recovery.

II. **Active-assisted:** In assistive therapy modality, the patient executes voluntary motion of his hand with the assist of the robots. But the robot would not offer force to the hand until the patient cannot move on its own [4].

III. **Active-constrained and bilateral:** During active-constrained therapy, desired movement was defined by the robot and maximum efforts of the human was needed to reach the target. In active-bilateral therapy, the target arm was assigned by the robot to do the same movement as the contralateral arm [4].

Q2. Principle of an assistant robot for tremor compensation.

Answer:

Tremor is a symptom associated with some abnormal neurological condition related movement disorder, which can affect the head, face, jaw, voice or the upper and lower extremities. Specially it affects the upper limbs. Assistant robot for tremor compensation OR reducing tremor, need to follow the principle of applying viscous or inertial loads and opposing forces to the arm tremor movement.

For example, the WOTAS (Wearable Orthosis for Tremor Assessment and Suppression) device was developed, which is a robotic exoskeleton that can apply dynamic internal forces, i.e., without any external reference, on the upper limb and it will be the platform used to evaluate control strategies for tremor suppression by applying biomechanical loads [1].

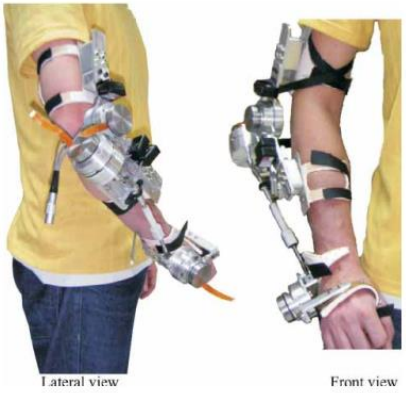

Figure: WOTAS (Wearable Orthosis for Tremor Assessment and Suppression) [1].

Q3. Explain the sensors used to acquire neurological signals in rehabilitation

Answer:

Sensors play very important role in the rehabilitation robot system. The sensor detects information of human to offer feedbacks or control signals to the human or robots. Sensors detecting the bioelectrical signals such as the EEG used to acquire neurological signals in rehabilitation. The EEG and EMG signals are the most representative signal obtained from the brain or muscle.

Q4. Indicate the role of virtual reality in the process of training for the use of a prosthesis

Answer:

Technological advances in prosthetic feild offer dramatically increased possibilities for powering the disabled people worldwide. As like any other tools to get use to with the prosthesis and its controlling need a good amount of practice. Virtual reality environment (VRE) allows the user to practice controlling the prosthesis within a virtual environment, using the same controls used in operation of the actual arm prior to use of the physical arm. Using virtual reality allows introduction to the control schemes and capabilities of the arm system which is very beneficial to the new prosthetic users.

Virtual Reality
CREB-UPC

Figure: Virtual reality in learning prosthesis use[5].

Q5. Perception system proposed for an assistant robot with a mobile base for personal assistance at home. Relate the mentioned sensors and perception systems to concrete tasks.

Answer:

Robots on a mobile base at can assist or work on a foxed workstation or can be use in random places at home. These kinds of robots performed their tasks and interaction based on the activity recognition. Figure below shown the perception system of robots on a mobile base.

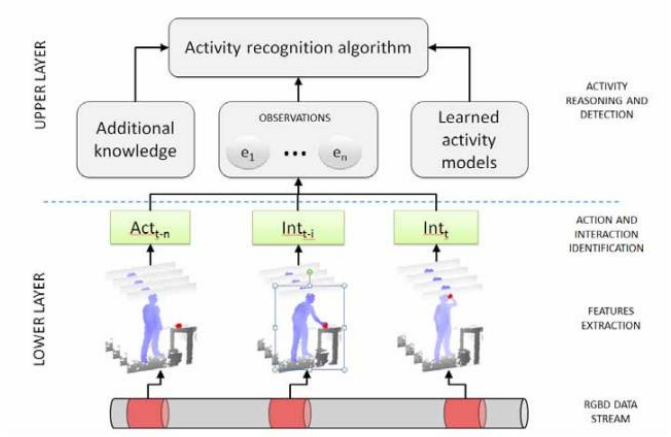

Figure: perception system of robots on a mobile base.[5]

So, the perception systems basically worked in two layers in general.

