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A retrofit design of safety and stability mechanism for two wheelers

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Abstract. This paper presents an idea of a retrofit design of a mechanism which helps in achieving the safety and stability of the two wheeler vehicle. The aim of the mechanism is to avoid the two wheeler from fall/skid and also work as an attachment for physically challenged drivers. The mechanism is a hydraulic system clubbed with linkages, where an extra two small sized wheels are grounded to provide safety from fall and give stability to the two wheeler. The proposed retrofit mechanism would replace the double stand of the vehicle. These extra wheels move along with the vehicle, hence providing the required stability. This forms a replacement of the costly attachments which the physically challenged drivers add to their vehicles. The shock absorbers would be included accordingly in the mechanism. The probable improvements on deploying the said mechanism on a two wheeler will provide easy riding, as the vehicle self-stabilize itself when the small wheels are grounded. This helps the less abled riders to easily ride the vehicle with no worries of grounding their feet. A number of designs were developed, studied and three designs were shortlisted based on the feasibility of the mechanism. Finally, a better design is proposed for further improvement and implementation.

1. Introduction

In present day scenario, transportation has become integral part of human civilization. Road transport has always been the dominant mode of transport in India, both in terms of traffic share and in terms of contribution to the national economy. Hence, to meet the demands of road transportation a big network of road connectivity has been led and is still growing. The harmful part of the growing road network along with motorization and urbanization is the increase in road accidents and crash fatalities. Today, road traffic injuries are one of the leading causes of death, disabilities and hospitalization in the country imposing huge socio-economic costs. It has been observed from the survey that out of all road accidents, two wheelers take the major share with around 35% [1]. Many accidents are due to the negligence of the two wheeler drivers and others due to the skid of the vehicle or fall due to imbalance. Figure 1 shows the vehicle topple due to skid, fall due to imbalance, etc. [2]





Figure 1(a). Vehicle fall due to skid/due to imbalance [2]



Figure 1(b). Vehicle fall due to slight collision [2]

In another angle, for a physically disabled or a debilitated person, transportation is a major hindrance and so the mobility of physically disabled people is among the great concern of the human civilization. It is really very hard to realize the problems of a physically disabled person who has a limited mobility. In India, the contemporarily modified scooters used by the physically disabled people for transportation are not very ergonomic and have oversized attachments. The modification done to the scooter is heavy and also expensive. These attachments also reduce the efficiency and performance of the vehicle. Figure 2 shows a few conventionally modified scooters for disabled people.



Figure 2. Conventionally modified scooters generally used in India [3]

It can be observed that the modified attachments are heavy and huge and also occupy more space. This becomes difficult for others while driving besides these vehicles. Hence to avoid this difficulty and also to prevent the two wheeler fall due to imbalance and skid, a retrofit solution needs to be developed. In this paper a feasible retrofit mechanism for scooters is proposed. This mechanism will behave like a supporting stability device which would not allow the vehicle to topple down. The main objective of a self-balanced two wheeler vehicle is to ensure safety of the rider and vehicle. This can be achieved if a retrofit stability mechanism is developed which can balance the vehicle.

2. Literature Review

Every year Government of India does survey on number of accidents (Road Transport and Highways report on Road Accidents in India), the survey of year 2015 and 2016 showed that around 29% and 36%, respectively were the accidents caused by two wheelers [4]. So, the safety and stability mechanisms and/or other safety measures need to be implemented in order to reduce the number of accidents and quantum of injuries.

Significant literature is available in which various designs for a modified scooter are presented. Few works concentrated on the two wheeler seating design changes. Neville [5] in his thesis studied the basic principles of two wheeler seating & positioning of kids and youth with physical disability. Based on his examination of various literatures the author compiled the better designs and proposed best principles for seating of disabled kids and teenagers. An overview of the normal and abnormal seating postures was also examined. Chandore and Deshmukh [6] presented an extensive review on cushion foam and seating structures. In general, about the seating designs for a two wheelers. The work examined included, the finite element simulation of the vibration of cushion foam and the supportive structures of the seat, along with the human buttocks' soft tissues in the seated position. They examined and analysed the various studies of other researchers that might facilitate redesigning or modification, assessment and examination of the seats of two wheeler riders for greater comfort while riding.

