Modification in Center Stand & Seat Lifting Mechanism for Moped by Automation

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Abstract: **The area of application of this research paper is in the field of using motor-arduino operated technology with the conventional vehicle system so as to minimize the efficiency of operator to use centre stand & lift seat of a vehicle. The stresses & timings observed are studied so as to avoid material failure using suitable torque & angular speed characteristics. The inclination angle is considered as an important parameter to optimize the working.**

Index Terms **– four bar link, automated, arduino, interfacing, simulation of stresses, σ, C/s, Toggle switch & void.**

I INTRODUCTION

Conventional method of applying a Centre stand requires lot of human efforts. Hence, applying scooter on the Centre stand is a herculean task, especially for ladies and old people. Due to this, they hardly apply Centre stand. Here we introduce automated Centre stand which is easy to apply and requires no man power. As a replacement to man power, a linear actuator driven by battery is used. The operation is controlled by a toggle switch which lifts the lower unit of stand assembly and apparently brings it down in order to lift the scooter. In the same way we have atomised the seat opening of a moped, so that a person can put his/her luggage in the trunk quickly in with minimal effort. This is obtained by using a DC motor & Kinematic four bar chain.

I.1 Problem Statement

On recent survey basis, it was found that, 72% males and 28% females drive scooters. Among those 72% males, around 20% are senior citizens and remaining are adults. Mostly females and old people find it difficult to apply centre stand and hence this made us develop and make it automated. It is also a time consuming task to lift the seat & expose the trunk by hand or manual effort, the above two aspects are also critical for physically disabled people. Moreover, applying a side stand:

1. Develops fatigue for stand operator.
2. Increases chances of accident.
3. Requires more parking spaces.
4. Reduces battery life since the electrolyte is in constant touch with electrode.

I.2 Objective

The automated centre stand is fixed at the same location for that of the conventional stand. It has two main parts; the lower unit and the upper unit. The upper unit is pivoted to the motorcycle frame and the lower unit is joined to a curved surface for easy lifting. The wiper motor is powered by automobile battery, controlled by toggle switch which changes the polarities of the supply. The wiper motor is pivoted to the stand assembly which distributes load equally on both the limbs of the stand.
Also a DC motor connected to a four bar link can easily lifts the seat with seat acting as fourth link.

II. LITERATURE SURVEY

We have extracted the data regarding the mechanism to accomplish our project with proper selection of materials and assembly. Following are the research papers and journals that we have referred for our final year project:

1. Deepak Kumar et.al Automatic Electric Powered Centre Stand for Two Wheelers: In this Paper an Electrically powered automatic centre stand has been proposed. A detailed analysis of the frame and the actuators was done. The observations of stress and deformation analysis of the frame conform to the design and safety of the system. On testing the model with a vehicle, it was observed that the actuator was able to lift the two-wheeler along with the rider and was perfectly balanced.

2. Sarvesh Hinganikaret.al Automated Centre Stand: The Centre stand of scooter is made automated under the scope of B.E. Mechanical Engineering project. Linear actuator and modified stand are used to make the stand automatically operational.

3. Ashish jyoti1 et.al Design and Development of Automatic Centre Stand For Two Wheeler: placing a Centre stand while parking on the uneven road is difficult and risky, to overcome his problem we are using some mechanical arrangement using rack arrangement which can adjust automatically according to the road surface and the whole system is actuated by mechanical actuator operating through switches. Thus, it is concluded that the use of this modified centre stand makes the human effortless and make the vehicle in were at optimum cost balanced condition rough surfaces (uneven surfaces) at optimum cost.

4. Ankit Kumar K. Shriwas et.al Design and Analysis of Standing Device for Two-Wheeler: Design and analysis of standing device on the basis of ease of actuation point of view is successively done. The analytical and FEM results show that standing device is safe to use and can sustain described load (1400N). The experimental results on UTM show that standing device is safe to sustain load of 1400 N. The new design is easy to actuate and doesn't requires lever pull action as in case of conventional motorcycle centre stand.

5. Amirul SyafiqSadun et.al A Comparative Study on The Position Control Method of Dc Servo Motor with Position Feedback by Using Arduino: The advantages are not only that the angular position can be controlled precisely, but the feedback of actual position can also be obtained during the system operation. The voltage feedback which comes from the built-in potentiometer is accurate enough to represent the actual angular position of the motor.

6. Leo Louis Working Principle of Arduino And Using It as A Tool for Study and Research: We have studied the working principle of Arduino, its hardware / software features and its applications as to where it is currently being used and where all it can be used. We have also learnt how to write sketches for Arduino in its own IDE (software). Developing new ideas with Arduino is endless, with the help of this paper we have learnt to build new devices of our own to create and implement innovative things.

