Vehicle Maximum Weight Limitation Based on Intelligent Weight Sensor

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Abstract. Vehicle weight is an important factor to be maintained for transportation safety. A weight limitation system is proposed to make sure the vehicle weight is always below its designation prior the vehicle is being used by the driver. The proposed system is divided into two systems, namely vehicle weight confirmation system and weight warning system. In vehicle weight confirmation system, the weight sensor work for the first time after the ignition switch is turned on. When the weight is under the weight limit, the starter engine can be switched on to start the engine system, otherwise it will be locked. The seconds system, will operated after checking all the door at close position, once the door of the car is closed, the weight warning system will check once again the weight during runing engine condition. The results of these two systems, vehicle weight confirmation system and weight warning system have 100 % accuracy, respectively. These show that the proposed vehicle weight limitation system operate well.

1. Introduction

Safety in driving plays important rules in order to reduce the number of accident in the road [1]. However, safety in driving usually being neglected when there is no enforcing regulates related to that practice. It can be ranging from not wearing a seat belt, over speed and also ignoring the load being carried by the vehicle, regardless it can promote a real danger which can lead to injury or even death of the driver or other people who may involve in the accident [2]. Overload will increase the braking distance of a car and could create a dangerous condition especially for the other vehicle in front of the car if it is not well considered by the driver [3].

Therefore, every vehicle manufacturers has designed a load limit for all of entire vehicle which aims to make the vehicle safe. When an excess weight is being applied to the vehicle, the vehicle will become unstable where the center of gravity of the car can shift away from the original designation and this definitely will harm the driver. Transportation excess burden is one of the causes of traffic accidents in the world [4] . Not only dangerous, it makes the vehicle very unstable, and also reduced the lifetime of the auto parts. The infamous accident that happened in Indonesia that's related to vehicle overload was the Indonesian celeberity Saipul Jamil. He fitted up to 10 people into a 7 seater car and some cargo, which cause the car to be unstable when he suddenly turn and hit the road seperator [5].

Some methods are applied in some countries such as active surveillance, weighing bridge, portable weighing etc. However, these methods are not popular with the public and mostly only being applied to high load transportation such as a truck [6]. This paper proposes a concept of an intelligent weight

monitoring system which can be embedded in any kind of vehicles. With this system, weight in a vehicle can be monitored and limited to a safe value following the recommendation of the vehicle maker.
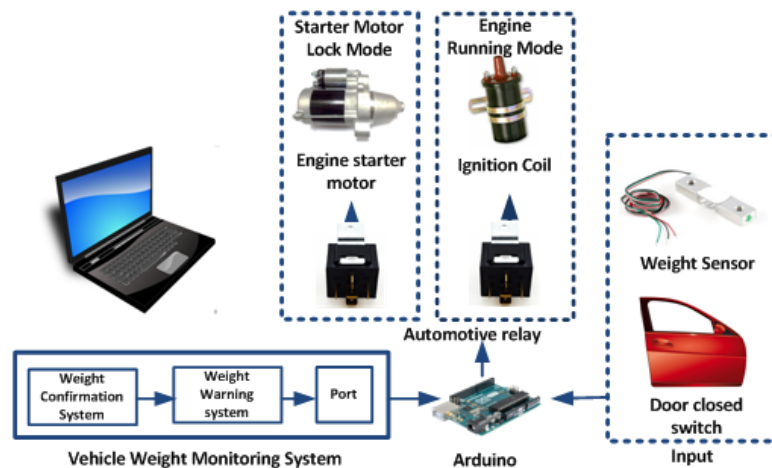

Figure 1. Proposed Vehicle Maximum Weight Limitation Based on Intelligent Weight Sensor.

2. Proposed System

2.1. Proposed System Description

Figure 1 shows the proposed system description, the system basically consists of three main systems, namely vehicle weight limitation system, automotive relay and input for weight monitoring system. In the vehicle weight limitation system, there are two steps involve which are weight confirmation system and weight warning system. In the weight confirmation system, the system will check the total weight of the vehicle and load in the vehicle when ignition key [7] being turned ON. The weight warning system is the next step where the total weight of the vehicle and load inside the vehicle will be checked after all the car doors are closed. This system is added to make sure that all loaded being checked are already all the load inside the vehicle exactly at the moment when the vehicle is ready to be driven.
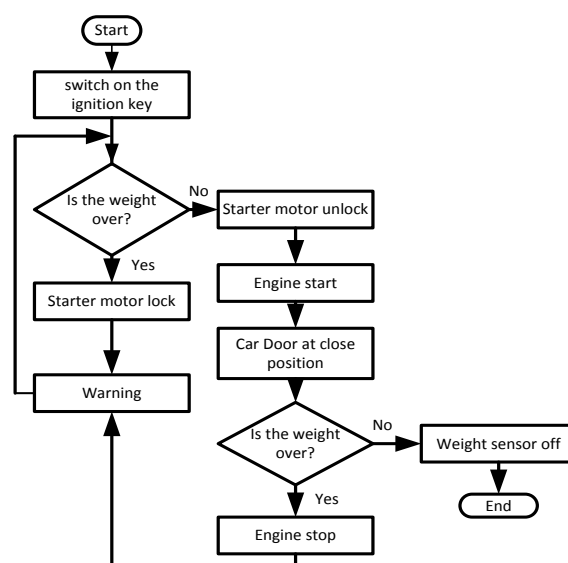

