

INVENTION OF A SHOOTING DEVICE FOR PARAPLEGIA AND QUADRIPLÉGIA AND PROPOSING A NEW FIELD OF SPORT IN PARA OLYMPIC MATCHES

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This paper describes the design of a special laser based shooting device designed for paraplegics. The device helps the disabled persons to take part in the sports activities. By this invention, a new field which is shooting is suggested to be included in Para Olympic matches. The device consists of two main parts, the gun and the target. A six link mechanism was designed to carry out the shooting task. Laser localisation and Image processing techniques were used to design the target. The device was built following the above design procedures. After that it has been tested for operation and safety. Also software fitness has been checked considering the ability to save and retrieve the player's data and shooting results correctly. The tests ensured perfect operation of the device in all the above mentioned aspects.

KEY WORDS: shooting, paraplegia and quadriplegia, laser, image processing.

INTRODUCTION: Disabled people, especially paraplegics suffer a lot from lack of activities and mental problems caused from their isolation from society. The idea in this study is to design a device which can be used by paraplegics and quadriplegics to take part in sport activities. This paper describes the design of a special laser based shooting device designed for paraplegics and quadriplegics. The new field of shooting can be proposed in Para Olympic matches by applying the invented device described in this paper.

MATERIAL AND METHODS: The device consists of two main parts, the gun and the target. The main parameters in the design of part 1, the gun, are human factors and its anthropometry; existing motions of the neck, eye, and mandible; weight of the gun; its material; and the safety of the device.

In order to achieve to the desired mechanism, the following factors are considered:

1. Minimization of the driving force.
2. Low weight and low volume, safety, low noise, trustworthiness, beauty, controllability, being easy to manufacture, being easy to assemble, and being easy to maintain.

The selected mechanism is a six link one as shown in figure 1. This mechanism is a combination of a three link mechanism and a cam- follower mechanism. The output of the above mechanism is used to provide the required force to produce an angular motion of the suspended system in a range of 30 degrees. The input of the mechanism is the mandible force and the rotation angle is 30 degrees. The cam is designed based on an involute curve to use a rolling movement.

Laser localisation and Image processing techniques were used to design the target. The matrices of sensors are arranged compressed on a surface next to each other, together with an optical filter (650nm - 700nm). As a result of laser beam collision, a sensor is activated, and finally a DSP circuit is used to display the point of collision on the LCD monitor. In addition to the natural frequency of the laser beam, a 120 Hz frequency is produced by the corresponding circuit to prevent the negative effect of ambient light. The use of optical filters and automatic calibration system, minimizes the percentage of system errors. Image processing software was used to specify the position of laser on the target, the software was written using C programming language. It also determines the mark of the shot based on the point of collision on the target and has the capability of saving the data for every player. The software can be installed on "Windows 98", "Windows 2000", and "Windows XP" environments.

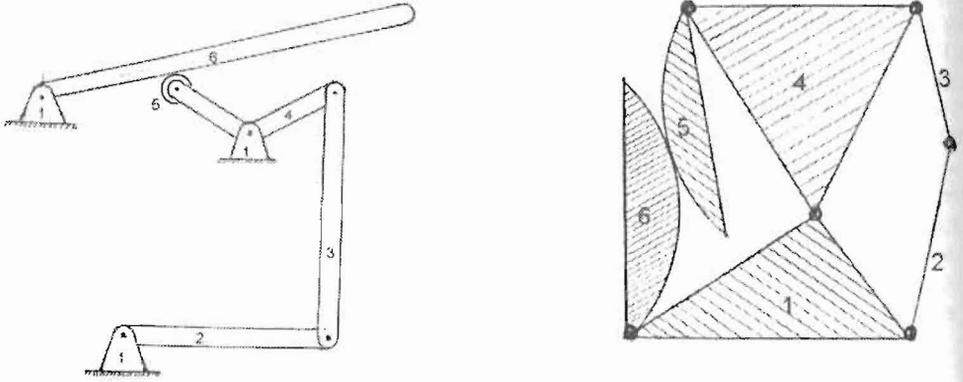


Figure 1: The six bar mechanism used to design the gun.

Table 1 The Kinematics Table.

n	e_I, e_{II}		
1	12	14	16
2	21	23	
3	32	34	
4	41	43	45
5	54	56	
6	61	(65)	

We use the ALT relationship to get the degree of freedom of the mechanism considering the kinematics table:

$$F = 3n - (2e_I + e_{II}) - 3 - \sum fid - S$$

$$F = 1$$

The maximum force is applied at the initiation of motion.

In this case the normal force is applied to link 6 which through link 5, has the shortest distance from the support. Link 6 is subject to the load of the weight of the laser gun, the tube and other parts with the value of 0.4 N. After calculation the following results are obtained:

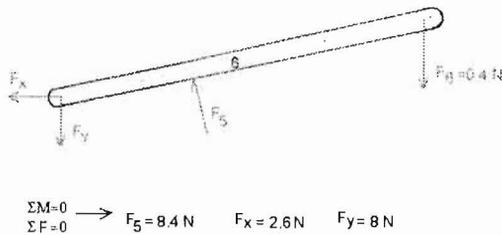


Figure 2: Free body diagram of link 6.

The same procedure is applied to links 3 and 4, and we get:

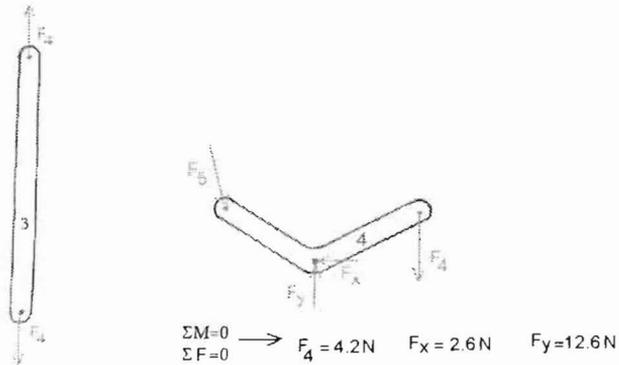


Figure 3: Free-body diagram of links 3 and 4.

Also in link 2:

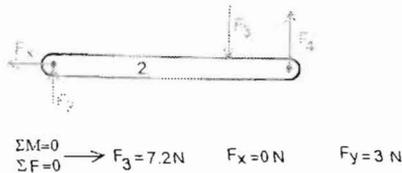


Figure 4: Free-body diagram of link 2.

F_3 , is the force applied to the lower mandible when working with the device. The safety factor of 15% is considered for applying dynamic forces to the system. Therefore the maximum load to the lower mandible will be 8.2 N, which is less than 5% of chewing forces.

RESULTS: The device was built following the above design procedure. The materials are selected as Polyethylene Foam and Polyethylene HD. After that it has been tested for operation and safety. The test of operation ensures correct pointing of the gun, target factors being the same as laser collision points, and the same target output as the point of laser collision. Also software fitness has been checked considering the ability to save and retrieve the player's data and shooting results correctly, selecting the number of shoots, audio/visual display of shooting action and collision, declaration of final results, comparison of current record with the highest record, operability in "Windows 98", "Windows 2000", and "Windows XP" environments.

Safety of the device was checked regarding the electrical currency, laser light, mechanical and biomechanical defects resulted from the device operation.

DISCUSSION: The test results were satisfactory and reproducible as it was repeated several times with the same subject and on different subjects

CONCLUSION: The New Shooting Device can be conveniently used by the disabled people. A new field can be introduced in the Para Olympic games by applying this invention. This can provide a competition spirit within the disabled people and make them feel better regarding their role in the society.

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