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Automatic Side Stand Retrieval System

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Abstract - *Two-wheelers are a very important part of our lives but also responsible for some minor and major accidents because most of the riders forget to stow the side stand to the riding position causing fatal accidents and injuries. About 40 percent of accidents happen due to the parked position of the side stand of the two-wheeler. According to research, there are 2300 two-wheeler accidents reported by over every million people in India. In which every 300 victims die at the site or during the medical proceeding. Forgetting to stow the side stand of the two-wheeler is one of the frequently done mistakes of the two-wheeler riders. These accidents can be prevented by using an automatic side stand retrieval system in two-wheelers. In this, a simple rack and pinion assembly is used to stow the stand when the rider starts the vehicle. The system will monitor the angle of the vehicle from the vertical axis and engine RPM with the help of a gyroscope and a photoelectric sensor. When the angle of vehicle is less than 15 degrees and the engine exceeds 1600 RPM the motor will receive power and the stand will be pushed to its riding position. The design and analysis of rack and pinion is done in Solidworks and Ansys workbench respectively. For manufacturing of rack and pinion and casing EN24 and Aluminum 6061 is used respectively and also achieved FOS of 1.5 for fatigue life cycle of 10^6 hrs. By using this method the rider will never have to worry about the stand ,and this will make sure the safe ride.*

Key Words: **Two-wheeler, Side-stand, Stove, Rack & Pinion, Interlocking, Reminder device, Clutch, Engine, Fatigue, Spring, Gyroscope**

1.INTRODUCTION

In the present developed world, two-wheelers are a very important part of our lives. It is very economical in comparison to cars. We all know, side stand in any two-wheeler is very important for instant parking. But, if the side stand is not used properly it may cause serious injuries and may also cause the death of the rider. In a developing country like India, accident rates have increased by a huge number. So, it is necessary to prevent such accidents by using some technological measures. The current technology of the side stand is manual, where the riders have to stow the stand by their foot before riding the bike. Though the riders most frequently forget to stow the side stand. To avoid this mistake, an automatic side stand retrieval system is introduced in this paper. The system is an attachment to the existing stand, which uses a rack and pinion assembly to stow the stand. This system will be operated by a DC motor which will take power from the battery of the vehicle. The system is small, light-weight, cost-effective, and also compatible with all types of two-wheelers (bikes and scooters).

Automatic side stands retrieval system uses very few components which makes it cheap to manufacture. And since rack and pinion are used, the durability of the system is also assured. This system will activate upon switching the bike on.

2.HISTORY

There are some concepts to avoid accidents, but those concepts are either indicative or a hindrance to the rider's comfort. Some of the concepts are –

2.1 Instructional Methods

Every motorcycle manufacturer has warned the riders in the owner's manual that:

"Forgetting and leaving the side stand down while riding could cause an accident. "OR "Before starting, turn back the prop stand fully to its normal position."

2.2 Reminder Devices

Reminder devices inform the rider that the side stand is down. They do not, however, physically interfere with the operation of the motorcycle. Most people are familiar with the buzzer used in the automobile to remind drivers of unbuckled seat belts or a key left in the ignition. Lights are used to inform truck drivers of insufficient air pressure, which may reduce the braking ability of their vehicle. Recently, side stand warning lights on the motorcycles' instrument panel have been introduced.

The 1982 Kawasaki KZ 550GP, warns the rider that the side stand is down by turning instrument panel lights on and off. In 1977, Marion Z. Miller patented a device for actuating the motorcycle's horn if the side stand is down, the ignition is on and the motorcycle is in the driving position. ("Safety Device for a Motorcycle," U.S. Patent No. 4,016,538.)

2.3 Interlocking Systems

Interlocking systems prevent the operator from riding the motorcycle with the side stand in the parked position.