Figure 2. Flowchart of the proposed system.

The detail flowchart of the proposed system is shown in Figure 2. First the system will check the weight of the vehicle for the first time after the driver switch ON the ignition key. If the weight of the vehicle is overweight, the system will lock the engine's motor starter by cutting off the electrical access to it using an NC (Normally Closed) relay [8] and a warning signal will be sent, otherwise the engine will be ON. If the vehicle is being overloaded, it can only be started if the driver already reducing the weight of the vehicle.
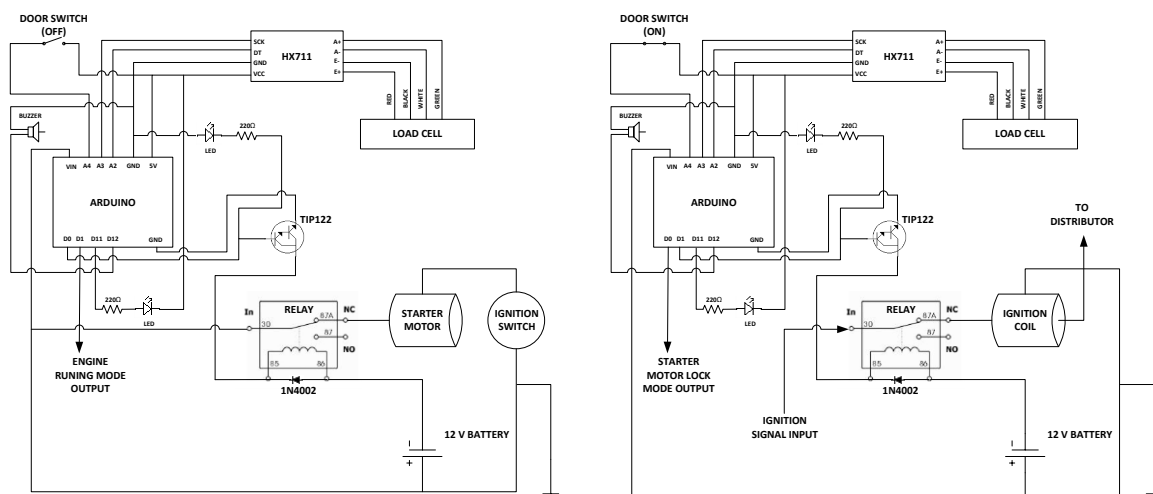
The weight warning system is the next checking sequence for the weight of the vehicle. Furthermore, this second checking is initiated after the all the door of the car is closed. If the weight is below the normal load, then weight monitoring system will be turned off to avoid dynamic load picking and the vehicle can run normally. If the weight is over the weight limit, then the engine will be stopped immediately by using an NC (Normally Closed) relay to cut off the electrical signal to the ignition coil and a warning signal will be given. The driver needs to check and maintain the maximum load so that the vehicle can be operated normally.

In the vehicle weight monitoring system, the weight of the vehicle is measured for the first time once the ignition key is switched on. If the weight of the vehicle is in the normal range, then the starter motor will unlock and the engine will start, otherwise, the starter of the motorcycle will lock, and there will be a warning. In the second system is input for weight warning system, the system is implemented based on the door car position. The system will check all the doors of the car is closed. Once the door is closed, then the weight is measured from the last time, before the sensor is switched off and the engine is continued working.

