Adjustable Hand-cranked Tricycle for Mobility Disabled

Aditya Soni, Ramanathan Muthuganapathy, Sandipan Bandyopadhyay

Abstract

Manually powered hand tricycles are commonly used vehicles used by the mobility challenged for conveyance and transportation in India. However, the existing models are inadequate in many essential features. The authors have developed a new design, which can be configured according to the user's requirement and comfort. The features that are adjustable are the driving mechanism, seat height, and inclination, back-rest inclination, and foot-rests. Telescopic tubes are used in all the modular features.

Keywords: Tricycle, Wheelchair, Mobility-disabled, Physically-disabled.

1 Introduction

Studies have indicated that arm-crank propulsion is superior to hand-rim propulsion in terms of mechanical efficiency and cardio-respiratory response [1]. However an arm-crank propelled tricycle must also be ergonomically suitable and comfortable to the user during all operations such as mounting, dismounting, and, riding which includes sitting, pedalling, steering, and braking. A mobility challenged user may have different needs arising from his stature, nature, and extent of the disability, age, gender etc. For comfortable experience, the user will prefer a customized design. For e.g. the user would want the seat at preferred height, inclination of seat and back-rest at a specific angle, the placement of the crank at a certain location, positioning of the foot-rests at required distance from the seat. A study by Faupin et al. emphasizes significance of suitable configuration to minimise injuries to upper extremities [2]. But practically, it is not possible for every user to have a custom made tricycle, due to many constraints, major one being cost. Therefore a solution lies in a tricycle with adjustable features.

Existing tricycles and wheelchairs were extensively studied [5]. Suggestions were taken from the users and the requirements pertaining to safety and comfort were considered. Prior to this design, two prototypes were developed and tested. Feedback from the users who participated in the test indicated need for an adjustable design. Following features are made adjustable:

1. Drive mechanism
2. Seat
3. Back-rest
4. Foot-rests

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2 Description

2.1 Drive mechanism

The modular drive mechanism is shown in fig. (1). The tricycle is propelled forward with the chain drive, provided on front wheel. The crank-pedal assembly is mounted on a five-bar mechanism with two degrees of freedom. The crank-pedal assembly can be positioned to the desired location by controlling the two degrees of freedom.

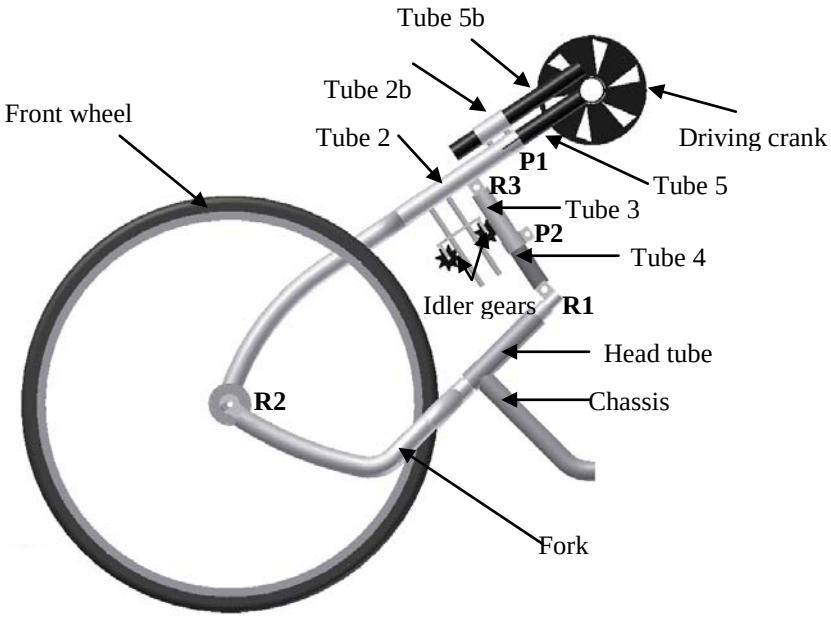

Figure 1: Drive mechanism

2.1.1 Longitudinal variation

The crank-pedal assembly is welded to tube-5, which can slide longitudinally along tube-2 such that tube-2 and tube-5 form a telescopic mechanism. Tube 5b, is welded at certain spacing, parallel to tube 5 which slides along and is inserted into stubbed length, tube 2b, which is welded with tube 2, at certain spacing. The prismatic joint between tube-2 and tube-5 is indicated by P1. The translational degree of freedom between tubes forming the telescopic mechanism is removed by tightening the clamp provided at P1.

2.1.2 Angular variation

One end of the tube-2 is pivoted at front wheel axle by a revolute joint indicated by R2. Tube-2 is connected with tube-3 by a revolute joint indicated by R3 and the fork is connected with tube-4 by a revolute joint as indicated by R1. Tube-3 and tube-4 form another telescopic mechanism in which tube-3 can slide along tube-4. The prismatic joint between tube 3 and tube 4 is indicated by P2. The angular position of

tube 2 can be changed by adjusting the length of the telescopic mechanism. Changing the angular position of tube 2 effectively changes the angular position of tube 5. The translational degree of freedom between tubes forming the telescopic mechanism is removed by tightening the clamp provided at P2.

