

Avoidance of Tractor Rollover and Reports In Emergencies



Engineering

KEYWORDS : tractor, stability, microcontroller, rollover, mercury tilt switch

Sujay Ballal

School of Electronics and Communication Engineering, VIT University, Chennai

Muthulakshmi S

School of Electronics and Communication Engineering, VIT University, Chennai

ABSTRACT

Tractors are the backbone for farmers in terms of both agricultural aspects and transportation. It is the largely used vehicle for transporting heavy loads like water, soil, waste etc. in villages and also in cities. The main problem faced by tractors while transporting these is the rollover which causes injuries and loss to the farmer. The tractors centre of gravity is high thus reducing its balance and stability. So to avoid this, have introduced a microcontroller based system which contains monitoring device that indicates the happening of the rollover to the driver. LCD, LED and buzzers are also included to indicate the rollover and helping the driver to avoid it. A mercury tilt switch senses the rollover of the tractor and sends a message through GSM Module to the emergency contact number that is interfaced to the microcontroller. The main advantages of this mechanism over the previous ones are that, this is more economical and more reliable.

I. Introduction

In India, tractors are one of the major means of transportation to haul goods and animals and the most requisite vehicle for farming. They are also one of the majorly used conveyances in villages and also in cities as it is a significant means of transportation of drinking water and displacement of soil, according to regional and geographical conditions.

So, the stability of the tractor is of major concern. As they are mostly driven on uneven terrains with varying load conditions, thereby leading to the possibility of rollover. This may happen because of slopes, overturns or irregularities of the road causing the driver to lose his balance leading to the accidental rollover [1]. Thus there are many cases of farmer's injuries and deaths due to these rollovers.

'Prevention is better than cure'. So we need to keep a check on the balance and stability of the tractors thus preventing it from rollovers. Hence it is essential to minimize the risk of the driver by designing some safety measures which indicate the driver priority about the possibility of the rollover, helping him to avoid it.

This project includes a monitoring device which is placed in the suspension system present in the wheels of the tractor. A switch is placed below the monitoring device. When the tractor's suspensions are compressed in an uneven manner to the threshold level, switch is pressed thus completing the circuit. Hence a signal is sent to the microcontroller for further actions. Here an LCD, buzzer and an LED is interfaced to notify the driver of the possibility of the rollover. Tilt orientation for the rollover is detected using mercury tilt switch. A GSM Module [2] is interfaced to the microcontroller which is used to send the message to the emergency contact number if any rollover has been occurred.

II. LITERATURE SURVEY

Sideways rollovers can occur due to two main reasons. They are 1. Sharp overturns 2. Moving down the slope The rollover depends on the centre of gravity, tipping axis of the tractor and also on the amount of centrifugal force developed during the action.

Firstly, the tipping axis [1] is the pivot line at which the tractor rollover occurs during a steep slope. For example in a crawler tractor, it is present at the outside edge. Precisely it is the intersection line between the road and the tractor when the tractor is tilted on a slope.

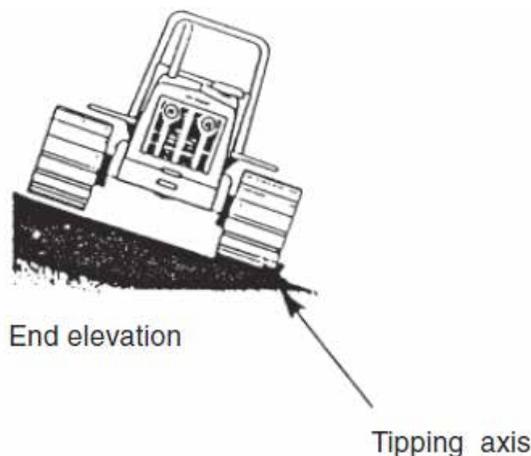


Fig. 1 The Tipping Axis of a tractor

Source: Accident Compensation Corporation of New Zealand, 1988

Secondly, centre of gravity is the imaginary point in the body where the whole mass of the body is assumed to be concentrated at that point. It is regarded as the balance point of the body. The balance of a particular body is excellent when its centre of gravity is as low as possible. For example the formula one cars are designed in such a fashion so as to keep its centre of gravity low. The centre of gravity changes according to the body's weight change.

