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Analysis of Stroke Patient Using Linear Robotic Arms with Four Degree of Freedom (DOF) by Using Simulink

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Abstract:. This paper dissaving a bio-mechatronic base designing and fabrication of 4 degree of freedom, focusing on designing shoulder, bicep, lower arms and wrist. The proposed design provided a novel tool upper limb paralyze patient for rehabilitation process. The propose 3D designs of robotic arms are described including an shoulder powered by Direct Current (DC) gearing motor, the actuator DC motor powered elbow and string actuated robotic arms with 2 Degree of Freedom (DOF) of wrist which acts as "slave" controlled by a sensor (Master). The robotics arms incorporates a master and slave system which proven suitable for Mirror Visual Feedback (MVF) therapy experimented on subject toward the completion of this project. There are several robotic arms which is commercially available, however, due to the disadvantage such as weight, expensive and complex mechanism, this research proposed new idea on problem solving by providing as robotics arms which present smart cosmetic, appearance, functional and used friendly

Keywords: Preliminary, 3 Degree of Freedom (DOF) Linear Robotic arms, rehabilitation and Actuator.

1.0 INTRODUCTION

The history of stroke can be tracked back since 2700 years ago, when Hippocrates, referred to as "the father of western medicine" (Grammaticos and Diamantis, 2008, Strong et al., 2007), was the earliest to describe the sudden paralysis which can be associated to stroke, more precisely ischemia stroke (Ashrafian, 2010, Thompson et al., 1996). The main reason of rehabilitation is to assist patients whose suffers from strokes or other injuries to return as much as possible to their previous normal condition through the process of relearning and redefining the knowledge of everyday living activities.

Moreover, rehabilitation also involves the support from family members which plays an important role in improving the process of rehabilitation. With the help of family members, home-based rehabilitation can promote early initiation of rehabilitation which can promote fast recovery. Early initiation of rehabilitation is necessary in order to prevent secondary complications such as contractures and de-conditioning (DeLisa et al., 2004). With the help of rehabilitation, patients will learn to

Understand the difficulties and try to adapt it in their daily lives. Usually in government or private hospitals a group of people comprises of staff with different skills working hand by hand to assist patients on developing and monitoring rehabilitation process is called multidisciplinary team.

These could be a group of specialist physicians from various medical specialties such as occupational therapists, psychiatrist, geriatrics, pharmacology, nursing staff, physiotherapists, occupational therapy, speech and language therapy, and usually a physician trained in rehabilitation medicine (Norrefalk, 2003). There are several more studies which produce the same results which proved that home-based rehabilitation program does not permit loss of improvement compared to supervised hospital-based rehabilitation. Throughout the literature

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review which had been carried out prior to the completion of this paper, there are very few studies concentrating solely on arm rehabilitation processes. This is the main motivation for the completion of this paper which hopefully can contribute on this area.

2. Method

The design of bio-mechatronics robot is a novel robotic arms related on parameter and kinematic during exercise was be analyze. Specially designed mechanism were identified and being under modification compared to the previously designed robotic arms. Fig.1 shows the bio-mechatronic of the robotic arms from the shoulder to the endpoint of wrist. The robotic arms bio-mechatronic has 3 DOF direction of forward and inverse kinematic. These kinematic axis joint provided shoulder dynamic rotation, forth motion, elbow kinematics and wrist movement (up and down). The bio-mechatronic movement design of each axis are shown in Fig.1.

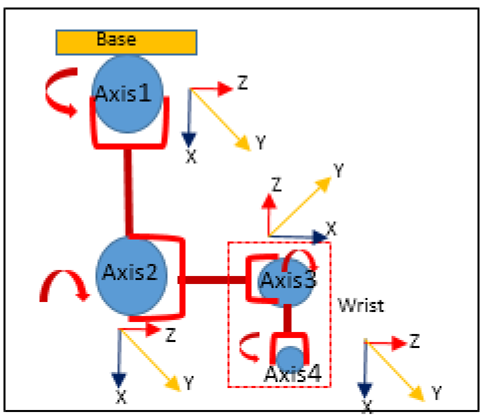

Fig.1: The proposed bio-mechatronics robotic arms joint system.

Referring to Fig.1, the robotic arms has four rotational axis and motion joint. Each joint movement shown in Table 1.