- In 1977 Shimanto Takshi patented a "Safety Device for a Motorcycle," U.S. Patent, 4,010,379, assigned to Kawasaki Jukogyo Kabushiki Kaisha, Japan.
- The 1981 Moto Guzzi Convert contains an electrical switch that prevents the engine from starting with the stand-in parked condition. The side stand also activates a cable-operated parking brake while in its parked condition.
- The Yamaha XJ 750J Model engine will not run with the side stand down unless the transmission is neutral.

2.4 Correcting (Passive) System

A correcting system will raise the forgotten stand to the stowed position without the driver's action.

Types of correcting systems

2.4.1 Type I

These type of correcting system contains an auxiliary mechanism that raises the stand either before or at the very beginning of the motorcycle's forward motion.

- An automatic side stands return mechanism is described in the 1977, 1978 Kawasaki KZ-400 service manual. This mechanism is actuated by the movement of a pin mounted on the engine sprocket. If this sprocket rotates with the side stand down, the sprocket pin pushes a lever that, in turn, swings the side stand up through a rod and a drive lever.
- A clutch activated mechanism has been used by Kawasaki on the 1983 AR125 LC and the 1984 KE-100 models. This mechanism retracts the side stand as the clutch lever is depressed.
- Bernd Hofman, in the 1964 East German Patent No. 18123 – "Motor scooter stand with safety provision" – Proposed a lever attached to the gear shifter shaft which contacts the side stand when first gear is engaged. This causes the side stand to rotate about its pivot to a point at which the tension spring can pull the side stand to its raised position.

2.4.2 Type II

These correcting system uses the friction forces between the stand and ground generated by the motion of the motorcycle at operating speed to retract the stand.

- The Harley Davidson design is an example of such a system. This 192 patent(W.S. Harley & Arthur R. Constantine, U.S. Patent 1,675,551) describes a stand of simple construction that will automatically lock itself inoperative position when the cycle is leaned to a parking position and which will automatically become disengaged when the bike is again brought to a riding position. If the operator forgets to move the support or stand to the inoperative position, the first obstruction met, or the making of a turn to that side upon which said support or stand is located will knock back said support or stand to its inoperative position."
- The Honda rubber-tipped stand is another type II correcting System. The Honda Patent(1975 Sato Minoru, et al. – "Side stand for Motorcycle," U.S. Patent 3,918,743) describes "Side stand for a motorcycle wherein an auxiliary member is provided at one side of the side stand in a length which stretches fairly beyond the contact surface of the side stand when the motorcycle is set upright for running. Whereby, even if the rider forgets to retract or level the side stand, frictional contact between the bottom tip end of the auxiliary member and the ground surface causes the side stand to be retracted automatically while running.

2.4.3 Type III

These devices utilize the ground friction force to retract the stand at the very beginning of motion. The BMW patented the design (Gunther Baron – "Side stand for a Motorcycle," UK patent application GB 2079698A, filed May 1981, by BMW). A Side stand for a motorcycle comprising a member. A free end of the side stand member can move upwardly, whilst in the parking position, relative to the motorcycle also against spring force over a limited angular extent. The side stand member makes contact with the ground when that member is at the lower extreme of the said angular extent with the motorcycle upright the side stand member is retracted automatically when the motorcycle starts.

These all systems are either been used in very expensive vehicles, cause discomfort to the rider, or are not efficient enough for every vehicle.

3. COMPONENTS

An automatic side stand retrieval system is designed with the thought of a system that should be effective and cheap at the same time. Hence very basic components are used for its construction. The components used are:

- Photoelectric sensor
- Gyroscope sensor
- Microcontroller
- Voltage regulator
- Relay
- DC motor
- Rack and pinion assembly
- Feedback Switches
- Battery (Vehicles already have)

The system is designed such that it takes engine rpm and vehicle angle as input signals. The controller controls the motor with the help of relays, which displace the rack connected to the side stand.

