Multipurpose Voice Controlled Wheelchair

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***Abstract*—This paper touches the life of people with various kinds of disability; especially quad-paralysis patients who need help at every step. Multipurpose voice controlled wheelchair is the best solution for those people. The wheelchair can serve the patients daily needs without continuous help from others. All commands are implemented just by the patient voice orders. The novelty of this wheelchair lies in its ability to turn into a bed, can rise up by 100cm, can move everywhere and at any direction, have a fan in the seat to refresh the air to protect the patient from ulcers and finally the patient and his family will not suffer any more from going to the bathroom or when taking a shower.**

Keywords—component; quad paralysis patients; Voice controlled Wheelchair

I. INTRODUCTION

The number of paralyzed patients who are dependent on others due to loss of self-mobility is growing with the population, especially in the Palestinian Territories. Mobility is the most prevalent disability and affects 48.4% of disabled individuals in Palestine [1].
There exist in the past literature various types of methods to allow individuals to manipulate and operate their wheelchairs such as follows:

A. Sip-and-Puff breath delivery controlled wheelchair

This type of wheelchair is commonly used by individuals who have lost all motor functions below the neck. Air pressure is used to control wheelchair by sipping and puffing. The chair is controlled with the help of normal inhalation and exhalation of breath. Sharp sips and puffs can be used to change the speed and direction of the wheelchair. Steering is accomplished by lower-level sips and puffs [2, 3].

B. Tongue-controlled Wheelchair

The Tongue drive System holds promise for patients who have lost the use of their arms and legs. The system is controlled by the position of the user's tongue. A magnetic tongue stud lets them use their tongue as a joystick to drive the wheelchair. Sensors in the tongue stud relay the tongue's position to a headset, which then executes up to six commands based on the tongue position (left, right, up, down, single click and double click) as shown in [4].

C. Eye movement controlled chair

Eye movements are translated to screen position using an optical type eye tracking system [5]. When a user looks at an appropriate angle, the computer input system will send a command to the software based on the angle of rotation [6-8].

In our research we opted for the choice of voice recognition technology. Statistics shows that the majorities of disabled people have lost their jobs and income sources due to their disabilities and therefore can't afford most of smart wheelchairs available in the market in overpriced rates. This is why voice-recognition technology was the best choice to achieve our goals due to its low cost and wide spread availability of its commercial hardware and software and it's the perfect solution for people with disabilities especially quadriplegia who can't move their extremities.

II. SYSTEM DESIGN

We designed the wheelchair in a smooth mechanical way by using SOLIDWORKS [9] to get the final 2D form as shown in Fig.1 and then we use ANSYS [10] to analyze the amount of system durability.

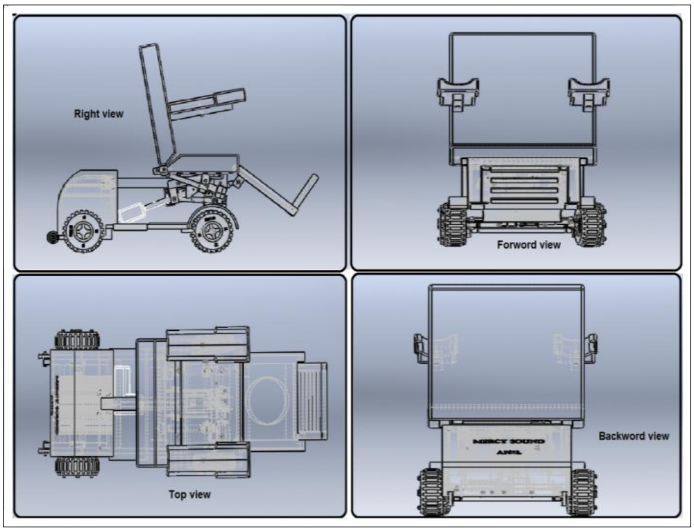

Fig. 1. The electric wheelchair 2d drawings.

A. Stress analysis

A stress analysis study was made on some specified structures and parts of the system based on the system specifications such as net weight, body weight and system dimensions.