The other major design study on two wheelers which concentrated on safety was carried out by Kumar et al. [7]. The author and team designed a three-wheeled vehicle for easy riding, for physically challenged people. The work introduced two design concepts named as Sholay and Chariot. Further, Sholay design was propagated as it proved to be a better design. Once the detailed design was performed in CATIA, the ergonomic issues of the model were carried out using Jack software. Finally, a working prototype model was developed.

Rumi et al. [8] proposed a design of a self-balancing two wheeler vehicle where they have used the gyroscopic principle. An android application was deployed, which measures the tilt angle and takes it as an input. This input (tilt angle) taken from the gyroscope is further sent to the receiver. Further, the Arduino controls the motor based on the received data, which further control the tilt direction of the two rotating disks of the self-balancing mechanism. This vehicle is designed to provide the safety that two wheeler vehicle does not have during an impact or at zero velocity.

There was a US patent entitled "Motorcycle safety device" [9]. In which a safety frame was designed where the rider could be saved from major injuries caused by the impact. The safety device or the exterior frame envelops the rider during impact and reduces the quantum of injuries.

To the best of the author's knowledge there has been no reporting on retrofit safety solution for two wheeler skid or fall due to imbalance. But a lift mechanism was observed in a "Scalevo" an electric wheel chair design [10]. In this design, two small sized wheels are drawn downwards so that the wheel chair is lifted up. This mechanism also helps in mounting the ramp of the wheel chair, so that it can climb the stairs. In this paper a similar concept of extra two wheels are used for the stability of the two wheeler vehicle. The conceptual design of the stability mechanism has been generated, which can be attached such that two extra wheels (small sized) are grounded and the balance of the vehicle is achieved.

3. Modelling and Design of the Stability mechanism

In this section, we mainly discuss the designs of the stability mechanism which are proposed and would be fitted under the scooter for balancing of the vehicle. Various designs are generated and then their comparison is done on the basis of their attributes in order to propose the best design concept.

3.1. Design Type-I

In this design concept, a hydraulic system is clubbed with a linkage mechanism. As the cylinder extracts the linkage is moved downwards where the wheels attached to the links touch the ground. These wheels touching the ground provide the required stability to the vehicle. Figure 3 shows the conceptual design of the stability mechanism. This design concept focuses on basic functionality rather than the ergonomics and external factors induced on it. It features a spherical joint on each side above the wheels

to provide better maneuverability in case of vehicle imbalance. The wheels are designed in such a way that a straight path be maintained during skidding and the speed can be reduced due to friction between wheels and road. Figure 4 shows the detailed drawings of the Design type-1. The major advantages offered by this design is easy to produce the components and simple assembly with economic installation.

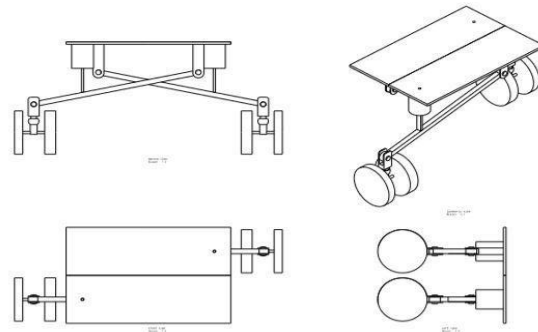
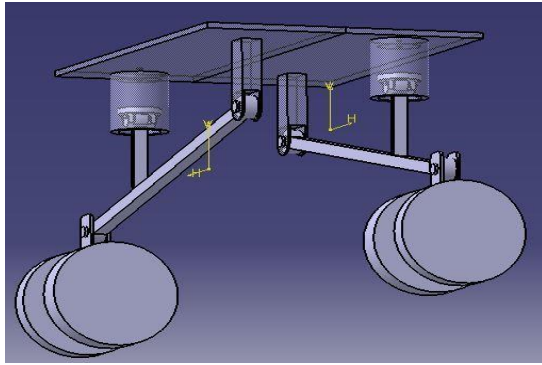


Figure 3. CAD Model of Proposed Design Type-1 **Figure 4.** Drawings of Proposed Design Type-1

However, the disadvantages of this design include more technical aspects such as the torque would be generated on the wheels, as they engage with the road. Synchronization of both the pistons when extracting the wheels will be critical. If synchronization is not proper than imbalance of vehicle will be caused. Wear associated with the wheels' outer surfaces as the wheels engage during vehicle motion. Also, vibrational jerk would be induced when the mechanism is engaged while traveling at high speeds.

