

# Optimization of Four bar Linkage Mechanism Using Mat Lab for Standing Wheelchair

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**ABSTRACT:** A person with leg disability may have to use a wheelchair for his entire life. Using conventional wheelchairs he spends most of his time seated in one position. Having no power in their legs to support the body weight, the standing wheelchair provides them the capacity of attaining the standing posture, all by their own. A standing wheelchair has a four bar linkage that can elevate the user to a standing position. The objective of this project is to build a completely manually operated standing wheelchair targeted for household use. The main parameters of consideration are safety, comfort of the user and cost of the wheelchair. The remaining parameters considered are portability, ease of use, maintenance and durability of the product.

**KEYWORDS:** conventional, four bar linkage.

## I. INTRODUCTION

For initiation of the wheelchair design, one must be clear of the basic user requirements, which serve as a starting point. These values are determined by user analysis and targeting the product for certain use. The given wheelchair is targeted for household use only. Thus the parameters targeted for designing the wheelchair are based on viewing the use of wheelchair from the perspective of a regular household user. Losing the standing ability gives rise to many physical as well as mental health related issues such as sore body, building of pressure points in body, lowered blood circulation due to lack of movements, dependence on other people for basic needs etc. A standing wheelchair provides a solution for these problems by giving standing ability to the wheelchair user. Mainly focuses on three things. They are i) Customer requirements ii) Engineering specifications iii) Design characteristics. The selected design was given dimensions using ergonomic data available on the internet as well as comparing with the existing wheelchairs. Thus some of the main dimensions were fixed using this data. The knee supports are to be added to the design as the handicapped person has no control over the legs. Also belts would be added to the seat and backrest to firmly bind the person to the chair in standing position.

The benefits of standing wheel chair:

- i) Standing enhances circulation and blood pressure
- ii) Standing improves respiration and voice control
- iii) Standing stretches muscles, preventing the onset of contractures
- iv) Standing increases bone density and reduces the risk of fractures
- v) Sitting or lying down for too long is a known cause for fatigue. Standing up helps exercises these muscles and reduce fatigue.
- vi) Wellbeing is dramatically increased by using a standing wheelchair. You can be on “the same level” when talking or communicating as others.

Various Mechanisms used for lifting the wheel chair:

- i) Pneumatic Linkage Lifting Mechanism
- ii) Screw-Scissor Lifting Mechanism

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iii) Four bar linkage mechanism.

Screw – scissor mechanism:

The scissor mechanism can be harmful to the user if not properly enclosed.

Pneumatic Linkage Lifting Mechanism

The system is difficult to operate by the user.

Four bar linkage mechanism:

The mechanism is very simple with low cost and ease to operate by the user.

**II.CUSTOMER REQUIREMENTS**

Table 1: Customer requirements

Standing wheelchair customer requirements	
Categories	Customer requirements
Safety	No harm to user Stable
Mechanism Functionality	Manual powered Quick height change Durable
Wheelchair Functionality	Same personal mobility as standard wheelchair Able to transport tools Easy to Operate
Geometry	Fit in factory aisle Achieve average person's height Comfortable
Budget	Low cost

**III.ENGINEERING SPECIFICATIONS**

Table 2: Engineering specifications

Standing wheelchair engineering specifications		
Engineering Characteristics (EC)	Specifications	Units
Number of exposed dangerous moving parts	0	#
Elevating velocity range	0.01- 0.15	m/s
Time to reach maximum possible height	<20	Sec
Number of electrical components	0	#
Maximum storage weight	3.5	Kg
Seat dimensions - (L x W)	L = 0.43 W = 0.40	M
Wheelchair dimensions - (L x W x H)	L= 1.70 w=0.65 H=1.60	M
Mass of wheelchair	<25	Kg
Maximum weight to be elevated	100	Kg

#### IV. DESIGN CHARACTERISTICS

Table 3: Design characteristics

Design Characteristics		
Engineering Characteristics (EC)	Specifications	Units
Wheelchair dimensions - (L x W x H)	L= 1.70 W =0.65 H=1.60	M
Maximum weight to be elevated	100	Kg
Seat dimensions - (L x W)	L = 0.43 W = 0.40	M
Mass of wheelchair	<25	Kg
Time to reach maximum possible height	<20	Sec
Number of exposed dangerous moving parts	0	#
Elevating velocity range	0.01- 0.15	m/s

#### V. FOUR BAR MECHANISM

The four-bar mechanism, in its simplest form, has four bar-shaped links and four turning pairs. In a four-bar mechanism, one of the rotating members usually is the driver and is called the crank or driver. The other usually is called the rocker or follower. The floating link that connects the crank and the rocker is called the connecting rod, and the fixed link is called the frame.

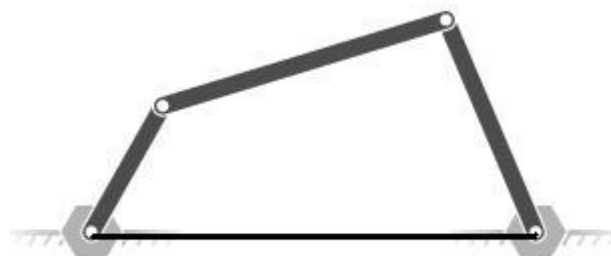


Fig.1.Four bar linkage mechanism

#### VI. LINK LENGTH DETERMINATION

MATLAB code is used to find the link bar lengths.

##### 6.1.MATLAB CODE:

MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment and 4th generation programming language. Developed by Math Works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of interfaces, and interfacing with programmes written in other language. Computer animations are valuable tools for demonstrating and teaching dynamics of mechanisms. Several software packages are commercially available to aid in this effort. The work presented in this paper is intended to complement,

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the animation capabilities of existing soft-ware by using the MATLAB programming language to animate a specific four-bar linkage.