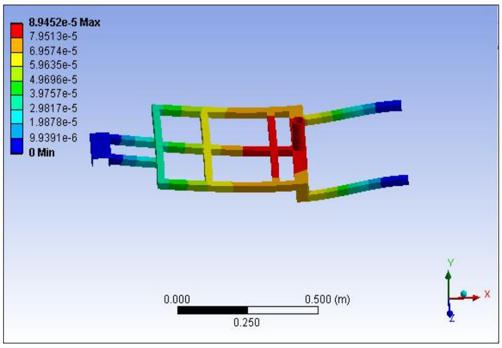

Fig. 2a *Main Structure total deformation*

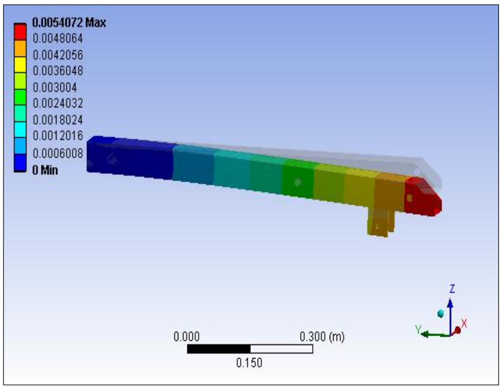

Fig. 2b *Holder analysis total deformation*

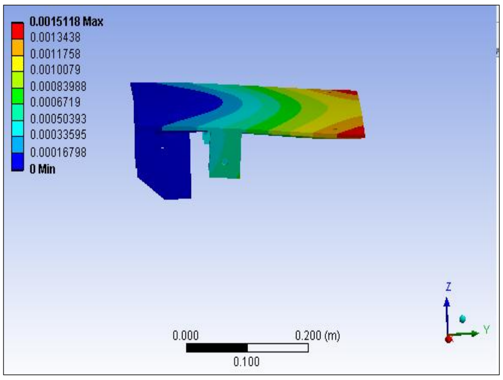

Fig. 2c *Seat structure total deformation*

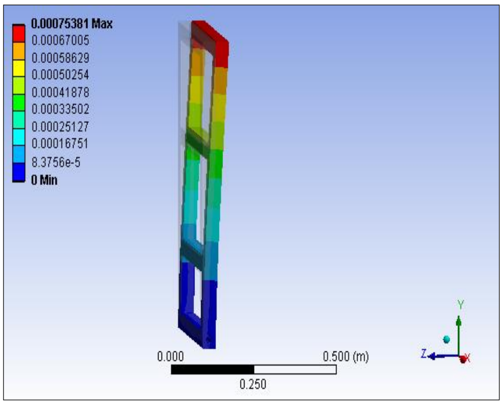

Fig. 2d) *Back seat structure total deformation*

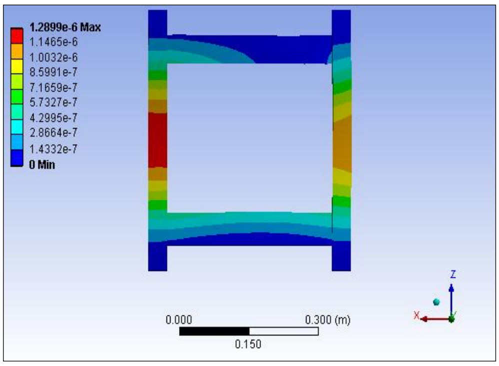

Fig. 2e *Leg rest total deformation*

From the results obtained in Fig. 2, the design will be strong enough to carry maximum weight of 150 kg.

The system is provided with multiple safety devices as listed below:

1. A belt: Fixed around the patient back to protect him from falling.
2. Emergency switch: When the patient pushes this button all motors will stop.
3. When the system takes the bed position the system stop moving.
4. The hand rest designed as a concave shape to avoid hand slides.
5. Adhesive phosphor tape glows in the dark.

B. Selection of motor

To select a motor, we need to find the power needed to lift a weight (up to 240 kg). Due to the design when the wheelchair start walking using the following equation.

$$T = F \times r \qquad (1)$$

Where T is the Torque driving the motion, r =0.13cm is the radius of the wheel and F =706.32N is the applied force, this will lead to a Torque of 95.3N.m

The required power is calculated as follows where ω is the angular velocity

$$P = T \times \omega \qquad (2)$$

P= 219.9 W and by using a safety factor of 1.5 the required power will be 329.88 W. After searching for motors we have used a 500 W dc motor.