Lastly, the centrifugal force emerges into action during cornering. It tends to pivot the vehicle on its outer wheels. The more the speed of turning, more is the centrifugal force. It depends on the weight, speed and the turning angle of the tractor.

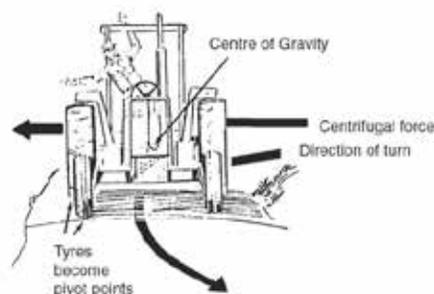


Fig. 2 Centrifugal force tends to pivot the tractor on outside wheels and tends to cause rollover

Source: John Deere. 1983

Rollovers can happen within a very short instant of time so the reaction time left for the driver is very small. The higher the centre of gravity, the less stable the vehicle is, and the more likely is to rollover. But unfortunately tractors are designed with high centre of gravity to allow cultivating tall raw crops.

At present gyro-sensors are used for measuring the tilt of the tractor and can detect the rollover by measuring its angle [3]. Even a mobile application is developed wherein the in-built accelerometer and gyro sensor can be used to detect the tilt and can avoid rollover [4]. But these methods are uneconomical and even the gyro-sensor has some limitations, so most of the farmers do not opt for it. So we have come up with a better and most economical system to avoid the rollover through this paper.

III. PROPOSED WORK

The base paper had used the iPhone mobile mounted onto the tractor wherein an application was developed to measure the tilt. The tilt was measured using an inbuilt accelerometer and gyro sensor present in the mobile. This is interfaced to the GSM Module to send the message during rollover. The message between the iPhone and the GSM Module takes place with the help of Bluetooth. Since this method is uneconomical and drivers are required to have iPhone which is costly.

Hence an economical system is necessary such that rollover of the tractor is minimized and driver can obtain assistance if unfortunately any rollover of the tractor occurs. The proposed design can be implemented in all the tractors with the available resources present in the tractor thus minimizing the cost and preventing the rollover of the tractor thereby avoiding the injuries and deaths of the driver.

IV. METHODOLOGY

The Fig. 3 shown below depicts the block diagram of the proposed system. It consists of six main parts, they are

1. Microcontroller AT89C51
2. Monitoring Device
3. LCD
4. LED
5. Buzzer
6. Mercury Tilt Switch
7. GSM Module

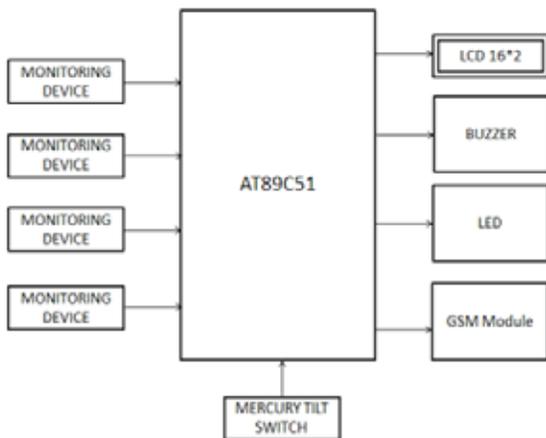


Fig. 3 Block Diagram

The monitoring device is placed in the suspension system pre-

sent in the wheels of the tractor. A monitoring device consists of a rod welded to the coil suspension and a push button switch. Only at some instant when the suspensions present in left and right sides of the tractor are compressed at one of the sides to a certain threshold, a signal is sent to the microcontroller. i.e., when a rod presses the push button switch. A switch is placed below the monitoring device. Hence a signal is sent to the microcontroller for further actions. Here a LCD, buzzer and a LED is interfaced to the microcontroller to notify the driver of the possibility of the rollover. A mercury tilt sensor senses the change in the orientation of the tractor. GSM Module is used to send the message to the emergency contact number if any rollover has occurred so that driver can get the necessary help.