Table 1: Rotation movement of robotic arms.

Axis (joint)	Part	Rotation(°)	Length (cm)
1	Shoulder	0 to 90	30
2	Elbow	0 to 90	28
3	Wrist 1	0 to 45	15
4	Wrist 2	0 to 35	6

Joint 1 in Fig.1 represents, the shoulder base and axis motion is z0 position on the x0 line. Joint 2 is identified as the z1 position on the x1 line for elbow, joint 3 and 4 represent movement of wrist stand of z3 and z4 line on x3 and x4. Each movement involves a number of difference degree of kinematic robotic arms. To have a smooth and safe motion of each joint, gear and mechanical lock system is applied. The limited robotic arms only in this X to Y position. A powerful gear system is undeniably important to efficiently move this robotic or even to carry any heavy loads.

2.1 Robotics Shoulder Design Segment

This is a vital part of robotic arms for supporting the burden of the weight that approximately measured at 10 kg. The structure is made up of steel and aluminum bar which is hard, strong and is suitable to apply to support for the whole robotic arms. The materials can provide a better performance for the shoulder part as it a reliable and durable material to support the design. The shoulder was make from steel and aluminum bar, it can be adjusted according to the length of the patient arms. Fig. 2 shows the design of the shoulder.

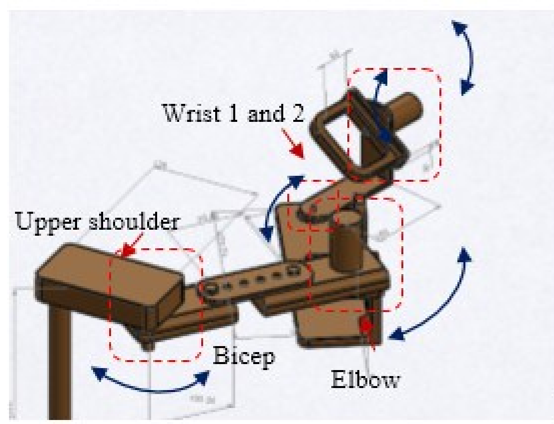

Fig.2: The structure of the upper shoulder

The weight of the robotic arms is (7kg), because the gearing motor and structure of body make from steel and aluminum bar. The torque and the side gears in the motor casing can move to a maximum of 0° until 90° position as shown in Fig.2 in 9V to 12V.

2.2 Robotic Elbow segment

The dimension and illustration of the shoulder, bicep arms and wrist shown in Fig.3. Technically, the structure of elbow is located of direct motor (DC) to control the movement of arms. The elbow and the lower arms with the X to Y axis movement of the biceplimitation

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from 0˚ to 90˚. The bicep consists of the DC motor which is powered in 9V to 12V volt full support by the gearing motor inside the casing of motor.

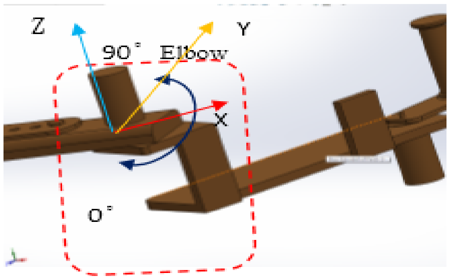
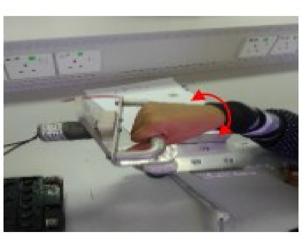


Fig.3: Segment of elbow connected to arms and wrist by pulley and dc motor.

3.3 Robotic Wrist 1 and 2

Fig.4 and Fig.5 show the illustration and kinematics movement the wrist in several angles, which are controlled by the movement of the gearing direct current motor.

Table 2: Difference segment of arms

Movement	Angle (degree)
	Initial position
	45 degree inward
	45 degree outward
	90 degree inward

The fundamental of this kinematics is essential for supporting the shoulder, bicep and arms. The phalanges rotation are designed to have a movement like a human at 0˚ to 45˚.Table 2 shows different segment of patient.