7. S.M.O. Tavares et.al Failure analysis of the rod of a hydraulic cylinder: Revised design improvements might possibly be obtained: using a steel with higher strength, such as 30CrNiMo8; considerably reducing the level of stress concentration (i.e., augmenting the shoulder fillet radius); improve the surface finishing, for instance, by grinding; applying fatigue strength improvement techniques (shot peening, …); using a larger cross section - enlarging the external diameter, reducing the internal diameter, or doing both things at the same time

III. THEORETICAL FRAMEWORK & COMPONENT SELECTION

III.1 Center Stand mechanism

III.1.1. 12 Volt Battery - Modern SLI batteries are lead-acid type, using six series-connected cells to provide a nominal 12-volt system. Despite having a very low energy-to-weight ratio and a low energy-to-volume ratio, its ability to supply high surge currents means that the cells have a relatively large power-to-weight ratio. These features, along with their low cost, make them attractive for use in motor vehicles to provide the high current. As they are inexpensive compared to newer technologies, lead–acid batteries are widely used.

Specification: 114x71x86 (mm)
1lbs.(lead-acid)

III.1.2. Toggle switch - A switch is an electrical component that can make or break an electrical circuit, Toggle switches are available in many different styles and sizes, and are used in numerous applications. Many are designed to provide the simultaneous actuation of multiple sets of electrical contacts, or the control of large amounts of electric current or mains voltages. A toggle switch or tumbler switch is a class of electrical switches that are manually actuated by a mechanical lever, handle, or rocking mechanism.

III.1.3. Arduino UNO - The Arduino Uno is a microcontroller board based on the ATmega328 "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. It has 14 digital input/output pins, 6 analog inputs, A16 MHz ceramic resonator, A USB connection, A power jack, An ICSP header and a reset button.

Specification:–
Operating Voltage: 5V
Input Voltage: 7-12V
Digital I/O Pins: 14 (of which 6 provide PWM output)
Analog Input Pins: 6
DC Current: 50 mA

Fig III.1 Arduino Uno

III.1.4. Relay - A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

III.1.5. Wiper Motor - The wipers combine two mechanical technologies to perform their task viz, A combination electric motor and worm gear reduction provides power to the wipers.

A neat linkage converts the rotational output of the motor into the back-and-forth motion of the wipers.

Actually, wiper motor is used for swiping the car window in rainy season. But we are using the wiper motor for the Centre stand because it is giving the reciprocating movement and the torque requirement.

III.1.6. Centre Stand - All two wheeled vehicles when not being driven by a rider are parked using a stand. There are two types of stands commonly used to park a two-wheeler. One of these stands is a side stand, provided generally between the wheel Centres. To park a two-wheeler using a side stand, the leg unit of the stand has to be swivelled to an open position and the vehicle tilted to one side to achieve a parked stationary position. The other type of stand is a Centre stand provided between the two wheels or at the rear axle.

Fig III.2 Centre Stand

Specification:
Model –Bajaj Sunny
Weight – 3Kg
Material – Mild Steel (20C8)

III.2 Seat Lifting Mechanism

III.2.1. 9 V Battery - The nine-volt battery, or 9-volt battery, is a common size of battery that was introduced for the early transistor radios. It has a rectangular prism shape with rounded edges and a polarized snap connector at the top. This type is commonly used in walkie-talkies, clocks and detectors. The nine-volt battery format is commonly available in primary carbon-zinc and alkaline chemistry, in primary lithium iron disulphide, and in rechargeable form in nickel-cadmium, nickel-metal hydride and lithium-ion. Mercury-oxide batteries of this format, once common, have not been manufactured in many years due to their mercury content.

III.2.2. DC Motor - A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight brushed motor used for portable power tools and appliances. Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

Specifications:
10 RPM

III.2.3. Hydraulic Cylinder

Fig III.3 Hydraulic Cylinder

The hydraulic cylinder consists of a cylinder barrel, in which a piston connected to a piston rod moves back and forth.The barrel is closed on one end by the cylinder bottom (also called the cap) and the other end by the cylinder head where the piston rod comes out of the cylinder.
Specifications:
Max Pressure = 5 bar
Bore diameter = 15 mm

IV. WORKING PROCESS & PROGRAM SIMULATION

Process (Stand Raising): When the battery is ignited, the Toggle switch is turned on, which sends the signal to Arduino Uno. The signal is then sent to the relay (clockwise) which in turn rotates the Wiper Motor pivoted at the Centre of the stand assembly. This rotates the Centre stand in clockwise direction touching the ground, it is not possible for the stand to move any further and hence the moped gets lifted gradually. On full displacement of the Motor, the stand is in applied position. The Motor cannot be manually displaced which gives an additional benefit in respect to safety. On reversing the polarity through the Toggle switch actuates the motor through Arduino and Relay. The motor starts to displace in reverse direction and hence lifting the stand and lowering the moped back onto the wheels in anticlockwise direction.