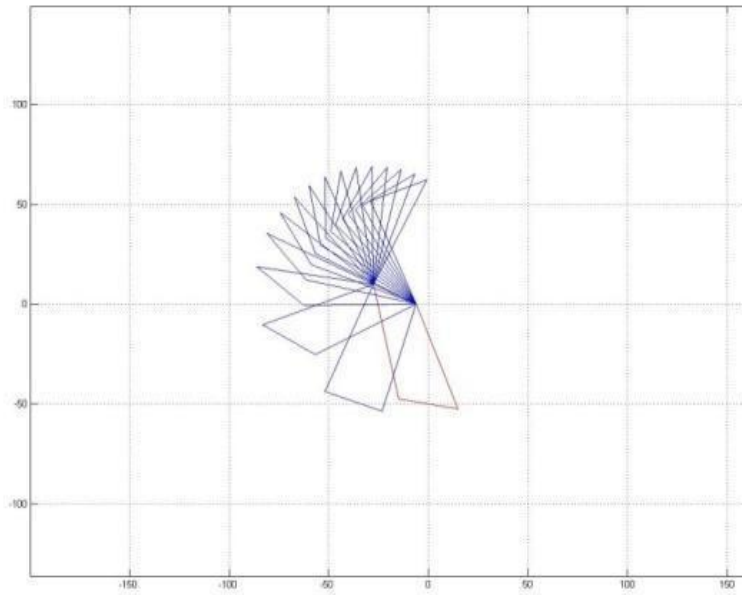


Fig.2.Optimization image

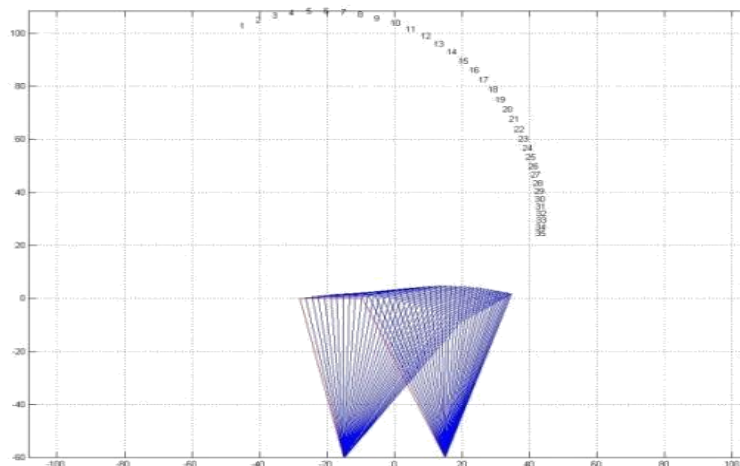


Fig.3.Optimization image

## VII. FOURBAR STRUCTURE

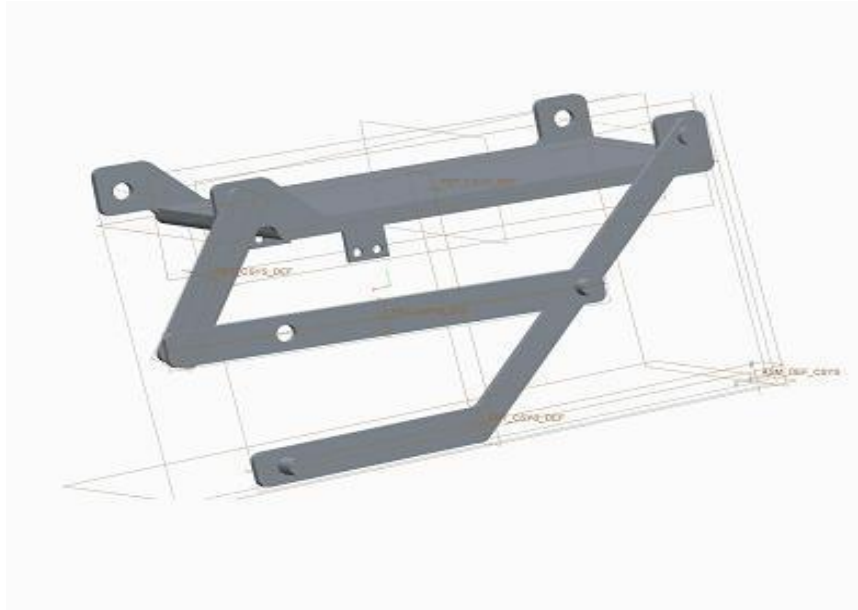


Fig.4.Four bar structure

## VIII. CONCLUSION

Manual wheelchairs provide the user with mobility in a seated position; however, there are many compelling reasons for enabling wheelchair users to stand.

The functional benefits of standing include:

A raised and enlarged workspace.

Allowing easy use of kitchen counters and appliances and access to overhead cabinets.

Being able to stand may thus increase independence and enhance employment and leisure opportunities.

Standing also has physical benefits—reducing the risk of osteoporosis, muscle spasticity, and contractures; improving cardiovascular, digestive, and renal function; and relieving or preventing pressure sores. Perhaps equally important are the psychological benefits: when standing, wheelchair users can interact with others eye-to-eye; they do not have to always look up at the rest of society, or have everyone literally look down on them. We optimize the four bar points using mat lab code and get the ultimate lengths and using the link lengths and design the four bars which is used in standing wheel chair.

## VIII.FUTURE DEVELOPMENTS

We can modify the standing wheel chair and make a stretcher arrangement in the same wheel chair. So the wheel chair is used in sleeping and standing positions.

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