Fig. 3 describes briefly the modes of operations of the wheelchair while Fig. 4 illustrates the system mechanical components.

Fig. 3 a) Normal mode

Fig. 3b) Sleep mode

Fig. 3c) Stand up mode

Fig. 3d) Toilet Mode

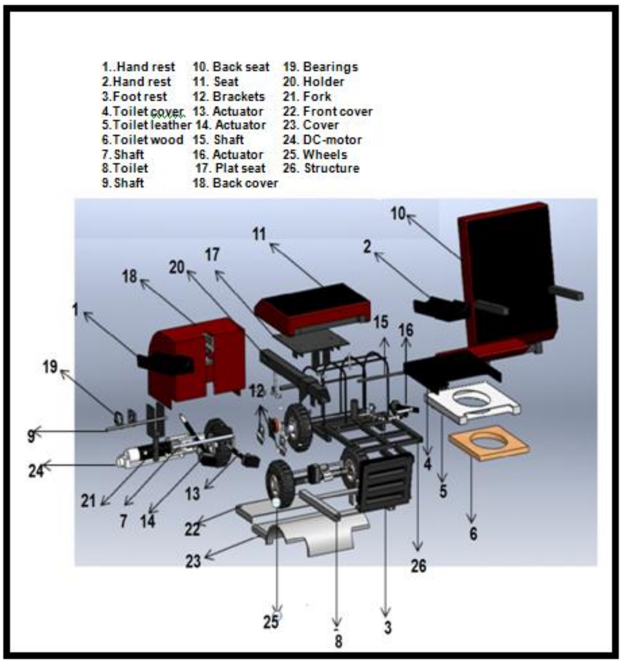

Fig. 4. Wheelchair Components

III. CONTROL AND SOFTWARE

The project aims at controlling a wheelchair by means of human voice. Arduino Mega microcontroller is the brain of the control circuit [11]. The voice recognition is done by an EasyVR voice recognition module [12]. Fig. 5 shows the block diagram illustrating the process. The whole system is initiated by taking voice commands from EasyVR. The voice recognition EasyVR is capable of operating in speaker independent voice recognition mode. In this mode, at first, the voice is recorded at EasyVR libraries with the help of a directly connected microphone at the Microphone signal input (J11) of the EasyVR keeping the mode selection key in the record mode, after training the voice recognition, the mode selection

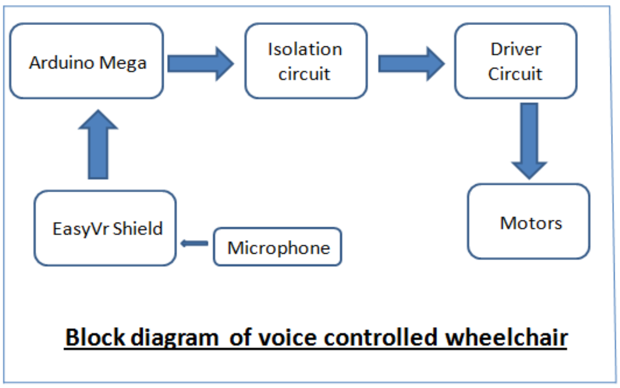

Fig. 5. Functional Block diagram of voice controlled wheelchair

key is switched to the voice input mode. Here the speech through the microphone at a particular instant is compared with the recorded sound and according to that digital output is generated.

The output of the voice recognition IC is then fed to the digital input ports of the Arduino Mega microcontroller. On receiving the signal, the microcontroller directs the motors through the control circuit. The speed and direction controls are also done in this way.

IV. CONCLUSION AND FUTURE WORK

The project objective of building a wheelchair that is fully controlled by the user voice commands was achieved. The project built is now able to receive the user commands, analyze them and make the decision of movement accordingly. The project can be improved by adding more useful sensors, we can also add massage feature to the back and body and we can also add heating in the chair.

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