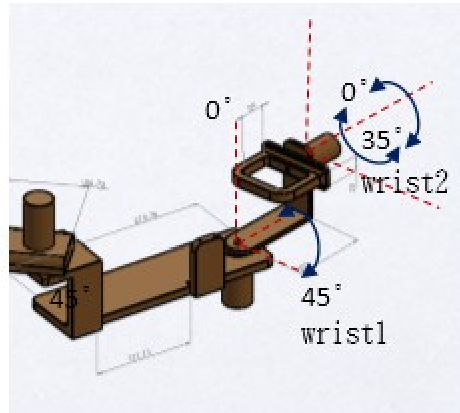
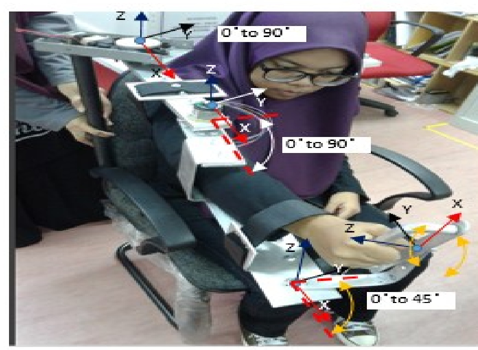


Fig.4: Segment of elbow connected to arms and wrist by pulley and (DC) gearing motor.

3. Result and Discussion

The movement of the each human joint (axes) and elbow area is record and analyzed by the processor in degree by using Engineering Software Kinovea. Than the output from the video will be analyzer by the Matlab Simulink with PID. The graph of the experiment is shown in Fig.6. Fig.6(a) illustrateds angular corresponding between degree of robotic arms bending and Robotic mechanisim.



(a) Bending on angle 90°

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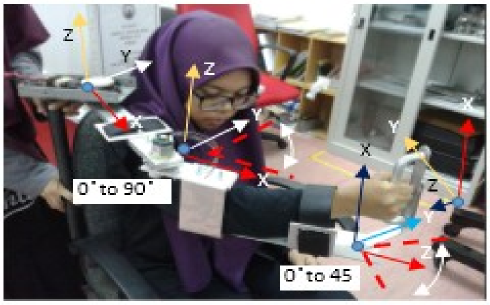
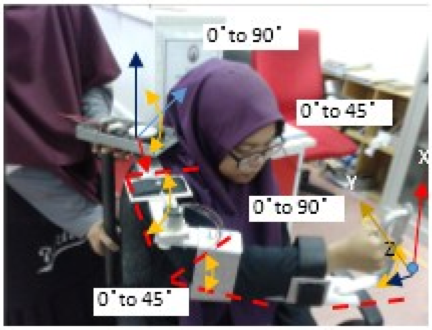


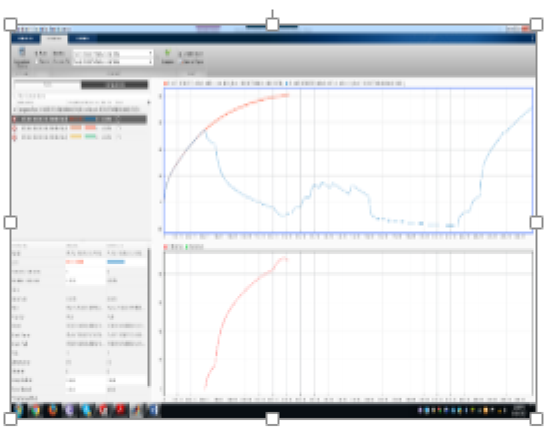
(b) Bending on angle 45°



(c) Bending on angle 90°

Fig.5: The movement of the upper and lower arms for Robotic.

Fig.6 shows the result of degree vs. time(s) output from PID Matlab application shows in Figure 5 (a, and b,). The result displays three graph, for each different angle peaks which is the position where the strength of the robotic arms is at the maximum use. From this signal, it shows that the kinovea records the robotics arms and human arms kinematics in different angle.



(a) Measurement of shoulder

(b) Measurement on elbow .

Fig.6: Data measurement from matlab robotic arms movement.

Conclusion

The robotic arms provide a smooth, more efficient and less painful therapy technique which can improve quality of life and reduce the need for further surgeries. By traditional therapy of patient undergoing recovery, the different therapy treatment groups allow research to evaluate the best course of treatment. The method includes testing three different design i.e. upper limb, lower limb and exoskeleton robotic design and measuring their success with compare to other design. Developed robotic technologies will be able to assist physical therapy protocol in improving totally of recovery.

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