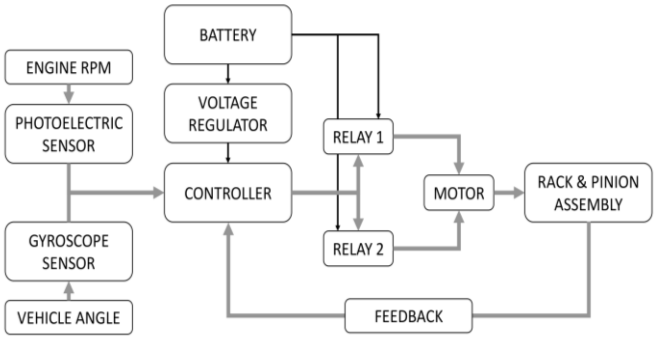

Fig -1: Block Diagram of the automatic side stand retrieval system.

4. DESIGN

The design consists of an assembly consisting of a dc motor and rack & pinion assembly. Here, the motor has to overcome the spring force of the side stand, therefore it is required a geared dc motor.
Firstly, the spring constant of springs used in different two-wheelers was measured by Hooke's Law. For every spring the spring constant was in the range of 24.0 N/mm. From here the torque required to stow the side stand was calculated.

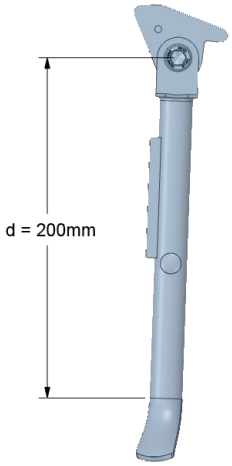

Fig -2: Side stand of a motorbike.

Let,
T = torque required to stow the side stand,
P_s = force required to stow the side stand,
d = distance at which force is applied from the pivot point.
δ = deflection in the spring
From test
Ps = 80 N

d = 200 mm (0.2 m)

So,

$$T = P_s \times d$$

$$T = 80 \times 0.2$$

$$T = 16\ Nm \qquad \text{.....(i)}$$

Secondly, the motor is selected such that it can provide the necessary force on the stand to stow it back at the riding position.

Fig – 3 DC motor (12V)

Thereafter, rack and pinion assembly is designed in Solidworks which will convert the rotatory motion of the motor to translatory and will push the stand.

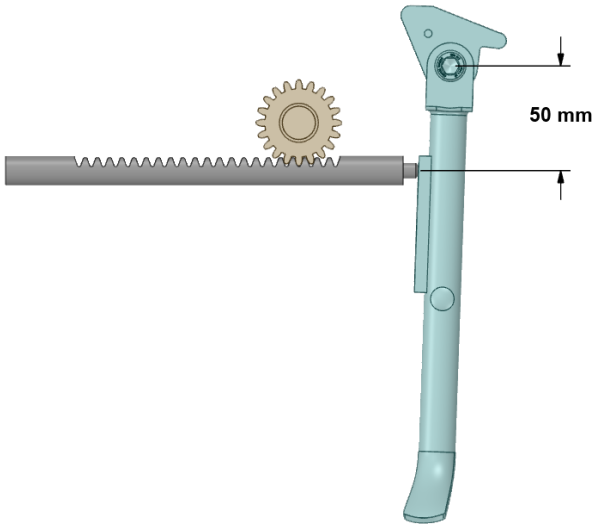

Figure 4. Design of Rack & Pinion.

Since very small space is available near the side stand. The rack assembly is mounted at a distance of 50mm from the frame of the vehicle. Rack & Pinion assembly is housed in its casing which is manufactured from an aluminum block. The motor will be mounted on a steel plate which will also have rack and pinion assembly on it. The mounting plate will be welded onto the frame of the vehicle.

Fig -5: Design of Pinion.

Dimensions
Pinion (EN 24)
No. of teeth - 20
Pitch circle diameter – 40mm
Rack (EN24)
Length – 150mm
Diameter – 15mm
Casing (Aluminum 6061)
Size – 90 X 65mm

Fig – 6: Design of Rack

5. CALCULATION

Let,

T_m = Torque of the motor.

