Modeling and Fabrication of Intelligent Automatic Braking System for Hill Station Vehicles Using MEMS Sensor

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Abstract—This article abstracts detailed designing and fabricating techniques of a module that is desirable for driving the vehicles in hill station. Vehicles moving along upward direction are operated with auto braking system. The slope of vehicle is sensed by using microelectro-mechanical system (MEMS) Sensor. This project introduces the enhanced automatic brake for hill station vehicles. The primary reason around fabricating automatic brake is that the automatic brake debars the vehicle’s reverse movement when condition of vehicle is off. This project explores avoiding the accident that is caused due to reverse movement of the vehicle in hill stations. The project contains simple mechanical arrangement.

The general trouble with the driver in the hill station is how to park their vehicles in slope and how to start up the vehicle. The car locomotes gradually in slow manner in traffic situations is a hard task for the drivers. The hardest task is to hold their car from not rolling along backward direction in the slope. The vehicle roll back stopping mechanism must be implemented that avoids the vehicle from rolling along the backward direction and also avoids vehicle from accelerating along the forward direction. This operation is done by using the ratchet with the pawl mechanism. The designed ratchet and pawl is connected with the rear part of the drive shaft on the rear drive vehicles. This work mainly focuses manufacturing equipment that protects the vehicle in a slant road from rolling along backward direction. Ratchet and pawl part fixed in the vehicle catches the rear rotating axle that is formed in the slant road.

Keywords—Auto braking system, Anti roll back system, Hill station vehicle braking system, MEMS based braking system, Intelligent control System for vehicles

I. INTRODUCTION

Driving the vehicles on hill station is little unmanageable task comparing the flat road. Since the road is slippery braking is difficult. To avoid this the rear wheel assembly is modified which allows the vehicle to move along the upward direction and slows rolling of the vehicle along the backward direction in the slopes. The hill station auto braking system is reconstructed with the Ratchet, a pin, a Rear wheel assembly and a Power drive. The rear wheel of the car is formed with the hub that is connected with the ratchet. The lever is connected with the two wheels and the pin lock of ratchet. The gear lever is formed with a main lever and a hand lever, where the main lever is controlled by the hand lever in the car. The mechanical assembly formed with the main lever, where the main lever is formed with a hole that is inserted with the ratchet lock pin. The ratchet wheel is connected with the ratchet lock pin. The aforementioned construction allows the wheel to move along forward direction and avoids back lashing of vehicle in the inclined road. This arrangement ensures driver safety and improves comfortable driving experience in the inclined road.

Many applications effectively employ the Ratchet and pawl mechanism along with one side power transmission. Consider an example

(i) Giant wheel- The Giant wheel is a large wheel found in the amusement parks. The Giant wheel persuading the number of passengers rotates along horizontal axis in unidirectional.

(ii) Clocks- The clocks are provided with hands, where the hands are rotating only along clockwise directions.

(iii) Baffle gates- The Baffle gates are fixed in the buildings entrance and the gates rotating uni-directionally along vertical axis.

(iv) Shaping Machines in formed with the crank and a slotted arm.

The main aim residing in this research is designing an enhance mechanism with a simple mechanical arrangement thus ensuring journey Safety and security along inclined roads. The other part of the paper is directed as follows. The introductory theories relating to the proposed work are described in Section II. The proposed system is explained in the section III and the implementation details are discussed in the section IV followed by result in section V. Last section V concludes the paper.

II. RELATED WORK

A prototype model illustrating automatic hill station braking system conception depicts emergency brakes working
applications on hill stations slope road driving conditions. Fabricating same model with the desired braking condition works well on hill station slope road during emergency conditions.