LCD displays the warning message on the screen. A buzzer produces sound alarm. A LED glows for remedial measures. In spite of having LCD, a supporting sound alarm produced by the buzzer is of use during bad weather conditions such as heavy rainfall, fog where he may not notice the indicator on the dashboard.

A mercury tilt sensor is interfaced to the microcontroller. This helps in detecting the rollover of the tractor. A drop of mercury flows away from the switch which is enclosed in hermetically sealed glass tube thus causing the switch to be open circuit, detecting the rollover of the tractor.

GSM Module is interfaced to the microcontroller's TX and RX pins. It is used to send messages to the mobile number which is previously fed to it, on occurrence of the rollover. The TX pin is used to send the data from the microcontroller to the GSM Module whereas the RX pin is used to receive the data from the GSM Module. The RX pin is usually used in case of acknowledgement. This added feature makes easier for driver by automatically sending the message thereby the delay for assisting the driver is reduced.

V. IMPLEMENTATION

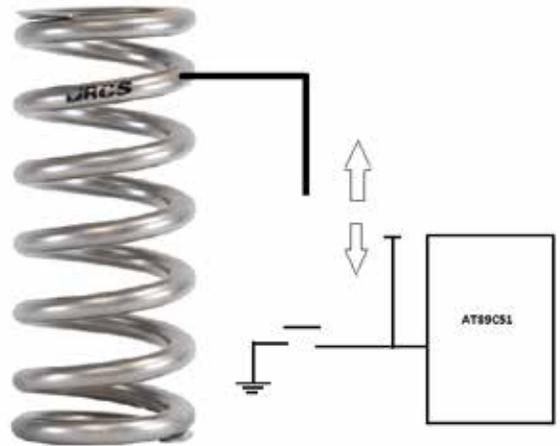


Fig. 4 The Monitoring Device

Fig. 4 shows the monitoring device. As shown, a metal rod is connected to the suspension of the tractor. One end of the metal rod is welded to the ring of the suspension and the other is placed near the switch. When the suspension of the tractor is compressed the rod comes in contact to the switch and completes the circuit. Thus the microcontroller gets the power and performs its assigned operation. This monitoring device will be present in all four wheels of the tractor to detect the rollover.

The 89C51 microcontroller activates the buzzer, LCD and LED on receiving a high on the pin to which the monitoring circuit is connected.

Another feature is added to encounter the overloading by providing an alarm to the driver. This may happen when accommodating the individuals in the tractor wherein the tractor is designed to accommodate only for the driver but sometimes the driver allows passengers to sit next to him or on the engine. This also may cause losing the balance of the tractor leading to risks of the driver and also the passengers. The monitoring system overcomes this problem by detecting the overload by pressing the switch indicating the driver about the risk.

On receiving low signal on the pin from the monitoring circuit, the LCD is powered up and the indication of the rollover is indicated. The LED's are used so as to indicate both the driver and the vehicles coming behind it about the chances of rollover. The buzzers are also used to indicate the probability of the rollover in case of bad visible conditions.

A mercury tilt switch is used to detect the rollover. It consists of drop of mercury which is a liquid metal that can flow and establish a connection between the leads of the switch. The blob of mercury will be in contact with the leads of the switch during normal operation of the tractor i.e., switch is closed. When there is rollover of the tractor, then the blob of mercury flows away from the leads of the switch making it open circuit thereby detecting the rollover.