3.2. Design Type-2

This design was conceived with the aim of replacing the vertical actuation of the piston with horizontal actuation to increase the vertical usable area of the apparatus. This was achieved using a 3bar linkage to convert horizontal motion into rotational motion. The output link of the 3-bar linkage was connected to a collar which would slide over the rotary arm resulting in extraction or retraction of the arm, two hydraulic piston and cylinder arrangements were mounted on the collar to pivot the wheels about a joint on the arm (as shown in Figure 5).

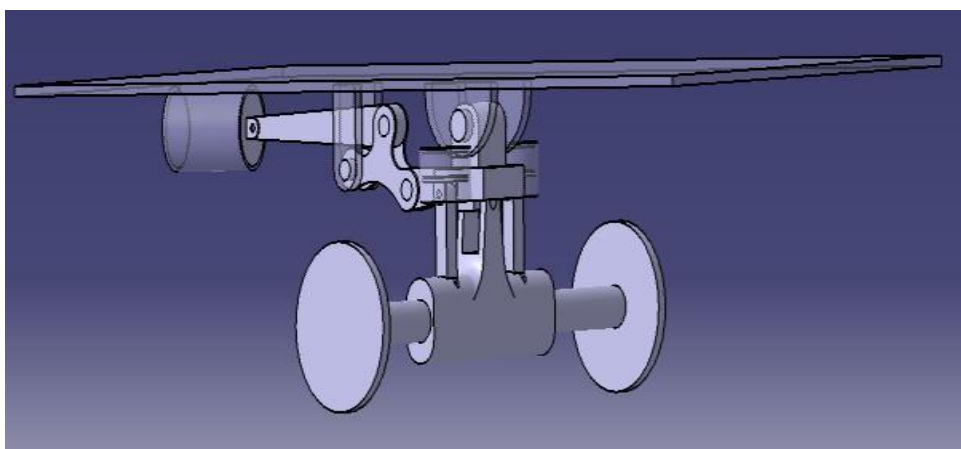


Figure 5. CAD Model of Proposed Design Type-2

This design aims to save space while obtaining the same functionality offered by the previous design. It also addresses the flaws faced by the previous design. The pivoting half of the rotary arm would provide better control on uneven roads and absorb shocks caused due to impact. The use of a single cylinder also eliminates the synchronization issues faced by the previous design. Figure 6 shows the detailed drawing of Design type-2.