D_p = Diameter of the pinion.

d_R = Distance of rack from the pivot.

F_p = Force on rack

η = Efficiency of the system

Force transferred on the rack from the pinion,

T_m = 9.6 Nm

$$F_p = \frac{T_m}{\frac{D_p}{2}}$$

$$F_p = \frac{2T_m}{D_p}$$

$$F_P = \frac{9.6 \times 2}{.04}$$

$$F_p = 480\ N$$

Force transmitted to rack = 480 N

Torque on the side stand

$$T_s = F_p \times d_R \times \eta$$

Taking η = 75 %

$$T_s = 480 \times 0.05 \times 0.75$$

(From figure 4. d_R = 50 mm)

$$T_s = 18Nm\ldots\ldots\ldots\ldots(ii)$$

From (i) and (ii) we get,

$$T < T_s$$

Hence the mechanism will push the stand to its stow position.

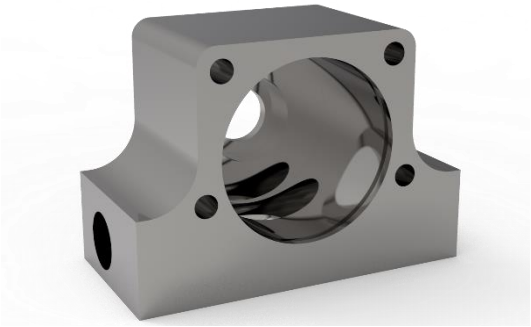

Fig -7: The casing of rack and pinion.

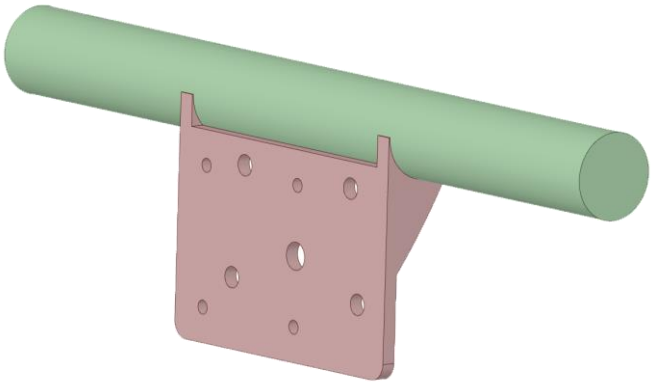

Fig -8: Mounting of assembly

6. Finite Element Analysis

Finite element analysis is performed for both rack and pinion for ensuring the life of the automatic side stand retrieval system. Transient structural analysis was performed in Ansys Workbench. A satisfactory factor of safety of 1.5 is achieved for both rack and pinion with EN24 material. The design was also verified using transient structural analysis of the complete assembly of the automatic side stand system.