I. **Lower layer:** In lower layer it acquires the data of its surrounding or workstation in the form of RGBD Data Stream by Kinect or others sensor. RGBD Data Stream basically provide the RGB image of the workstation and the dept of that image. Afterward features were extracted from the data and based on that extracted features it's tried to identify the action occurred.

II. Upper layer: In upper layer the identified actions in the lower layer were analyzed with the activity recognition algorithms based on the learned activity and additional knowledge.

Q6. What's the reason to provide a wheelchair with articulated wheels?

Answer:

Wheelchair is a kind of assistance device provide mobility for the disabled and elderly people. In general wheelchair the wheels are fast on flat ground but have difficulties to deal with the obstacles and stairs which is barrier free environments.

articulated wheels a possible mechanism optimized for wheelchair use and targeted at overcoming the normal wheels shortcomings in case of obstacles and stairs. Articulated wheels improve mobility, stability and climbing capabilities by changing the position and orientation of the wheels for specific purposes.

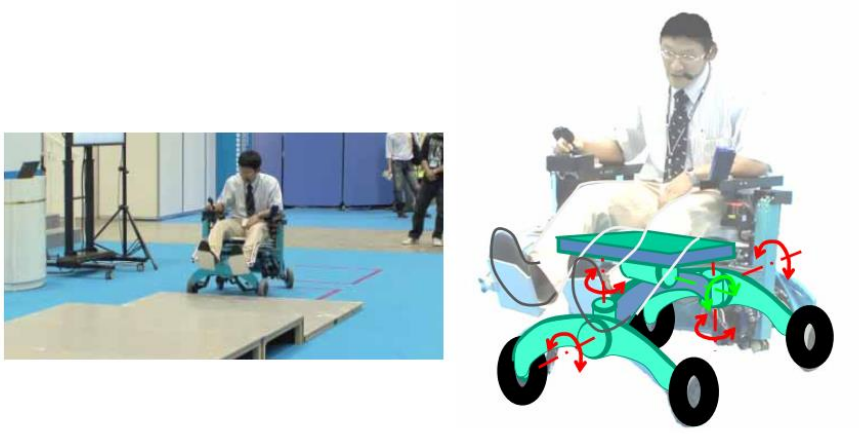

Figure: wheelchair with articulated wheels [5].

Q7. Justify the slower progress of medical robotics with respect to industrial robots?
Answer:

Use of robots in the industrial environment which is common thing for many years compared to the use of robots in medical sector. The figure below showed an overview of the industrial vs medical robots.

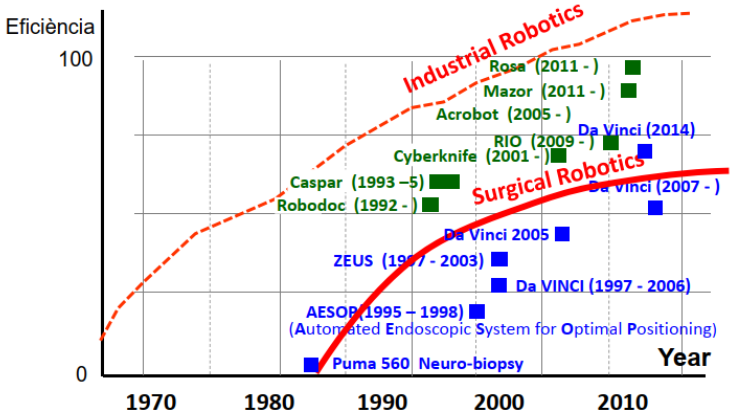

Figure: Industrial vs medical robots [5].

So, well defined progress between industrial and medical robots. But this gap in progress is well justified. In past our society is more focused on the industrial aspect of robotics than medical sectors. Medical robotics field required more precision and accuracy than the industrial field. Robotics in industrial field is comparatively as most of the cases you can control your workstations which is quite uncertain for medical robotics field. Moreover, still medical robotics need to accept by the patients to fulfill the trust and safety issue.

Q8. What are the main requirements of a robot for implanting electrodes in the brain?
Answer:

For personalized therapy sometimes its required for implanting electrodes in the brain. The main requirements of a robot for implanting electrodes in the brain

I. Operation very close to humans.
II. Adaptable architecture
III. Force capability versus lightness.
IV. High monitoring capabilities

Q9. When you would suggest use teleoperation versus programmed robots in surgery?
Answer:
Robot enhance medical surgery by improving repeatability, stability and pression. This precision and repeatability of surgical robots and judgmental capabilities of surgeons make a formidable combination.
Controlling surgical robots can be categorized in autonomy or programmed robots or teleoperation. Programmed robots can be used to plan and execute cutting trajectory for Orthopedic and neurosurgery applications. Teleoperation is soft tissue surgery, where the deformation of the tissue is unavoidable.