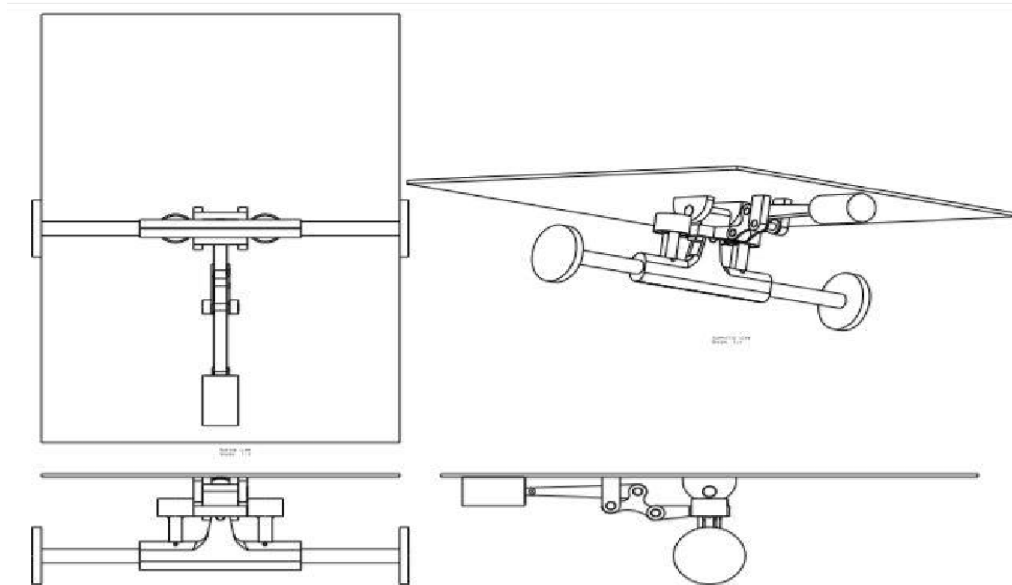


Figure 6. Drawings of Proposed Design type-2

Major advantages of this design are the increased features, better control and increased safety. The disadvantages of this design are higher cost, manufacturing of complex parts, difficulty in designing the 3-bar linkage and its installation.

3.3 Design type-3

In this design horizontal actuation was switched with vertical actuation yet again to simplify the design, reduce of cost and decrease the number of moving parts. This design can achieve a balance between the simplicity of the first design and functionality of the second design. This design only involves 4 moving elements i.e. arm, connecting rod, piston and wheels (as shown in Figure 7).

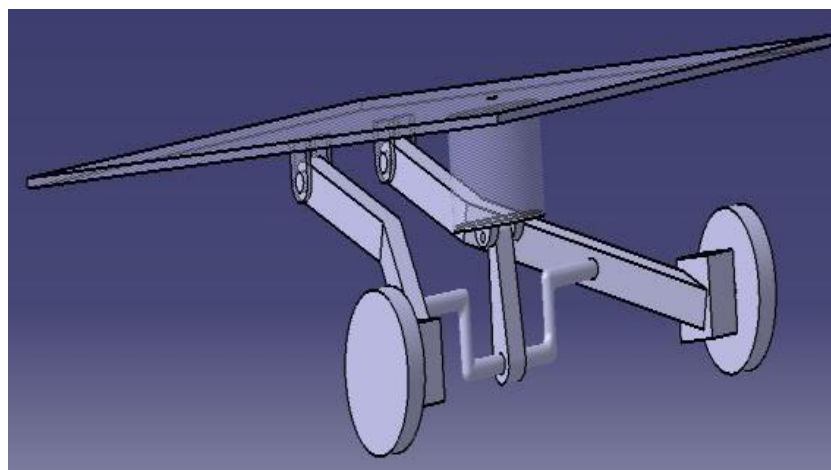


Figure 7. CAD Model of Proposed Design type-3

This design features complete retraction of the wheels up to the platform. It also replaces the double stand of the vehicle, as the wheels in extracted position would behave as the stand for the vehicle. This design achieves complete retraction by virtue of a U-shaped bar connected to both the arms and also connected to the piston via a connecting rod into which a shock absorber could be integrated. Figure 8 shows the detailed drawing of the Design type-3.