Some of the Existing Research works done yet

A. Vehicle transmission hill holder

Alvin H. Berger designed a one-way clutch at the point when connected with it forestalls moving of the vehicle. A device operable in a transmission for generously averting vehicular rollback on a slope incorporates a shaft, a gear, a one-way clutch, and a pawl part. The gear is specifically associated for common pivot with the shaft. The gear is rotatable in a first and second rotational ways. The one-way clutch is formed with an internal race and an external race, where the internal race is associated with the gear and the external race is formed with an external surface that is provided with a majority of drawing in teeth. The pawl part is provided with a first end and a second end, where the primary end is critically mounted to a transmission housing. The second end of the pawl is formed with a first angled portion designed to discharge and connect with no less than one of the majority of engaging teeth of the external race as the external race turns the second rotational way.

B. Release mechanism for a hill holder device

William K. Messersmith utilized a load cell that is provided with a electrical control part for braking system. The load cell continuously needs electric energy for the producing and displaying the signals. Likewise it also needs the amplification circuit for displaying generated output where gauge signals have very low voltage of milli-volts. The vehicle is provided with a clutch pedal, a brake pedal, and a hill holder device. The hill holder device holds the brake pedal along fixed applied position while the driver foot is released to control the accelerator pedal. A mechanical brake control device is fixed between the clutch and brake pedals, where the clutch pedal is formed with a linkage that is fixed with the brake control device. The clutch pedal relinquish causes brake control device deactivation and results the brake pedal release from the position that is applied. The release mechanism should be usable with either a mechanical brake control device or a braking assistance servo-motor system.

C. Improved release mechanism for a hill holder device

Grzegorz Janiszewski expressed that a piston cylinder device is formed with an electronic unit that is controlled, connected with a hydraulic pressure system and pursues the pedal of the brake for about two seconds.

D. Improved release mechanism for a hill holder device

William kent used a load sensor that is connected with a wheel brake for sensing wheel braking torque alterations and communicating with the mechanical brake control device in a responsive manner. On an inclined road, when the car is halted meanwhile if the motor is still running, availability ratio for kind of hill-start control condition is increased. A sensor that detects an incline of more than a certain amount, three degrees or more, can send a signal to the hill-start control indicating that the vehicle has the potential to start rolling. The incline detection weakness is when car a might be sometimes on incline without requiring hill-start control - for instance, when a tire slips into a pothole.

E. Anti-creep and hill holder brake system

Cook George suggested a hill holder mechanism holds the vehicle in slope for 2 seconds by using the brake pressure. A device operable in a transmission of a vehicle for substantially preventing vehicular rollback on an incline, comprising: a shaft rotatable which is supported in a transmission housing; a gear selectively connected for common rotation with the shaft, wherein the gear is rotatable in a first rotary direction and a second rotary direction.

III. Design of braking system

The design comprises braking mechanism with loading conditions of Maruthi Alto. The front drive shaft circumference of Alto is noted and the diameter is calculated and is about 23.89mm. The weight of the vehicle car is 1060 Kg and the torque of the vehicle is 190N-m.

Slope of the road: In South India Tamilnadu, the sheerest road is Kolli Hills Road whose inclination angle is 18.80 degrees. The slope percentage is about 30%.
The ratchet and pawl are made of Grey cast iron and C45 materials respectively. Surfaces of the both devices are thought to be highly solidified. The ratchet wheel teeth is determined as 12. While designing the mechanism the abiding parameters are counted. The mechanism (3D) three-dimensional model is illustrated in Figure3.1.

\[
\begin{align*}
\text{Module (m)} &= 5 \text{mm} \\
\text{Width of ratchet (b)} &= 12.5 \text{ mm} \\
\text{Diameter of pawl (Dp)} &= 14.47 \text{ mm} \\
\text{Length of pawl (L)} &= 31.4 \text{mm}
\end{align*}
\]

A. Ratchet

The ratchet is named as a mechanical device allowing linear or rotary motion along one direction in a continuous manner meanwhile forbidding motion along the opposite direction. Wide applications of the Ratchets include machinery and tool applications. Despite the fact that something of a misnomer, "ratchet" is additionally frequently used to allude to ratcheting socket wrenches, a frequent tool with a ratcheting handle is functioning on the way like a ratchet is moving along forward direction. The ratchet is comprised with a round gear or linear rack that is formed with teeth, and a pivoting. The spring loaded finger is called a pawl that is fixed with the teeth. The teeth are asymmetrical designed in a uniform manner, where the every one edge of tooth is formed with a curb slope and a heaviest slope on another edge. The pawl glides up over the mildly sloped teeth edges in an easier manner when the teeth are moving in along the unrestricted (i.e., forward) direction, where a spring driving it (often with an audible 'click') into the depression between the teeth as it passes the tip of each tooth. When the teeth move in the opposite (backward) direction, however, the pawl will catch against the steeply sloped edge of the first tooth it encounters, thereby locking it against the tooth and preventing any further motion in that direction.