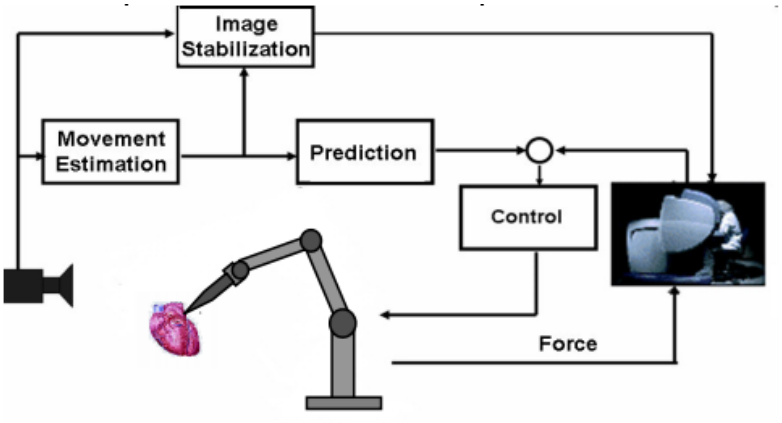

Figure: Shown an overview of teleoperation surgery [5].

Q10. Explain the concept of virtual fixtures and its use in surgery.
Answer:
Virtual fixture is an overlay of augmented sensory information upon a user's perception of a real environment to improve human performance in both direct and remotely manipulated tasks [3]. The virtual sensory overlays can be presented as physically realistic structures, registered in space such that they are perceived by the user to be fully present in the real workspace environment [3].
Minimal invasive endoscopic surgeries result in reduced patient pain and trauma, fewer complication and shorten the recovery time. Although this method includes challenges for the surgeons with decreased visual and haptic information, and significant motion constraints. Robots in the medical surgery provides more precision, repeatability. This precision and repeatability of surgical robots and judgmental capabilities of surgeons make a formidable combination. The goal of virtual fixtures is to provide anisotropic motion behavior to the surgeon’s motion command and to filter out tremor to enhance precision and stability.

Q11. Make a list of the kind of assistance a teleoperated robot can provide in surgery with a short justification

Answer:

Teleoperated robot can solve many of the problems encountered in conventional surgery in terms of ergonomics, dexterity, fine manipulation capability, and haptic feedback capability for the surgeon.

I. **Tremor reduction:** Allow precise movements through scaling the hand motions and filter out hand tremors.
II. **Comfort:** The surgeon becomes less fatigued setting in a comfortable consol.
III. **Added degree of freedom:** Provides surgeons with more degree of freedom in rotation and movement with precision.
IV. **Magnification and better visual contact:**provide anisotropic motion behavior to the surgeon's motion and provide better visual contact.
V. **Good repeatability:** Good repeatability of movements is possible.

Reference:

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[2] Resnik L, Etter K, Klinger SL, Kambe C. Using virtual reality environment to facilitate training with advanced upper-limb prosthesis. J Rehabil Res Dev. 2011;48(6): 707-18. DOI:10.1682/JRRD.2010.07.0127

[3] L. B. Rosenberg. The Use of Virtual Fixtures As Perceptual Overlays to Enhance Operator Performance in Remote Environments. Technical Report AL-TR-0089, USAF Armstrong Laboratory, Wright-Patterson AFB OH, 1992.

[4] Google Books. (2019). *Novel Design and Applications of Robotics Technologies*. [online] Available at:https://books.google.com/books?id=pHdqDwAAQBAJ&pg=PA225&lpg=PA225&dq=activeconstrained+and+bilateral+therapy&source=bl&ots=GWE7BHW1wt&sig=tB2fR9wREOEiU0-cjFXxJO1eJS8&hl=en&sa=X&sqi=2&ved=2ahUKEwipqc3Aou7fAhXRdd4KHZgcBNAQ6AEwD3oECAcQAQ#v=onepage&q=activeconstrained%20and%20bilateral%20therapy&f=false [Accessed 14 Jan. 2019].

[5] Course Slide: *Computer Assisted Surgery and Medical Robotics.*