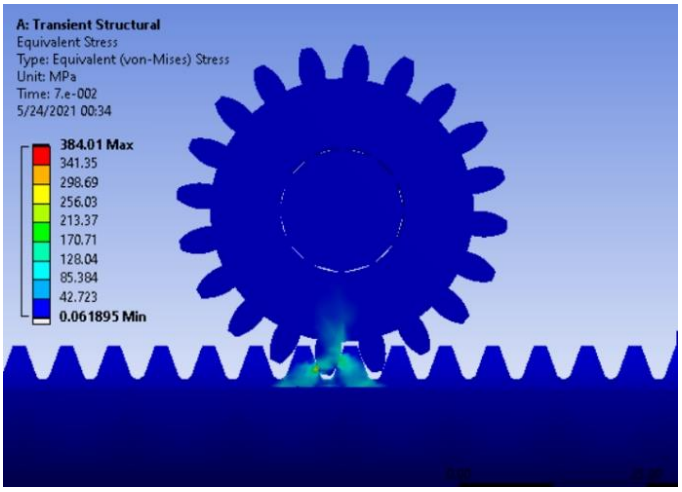

Fig -9: FEA of Rack and Pinion

7. WORKING

When the rider starts the vehicle, he must increase the engine rpm above the idling rpm at the same time he will also make the vehicle vertical with respect to the ground. Therefore the automatic side stand retrieval system will use both as input. The gyroscope sensor and photoelectric sensor will measure the angle of the vehicle with respect to the ground and engine rpm respectively. The signals will be sent to the microcontroller. When the vehicle will have an angle (θ) less than 15^{o} and engine rpm more than the idling rpm, in this condition only the motor will receive power and the stand will be pushed to its riding position. Hence the system will ensure that the stand will not stow when the vehicle is in a parked position. Which will reduce any kind of injuries during parking.

After pushing the side stand to the riding position the rack will hit a feedback switch which will trigger the relay and reverse the direction of rotation of the motor. Hence, when the rider will park the vehicle again the side stand will work normally, without any hindrance.

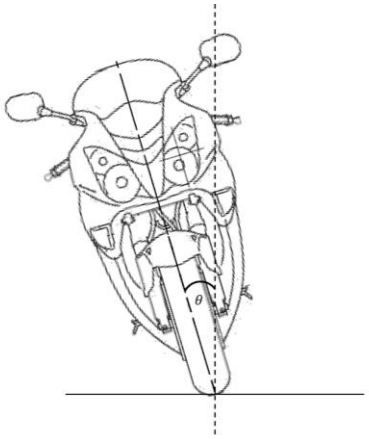

Fig -10: Bike Inclination with vertical axis.

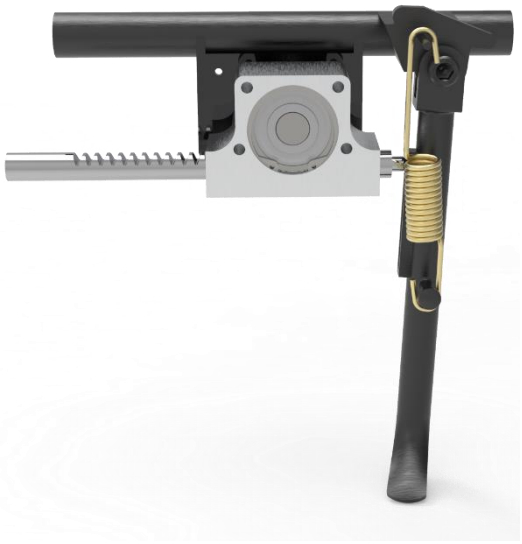

Fig -11: Automatic side stand at parked position.

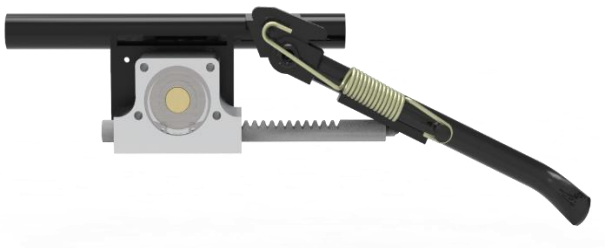

Fig -12: Automatic system pushing the side stand.

8. Result

The torque generated at the stand is 18Nm which is greater than the required torque. Hence the stand will stow automatically. Use of EN24 for rack and pinion will increase the fatigue life to 10^{6} hrs. By using this method the rider will

never have to worry about the stand ,and this will make sure the safe ride.

9. Conclusion

The automatic side stand retrieval mechanism successfully stows the side stand every time with low power consumption. This will reduce the chance of accidents due to the parked position of the side stand. This will reduce the effort and also eliminate the forgetfulness of the rider to stow the side stand. Since the automatic side stand retrieval system is very compact and all the electronic components can also be accommodated in the vehicle. It will make the two-wheeler rides far more safe than vehicles with previous generation side stand technology. The automatic side stand is designed such that it is compatible with the present side stand assembly.

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