B. Pinion:

A pinion is formed as a round gear that has many applications: In general the smallest gear is connected with the gear drive train, although in the case of John Blenkinsopp’s Salamanca, the pinion was rather large. In many application such as remote controlled toys, the pinion is also called as the drive gear. A 90- degree angle is formed by the smaller gear that drives along a crown gear in a differential drive. A small front sprocket is fixed on the chain driven motorcycle. A round gear is engaged with the rack that drives the rack. The rack is connected with the pinion mechanism and the rack is fixed with the rack railway. The pinion gear is considered as the clutch bell by connecting it with a centrifugal clutch in many cases of radio-controlled cars fixed with an engine (i.e. nitro).

C. Backlash:

At discrete points only the ratchet can block the backward motion (i.e., at tooth boundaries). The ratchet admits only a limited amount of motion along the backward direction. While limiting the motion along the backward direction a maximum distance that is equal to the spacing between the teeth is called backlash. It is necessary to reduce the backlash, a smooth toothless-type ratchet is formed with a high friction surface. The smooth toothless-type ratchet is used that is made of rubber sometimes. The pawl is departed from the surface by forming an angle, in that angle any motion along backward direction causes the pawl jamming it against the surface and thus forbidding further motion along the backward direction. Since the retrogressive travel remove is essentially an element of the compressibility of the high erosion surface, this instrument can bring about fundamentally decreased backfire. Utilizations Ratchet systems are utilized as a part of a wide assortment of uses, including these: Freewheel (overwhelming grip), Capstans, Jacks, Roller, Clocks, liners, Turnstiles, Slack lines, cuffs.

D. MEMS Sensor
Microelectromechanical system (MEMS, also written a micro-electro-mechanical, Micro Electro Mechanical or microelectronic and microelectromechanical systems and the related micromechatronics) is the technology of microscopic devices, particularly those with moving parts.

The accelerometer is provided with a low power, formed as a low profile capacitive micro machined and connected with an Accelerometer featuring signal conditioning unit, a 1-pole low pass filter, a temperature Compensation unit, a self-test type part. The 0g-detect part detects the linear freefall action, and g-Select allows selection of sensitivity between 2 sensitivities Zero-g offset and sensitivity is Factory set and which does not require any external devices. This is inclusive of a Sleep Mode, where the Mode is ideal due to handheld battery that is powered elect.

![Figure 3.3 MEMS Sensor](image)

To MEMS senor is used to determine the accelerometer's acceleration ability and to measure more important values that are very useful to electronic and robotic projects and designs:

- Acceleration
- Tilt and tilt angle
- Incline
- Rotation
- Vibration
- Collision
- Gravity

E. PIC 16F877A Microcontroller

The Microchip Technology with PIC and PIC micro are registered trademarks. Broadly speaking the PIC is abbreviated as Peripheral Interface Controller, Even though General Instruments’ unique acronym for the underlying PIC1640 and PIC1650 gadgets was "Programmable Interface Controller"

Chandler Microchip Technology produced microcontroller chips which includes PIC microcontrollers in specialized family, Arizona. The acronym PIC stands for "peripheral interface controller," that is seldomly utilized in present. A typical microcontroller is provided with a processor an d formed with a memory unit and any peripherals.

The microcontroller is a device that is coded/programmed for executing a specific function. The codes are burnt into the program memory unit. The special purpose device microcontroller have lot of application in battery management, automobile, instrumentation, medical, motor, control drives, USB and smart phones accessories using wireless technology etc.