3. Results

3.1. Experiment Setup
A personal computer (PC) of 2.1 MHz Intel Core i3 processor is used to develop the program of the proposed system. The flowchart of the program developed based of the Arduino [9] software in the computer. The program is then being uploaded to the Arduino to run the system. Weight sensor and car door position switch are used as input to the system. The weight sensor located at pin A2 and A3. The car door position input in pin A4 (input from the switch door sensor). The output of the Arduino is connected to pin D0, D1, D11 and D12 as shown in Figure 3 and 4. Output from the Arduino is the sent to the relay which works on 12 volts DC power supply and it is set in normally closed (NC) condition to lock the starter motor or to turn off the ignition signal. Figure 3.a shows the configuration

(a) weight confirmation system (b) weight warning system

Figure 3. Arduino and relay circuit [8] for weight confirmation configuration.
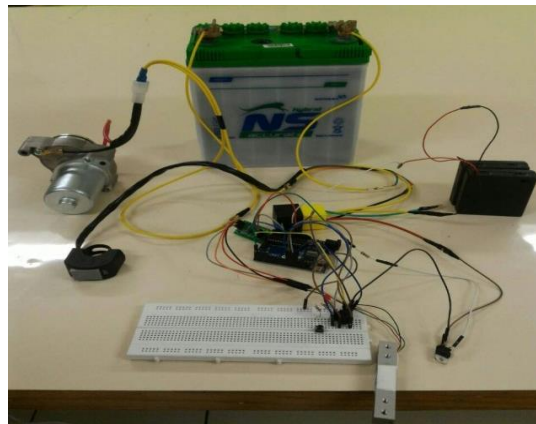
Figure 4. Experimental setup for simulation of the proposed system

for weight confirmation where the first checking is applied. Figure 3.b shows the configuration for a weight warning system of the second step where the door position is closed, once all the door car is closed, then the weight sensor will activate to measure the weight. Once the weight is in the normal range, then the Arduino will switch off the sensor otherwise it will send signals to turn off the engine. Figure 4 shows the experimental setup of the proposed system, the simulation consists of several parts, namely ignition system, ignition switch, NC relay, battery 12 Volts, weight cell sensor [10], circuit simulation and switch ON/OF the door sensor simulation. The input from the weight sensor will activated the electrical circuit which will activate the Arduino. The output from the Arduino will activate the NC (Normally Closed) relay to switch on the electrical signal to the ignition coil.

3.2. Experiment Setup
The weight of the vehicle is measure using weight cell sensor. The result of the weight sensor is used as input to the proposed system which will activate the Arduino. Once the Arduino is activated, then the automotive relay is active which will start the engine through activating starter motor or stop the engine through stopping the ignition pulse. The experiment divided into two parts, firstly when the condition of the weight after the same weight as the first condition and the second condition is when the weight a bit increase from 0 to 900 grams, by an interval of 50 or 100 grams from the previous weight. The weight limit is set to be not more than 800 grams. The result of the first experiment, where it is assumed that the car door is still open is shown in Table 1. Meanwhile, Table 2 shows the result where it is assumed that the engine is already turn on and the all the door already closed. Additional weight is added to check the weight warning system after it is assumed that all of the door is closed.

Table 1. The result of the experiment when the car door is still open.

No.	Weight (gr)	A proposed system designated action (starter motor condition)	Proposed system condition based on experiment
1	0	UNLOCKED	UNLOCKED
2	200	UNLOCKED	UNLOCKED
3	300	UNLOCKED	UNLOCKED
4	400	UNLOCKED	UNLOCKED
5	500	UNLOCKED	UNLOCKED
6	600	UNLOCKED	UNLOCKED
7	700	UNLOCKED	UNLOCKED
8	800	LOCKED	LOCKED
9	900	LOCKED	LOCKED

Table 2. The result of the experiment when there is increasing weight after all the door is closed.

No.	Weight (gr)	Door switch is On (All door are closed) (gr)	The Proposed system designated action (Ignition coil condition)	Proposed system condition based on experiment
1	0	(+50)50	ON	ON
2	200	(+50)250	ON	ON
3	300	(+100)400	ON	ON
4	400	(+100)500	ON	ON
5	500	(+100)600	ON	ON
6	600	(+100)700	ON	ON
7	700	(+100)800	OFF	OFF
8	800	(+100)900	OFF	OFF
9	900	(+0)900	OFF	OFF

The result shows that the proposed system works well for the weight confirmation and weight warning system. The experiment achieved 100% accuracy in the condition after ignition switch is turned on and conditional control whether the starter motor can be turned on (unlocked) or turn off (locked) is aligned with the designated purpose. Furthermore, the experimental results of the proposed system; with additional weight during all the car doors are closed is as shown in Table 2. The result shows that t proposed system achieved 100% accuracy where the signal to turn off the engine will be sent if the weight is above the limit. It shows that the system will work well for weight vehicle monitoring.

4. Conclusions

This paper shows a preliminary study to apply a weight limitation system in a vehicle to make sure that the vehicle is not overloaded, thus increase the safety of the vehicle. Experimental results showed that the proposed system produced a good performance. The application to the real vehicle need to be developed.

5. References

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