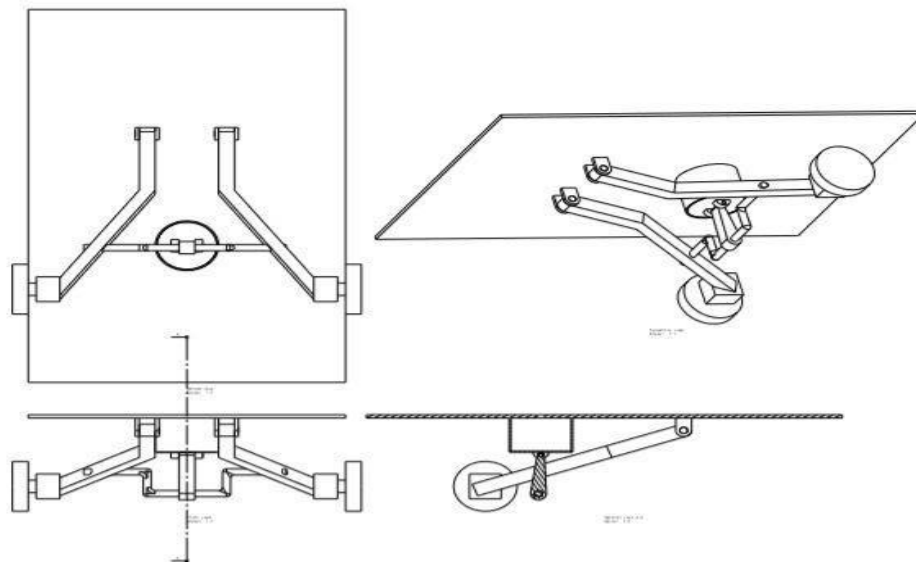


Figure 8. Drawings of Proposed Design type-3

Advantages of this design include easy installation, simple and low number of parts, lower costs, easily reproducible and no requirement of synchronization of the hydraulic system. This system currently has limited disadvantages related to its practicality and life.

Based on the comparison of all the three designs, Design type-3 proves to be the better and simpler to install. This system has been the better concept, as it provides the required functionality with less problems. Whereas, the practical applicability needs to be tested. The mechanism will be fitted below the vehicle thus the clearance between the vehicle and the road will be reduced. The efficiency of the vehicle would reduce a little, as extra weight is being added to the vehicle. Also, if the road conditions are not good and/or bumps are present, then the mechanism may face slight problems. However, these problems can be solved with proper shock absorbers and slow riding in typical conditions. Practical testing will be carried out further on the mechanism (Design type-3).

4. Conclusion

The proposed mechanism is basically on the concept to avoid the fall of a two wheeler vehicle and also form a replacement for the physically challenged drivers. The mechanism will help the two wheeler rider to ride the scooter without worrying about the stability of the vehicle. It was observed that Design type-3 provided better functionality and is easier to install compared to other proposed designs. However, practical testing needs to be performed for further implementation of the mechanism. The idea of the retrofit stability mechanism is a new viewpoint and will provide greater advantage in reducing the quantum of injuries, fatalities in the present two wheelers.

References

- [1] "Deadly afternoons: 35% of road accidents in India reported between 3pm and 9pm"[Online]. Available: <https://www.hindustantimes.com/india-news/deadly-afternoons-35-of-road-accidents-in-india-reported-between-3pm-and-9pm/story-FlxcGYsmGc62GLHjHtCuTL.html>

- [2] “Motorcycle Accident: Statistics, Reasons, Common & Severe Injuries, Protective Measure, Role of Attorney”[Online]. Available: <https://www.epainassist.com/personal-injury/autoaccident/motorcycle-accident-injuries-statistics-role-ofattorney>.
- [3] “Modification of Vehicles for Physically Handicapped.” [Online]. Available: <http://bajeasons.blogspot.com/>.
- [4] T. Dawda, “Two-wheelers and commercial vehicles see highest road accident fatalities,” *AUTOCAR, Professional*, pp. 1–3, 2016.
- [5] L. Neville, “The Fundamental Principles of Seating and Positioning in Children and Young People with Physical Disabilities,” B.Sc project thesis, University of Ulster, 2005.
- [6] A. S. Chandore and T. R. Deshmukh, “Design of Two Wheeler Seat: A Review,” *Int. J. Pure Appl. Res. Eng. Technol.*, **vol. 2, no. 9**, pp. 450–458, 2014.
- [7] S. B. Kumar, K. V. Banthia, and K. A. Ray, “Design of three wheeler vehicle for physically challenged people,” *Sas Tech J.*, **vol. 12 (1)**, pp. 80–89, 2013.
- [8] S. Mohibul, I. Rumi, M. F. Hossain, I. S. M. S. Islam, and K. Rahman, “System Design of Two Wheeler Self-balanced Vehicle,” in *10th France-Japan/8th EuropeAsia Congress on Mechatronics (Mechatronics-2014 - Tokyo)*, 2014, pp. 331–336.
- [9] J. J. Bouvier, “United States Patent 4227717- MOTORCYCLE SAFETY DEVICE,” 1980.
- [10] S. Smith, “Scalevo, An Electric Wheelchair, Can Climb Most Staircases And Hopes To Negate The Need For Ramps And In-Home Lifts,” *Medical Daily*, 2015.

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