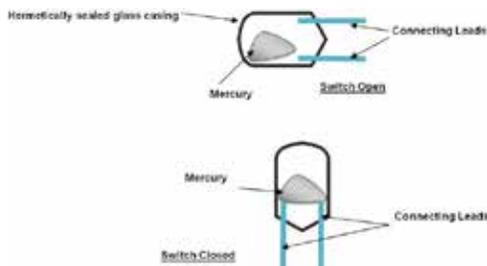


Fig. 5 Mercury Tilt Switch

When rollover of tractor happens, a GSM Module sends a message to the emergency contact number indicating for help and also buzzer alarms so nearby people can hear it and provide the help for the driver.

The TX pin of the microcontroller is connected to the RX pin of the GSM Module for sending the messages when the mercury tilt sensor orientation is changed due to the mercury bead moving away from the contacts of both of the switches hence indicating the rollover of the tractor so that the driver can obtain suitable help. The TX pin of the GSM Module is connected to the RX pin of the microcontroller for the purpose of acknowledge-

ment. An on-board SIM card slot is provided for the driver to insert the SIM card of any service provider. This helps the driver in getting attention as quickly as possible.

VI. CONCLUSION

As we had discussed earlier, the tractors are a major aspect of transportation for the farmers. The stability and the balance of the tractor should be given much importance and thus the rollover should be avoided.

So, the system which is developed now is fulfilling the requirements for the avoidance of the rollover of the tractor. The major problem faced by the driver is that they are not able to figure out whether a rollover occurs or not. This project is capable of eradicating that problem, by its feature of prior indication of the rollover to the driver on beforehand.

It also has a unique feature of indicating other vehicles around it about the happening of the rollover, so that they can be more careful and take guard.

Another important facility provided in this project is the GSM Module. It sends the message to the emergency contact as soon as rollover occurs. This helps the driver to get an immediate attention and the alternatives could be arranged.



Fig. 6 Prototype of the design

VII. FUTURE SCOPE

Although a lot of problems are resolved in this project, we are left out with some issues which needs to be addressed in future.

Even though we have a GSM Module to send instant messages on rollover, we are not able to indicate the receiver the exact location of the accident. So this drawback can be overcome by implementing GPRS in the tractor which helps the receiver to locate it and act immediately.

Another drawback in this project is that the system is not portable. The monitoring device is fixed to the suspension of the tractor and is irremovable.

REFERENCE

[1] Erlich, M. Driscoll, T. Harrison, J. Frommer, M. & Leigh, J. Work- "Tractor Rollovers" Related Agricultural Fatalities in Australia. 1982-84 | Scandinavian Journal of Environmental Health 1993. 19. pp 162-67 | [2] Vasif Ahmed, Naresh P. Jawarkar, "Design of Low Cost Versatile Microcontroller based System using Cell Phone for Accident Detection and Prevention", 2013 6th International Conference on Emerging Trends in Engineering and Technology | [3] Stephen C. Spry and Anouck R. Girard, "Gyroscopic Stabilization of Unstable Vehicles: Configurations, Dynamics, and Control" in March 31, 2008 | [4] A. Bulent Koc, Bo Liu, "Demonstrating Tractor Rollover Stability Using Lego Mindstorms and Smartphones", Journal of Agricultural Systems, Technology, and Management, January 2013 | [5] David W. Smith, "Safe Tractor Operation: Rollover Prevention", AgriLIFE EXTENSION Texas A&M System | [6] Jihan Ryu, Eric J. Rossetter, and J. Christian Gerdes, "Vehicle Sideslip and Roll Parameter Estimation using GPS", AVEC 2002 6th Int. Symposium on Advanced Vehicle Control, Hiroshima, Japan, 2002 | [7] US Department of Health and Human Services, Centers for Disease Control and Prevention National Institute for Occupational Safety and Health. Injuries Among Youth on Farms in the United States. June 2001 DHHS (NIOSH) | [8] Jihan Ryu, J. Christian Gerdes, "Estimation of Vehicle Roll and Road Bank Angle", 2004 American Control Conference, Boston, MA