Process(Seat Raising): When the battery gives current to the toggle switch it turns on the DC motor. The DC motor rotates the rod mechanism connected to its shaft. The rod mechanism pushes the seat in upward direction, thereby lifting the seat. As soon as the seat is lifted partially, the hydraulic cylinder ensures that the seat is lifted fully. The retraction is done manually by the operator.

IV.1 Program of Arduino Uno

IV.1.1. Main code

```
void setup()
{
pinMode(relay1,OUTPUT);
pinMode(relay2,OUTPUT);
pinMode(sw1,INPUT_PULLUP);
void loop() {
 // put your main code here, to run repeatedly:
int val1=digitalRead(sw1);
int val2=digitalRead(sw2);
int val3=digitalRead(sw3);
if(val1==LOW)
{
digitalWrite(relay1,HIGH);
digitalWrite(relay2,LOW);
}
if(val2==LOW)
{
digitalWrite(relay2,HIGH);
digitalWrite(relay1,LOW);
}
```

IV.2 DESIGN CALCULATION

IV.2.1. Base Chassis Design

We have selected a chassis model of sunny moped for the suitability & to represent the prototype of our project. The chassis material is aluminium alloy (Al 64430). It is essential that the frame must not buckle on roads or surfaces which are undulating. The main objective of the project is to make a mechanism for suitable automation purpose in stand & seat of the vehicle. So we have selected the design of model having 80 kg weight & having a circular cross section of varying diameter from 11 to 52 mm & an average thickness of 6mm, on some critical positions, the shape also changes from circular to oval.

IV.2.2. Design parameters of Centre Stand Mechanism

Lifting torque on stand:
Torque on crank considering motor torque:

$2*3.14*N_m*T_m/60$ = Power.

Considering wiper motor has power rating as 50 Watts & angular speed as 30 rpm,

.: $2*3.14*30*T_m/60 = 50$.

So, Torque on crank is 15.92 Nm.
Using ICR method to calculate angular speed of stand during raising or lowering the vehicle:
From ICR diagram

$V_3= W_2(I_{12}I_{23}) = W_4(I_{14}I_{34})$.

$W_2/W_4 =N_2/N_4 = d(I_{14}I_{34})/d(I_{12}I_{23})$

N_2= 30 rpm for the crank connected in the mechanism.
This is provided by the spindle connected to the motor.
.: N_2/N_4= 180/78.3
N_4= (78.3*30)/180
N_4= 13.05 rpm.

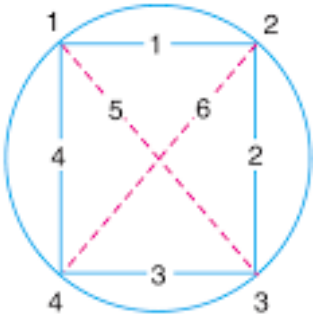

Fig No IV.1 ICR Configuration Circle

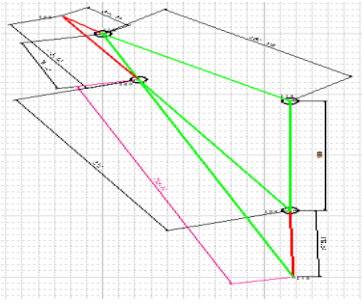

Fig No IV.2 ICR Plotting Diagram

Considering the efficiency of mechanism as 90 %
Power output= 0.9*(Power input)
T_4w_4= 0.9*2*3.14*13.05/60=45 W
Therefore T_4= 32.92 Nm.
Therefore Shear stresses check:
= $16*T/(3.14*d^3)$.