2.1.3 Idler gears

A pair of idler gears is provided so as to keep the chain taut. The idler gears are mounted on fixture which has two holes. A pair of parallel bolts passes through the holes. The position of idler gears can be adjusted by sliding them along the bolts. The fixture can be affixed by the pair of two nuts sandwiching the fixture.

2.2 Seat

The design permits to change both the height and the inclination of the seat. Refer fig. (2). The rearmost part of the seat frame is pivoted on the bolts, inserted into holes provided on the flat, rectangular pieces of metal, welded with the tubes of the chassis. The holes are provided longitudinally (Ri) on the flat metal piece with certain pitch.

The tubes are at certain angle with the vertical so that increase in height of chair will bring the chair horizontally closer to the rear axle. This is to ensure reaction forces increase on the rear wheels to counter increase in moment due to centripetal force during cornering. The moment due to centripetal force increases with increase in height of centre of gravity, which would increase with increase in seat height. Additionally this arrangement will create more leg space more of which may be required by a person preferring seat at more height.

The front part of the seat is supported on two identical telescopic tubes on either side. The left telescopic tube as shown in figures 2 and 3, are pivoted with seat frame and chassis at R2 and R3 respectively. Length of telescopic tubes can be set as required depending upon height and inclination of the seat. Length of the telescopic tubes can be fixed by tightening the clamp provided at P.

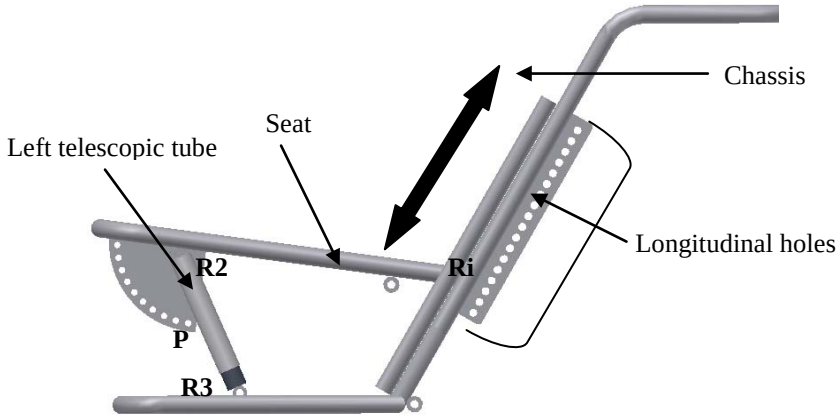

Figure 2: Seat at lower height

2.3 Back-rest

Refer fig. (3). The bottom ends on either sides of the backrest are pivoted on the same bolts, indicated by Ro where the seat is pivoted. The side tubes of the frame of the back-rest are extended towards bottom. At the centre of the bottommost tube of the frame, indicated as R1, one end of telescopic tube is pivoted. Another end is pivoted at tube welded with the frame of the seat, indicated as R2. The seat frame, back-rest frame and the inner and the outer tubes of the telescopic mechanism comprise a four bar mechanism with three revolute joints and one prismatic joint. The inclination of the back-rest with the seat can be changed by adjusting the length of the telescopic tubes.

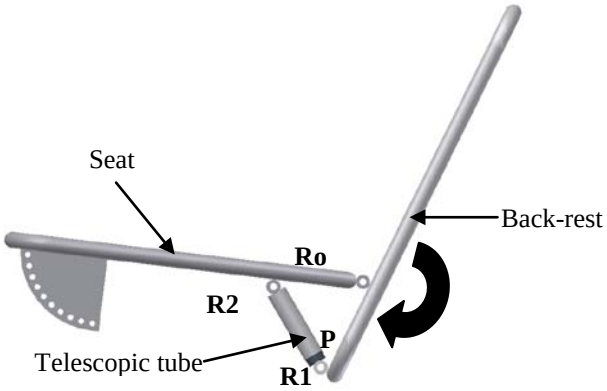

Figure 3: Back-rest at steeper angle

2.4 Foot-rests

The foot-rests are independently modular. Both length and the inclination of the foot-rest can be changed. Refer fig. (4). The length is made changeable by employing the telescopic mechanism.

Two flat metal plates are welded with the frame (for two footrests). Hole O is drilled and around this a number of holes are drilled circumferentially along section of a circle with O as centre. The top end of tube-1 is pivoted at O. The tube-1 is therefore free to rotate about O and its angle can be adjusted. Position of tube 1 is affixed by bolting it with one of the holes drilled circumferentially (Oi) on the flat metallic plate.

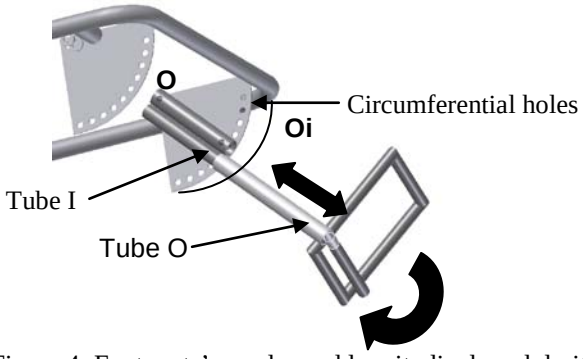

Figure 4: Foot-rests' angular and longitudinal modularity

3 Conclusion

In this paper, a methodology for a tricycle with adjustable features has been provided. The design shows that adjustability can be achieved without loss in features. The fabrication of the prototype is in progress.

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