The best latest product from Microchip is the PIC16F887. The PIC16F887 is manufactured with all specific features that are generally fabricated in the components of the modern microcontrollers. Wide range of application of PIC16F887 is due to its low price, high quality and easy availability. The ideal feature of the PIC16F887 include due to its solutions in applications such as: various processes in control industry, different measurement values, machine control devices etc. The main features of the PIC16F887. A capable 16F877A microcontroller does many important tasks due to its enough large programming memory (large in terms of sensor and control projects) 8k words and 368 Bytes of RAM. This is enough to do many different projects (see links at end of this page for some example projects on this site).

![Figure 3.4 PIC 16F877A IC](image)

The PIC 16F877A is provided with 40 pins to make use of all the peripherals for the specific functions that are dispersed over the pins. The decision of external devices is made easy by attaching without any worry too much if there are enough pins can perform the allotted job. Every pin is connected with between two or ternary function unit to make easy decision is the main advantages of deciding what the pin function (other devices have up to 5 functions for a pin)
IV. EXPERIMENTAL RESULTS

A filter is provided with 12V DC supply for converting the pulsing DC into a pure DC supply. The voltage regulator is provided with the 12V DC supply that is converted to 5V DC supply. The Microcontroller 40th pin (Vcc) is given this 5V DC and Microcontroller 9th pin is formed as a RESET button.

The microcontroller port C is fixed with a pull up resistor and interfaced with display. The microcontroller Port A is connected with the MEMS sensor using using I2c protocol and microcontroller port D is fixed with the L293D driver IC. The microcontroller connected with the MEMS sensor receives the data and according to the data from the sensor the appliances are operated. The MEMS sensor output is provided to the Microcontroller, where the Microcontroller converts the output of the MEMS sensor into digital data. The pinion is controlled by connecting the driver IC to the port D of the microcontroller. The driver circuit controls pinion direction. The Pinion is connected with vehicle wheels and the motors.

The designed and fabricated mechanism is experimentally examined by connecting the mechanism with the drive shaft. The testing is done to check whether the design objective functionality is accomplished (Figure 4.1). The hand driven lever is crawled along the forward direction, according to car progression, the ratchet rotation is stopped by the pawl. The hand lever is crawled along the opposite direction in the hill road according to the contrary motion of the car ratchet rotation is stopped by the pawl. The rotation of the wheels are stopped and the drive shaft movement is avoided.

![Figure 4.1 Testing Model](image)

Therefore in the hill road vehicle wheels revolving along the reverse motion is stopped. This stopping criteria is accomplished by fitting this mechanism in the car. The mechanism connected with the vehicle drive shaft will support the hill road vehicle wheels rotation stopping process. When it has been done the car cannot move in reverse direction in the slope as the pawl locks the ratchet.

V. CONCLUSION AND FUTURE WORKS

Finally to conclude, Safety Auto Brake System prototype is successfully designed, fabricated and examined. Each and every hardware component utilized for the development of the prototype is effectively done by integrating features. The best working units are contributed by cautiously placing every component with specific reason.

Eventually the mechanism created avoids rolling back of the vehicle on the slopes. The mechanism developed is more assistive for the drivers while driving their cars on hilly roads in a comfortable manner. The driver in hill road can drive the car without rolling along backward direction. The automatic slope region vehicle braking system project is successfully designed, fabricated and tested under various conditions. The project is implemented by integrating the features of all the hardware components. Firstly, it is believed that every component utilized experience the basic reason and they carefully are invested for best contribution in working unit. Secondly, the project using highly advanced IC’s utilizes help of growing technology for the successful implementation.

In our future work, the Safety Auto Brake System can be implemented in many vehicles that keeps off the vehicles from colluding and from accidents. The vehicles might be used with Regenerative braking in order to save the energy and to store them in the battery, where the stored energy can be used for foster purposes. Any type of hybrid vehicles can use type of braking and thus it can reduce the usage of fossil fuels.

REFERENCES


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