$= 16*32.92*10^3/(3.14*26^3)$.
$= 9.55$ MPa.
When stand is touching the ground & motor is switched on, approximate angle between the stand & ground is 65.26^0 .
Therefore Couple force exerted upon the stand will be calculated as
T = F*L…. (where L is stand length in mm).
$32.92*10^3 = F*260$
Therefore F = 126.61 N.
$F\cos\theta = F_H = 126.61*\cos 28$… (0= 90- stand angle).
Therefore $F_H = 111.8$ N
Fv= 126.61*sin 28 = 59.44 N
Effect of this force is negligible hence not considered.
Considering chassis load on stand rod as UDL
Chassis load is 80kg
Therefore Weight of udl(W_c) = 1.5*80*9.81 = 1177.2 N/m
Length of stand rod at top = 80 mm.
Therefore Maximum bending moment at Centre of Rod = $W_c*(L_{SR})^2/8 = 0.94176$ Nm.
$\sigma_b = M_{max}/Z_r = 32*0.94176*10^3/(3.14*15^3)$.
$= 2.8422$ Mpa.
$\sigma_d = Fv/(3.14*D^2/4)$.
$= 59.44/(3.14*15^2/4)$.
$= 0.336$ MPa.
$\sigma_r = \sigma_b + \sigma_d = 3.18$ MPa $< \sigma_{all} = 88$ MPa…. ($\sigma_{all} = S_{ut}/N_f$)
S_{ut} =440 Mpa for Mild Steel
$N_f = 5$

IV.2.3. Design parameters of Seat Lifting Mechanism
Pressure Capacity of hydraulic rod for lifting the seat:
In this design, an assumption is made that diameter of plunger is 15mm & weight of the seat including accessories is 3.5 kg.
By using moment balance equation,
Moment of seat acting due to self-weight passing through C.G.= Moment created by force of hydraulic plunger
Taking length in mm & force in Newton,
Therefore,
$(Weight)_{seat}*l(AB) = F_{plunger}*l(AC)$
Seat weight (Ws) with allowances is taken as 35 N
$W_s*l_{CG} = F_{cyl}*l_{cyl}$
366*3.5*9.81=F*152 (eqn 1)
Therefore F= 82.67N = 83N(approx).
$Pressure_{cylinder}$= Force/Area = 83/ $(3.14*(d^2)/4)$ Area of rod (c/s).
Pressure= 5 bar (assumed, so as to lift about 5 kg of weight without any impact)
Therefore $5*10^5 = 107/d^2$
d = 14
Therefore Do = 14 mm, Di = 5 mm
(available std size).
Stresses on rod.
Direct stress= $F_{plunger}/(3.14*d^2/4)$
$= 3.5*9.81/(3.14*15^2/4)$.
$= 0.1942$ MPa
Stress on piston side = $\sigma_p = 75.52/(3.14*(Do^2-Di^2)/4)$
$= 0.5621$ MPa< 47.5 (σ_{all}=190/$N_f$for chrome steel).
Stress on rod side =$\sigma_R = 75.52/(3.14*Di^2)$.
Therefore $\sigma_R = 0.9625$MPa< 47.5 (σ_{all}=190/$N_f$for chrome steel).
As the stresses produced in the components are less than allowable stresses, the design is safe.

V.CAD MODELLING

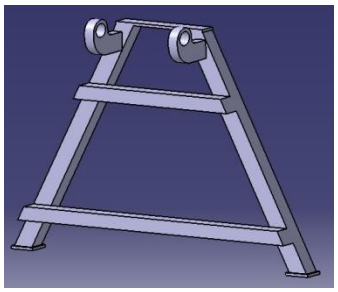

Fig V.1 Centre Stand (CAD Model)

Fig V.2 Hydraulic Cylinder (CAD Model)

The dimensions of components are adjusted to suitable tolerances to fulfil the strength & performance criteria. Actual model dimensions are slightly tedious to calculate as it involves intricate shapes & geometry. We have designed the components in CATIA V5 software; also, there is software limitations associated with the selection criteria.

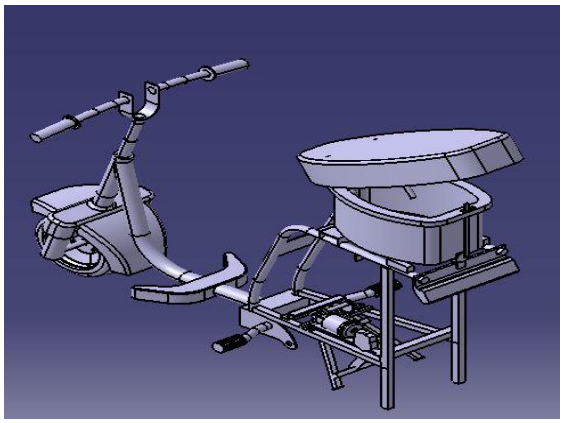

Fig V.3 Final Project CAD Model

Above is the final selected chassis prototype with assembled components to achieve all the desired features & working mechanisms in the project.

VI. SIMULATION IN WORKBENCH & TESTING

VI.1. Workbench Simulation

In this chapter, we have performed stress analysis in ANSYS Workbench 14.5 & 19.1 versions so as to compare the calculated stresses with the analysed stress. This gives general idea whether the design is safe or material needs to be changed due to inefficient bearing properties. Von Misses criterion is applied to consider the combined effect of all possible stresses. The models are shown below subsequently.

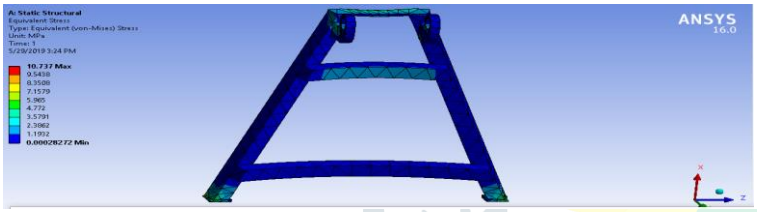

Fig VI.1 Centre Stand Stress Analysis

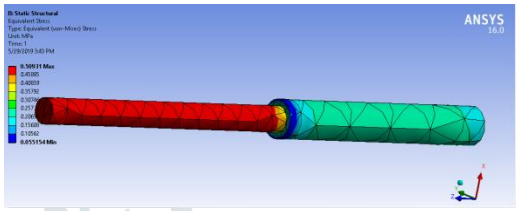

Fig VI.2 Hydrualic Cylinder Stress Analysis

VI.2. Testing Results

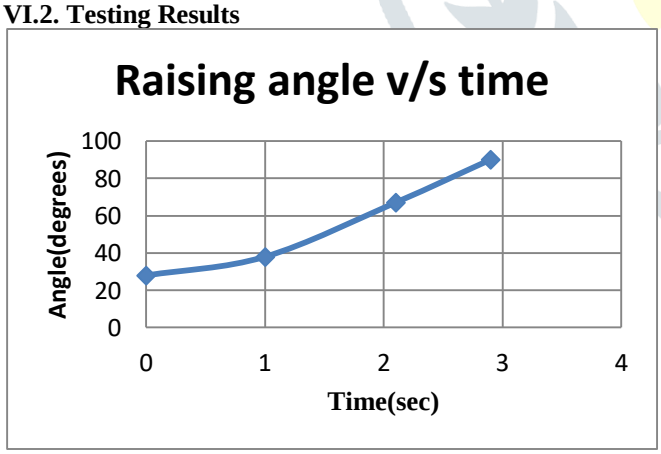

Fig VI.3 Raising angle of stand v/s time

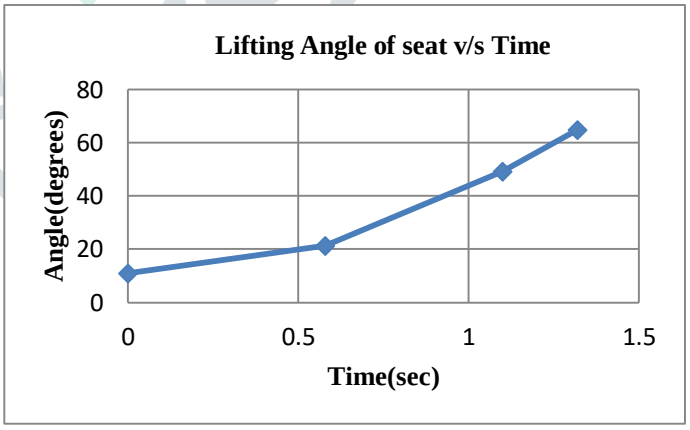

Fig VI.4 Raising angle of seat v/s time

There is a gradual rise in angle as shown by the above graph. With minimum time stipulation, so quick movement is achieved with minimum stress fluctuations. The lifting of seat is a gradual process with minimum contact forces as once a pushing force gets created; the seat gets lifted quickly due to cylinder rod movement.

VII. CONCLUSION

The Centre stand of scooter is made automated under the scope of B.E. Mechanical Engineering project. Linear actuator and modified stand are used to make the stand automatically operational. The main advantage of this mechanism is to reduce the human efforts and parking space required while the scooter is parked on side stand. This mechanism also assists specially able people to guide & support the vehicle. The interfacing of mechanism actuators with Arduino has many advantages as it assists variable torque handling system is possible. This model can lift weights up to 2000 N with suitable motor & mechanism linking.

VIII. FUTURE SCOPE

Under industrial guidance or sponsorship, the design can also get flourished in different aspects of strength & ergonomics. Mass production of such a project can enhance its cost effectiveness. Further research can help to optimize the system under a single battery unit. The delay time can be varied with advanced interfacing using MATLAB/Java coded relays &Arduino computing systems.

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