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Speed Limiter Integrated Fatigue Analyzer (SLIFA) for Speed and Fatigue Control on Diesel Engine Truck and Bus

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Abstract. Every second, the number of road traffic deaths is increased globally with millions more sustaining severe injuries and living with long-term adverse health consequences. Jakarta alone in year 2015 had recorded 556 people died due to road accidents, approximately reached 6.231 road accident cases. The identified major contributory factors of such unfortunate events are both driver fatigue and over speeding habit especially related to the driving of truck and bus. This paper presents the idea on how to control the electronic system from input fuel system of injection pump and the combustion chamber engine will control the valve solenoid in injection pump which can lock and fuel will stop for moment, and speed limit can be success, by using sensor heart rate we can input reduce speed limit when fatigue detection driver. Integration process this tool can be relevant when Speed Limiter Integrated Fatigue Analyser (SLIFA) trial in the diesel engine for truck and bus, the result of this research Speed Limiter Integrated Fatigue Analyser (SLIFA) able to control speed of diesel engine for truck and bus almost 30km/h, 60km/h, and until 70 km/h. The installation of the sensor heart rate as the input speed limit *SLIFA* would work when the driver is detected to be in the fatigue condition. We make Speed Limiter Integrated Fatigue Analyser (SLIFA) for control and monitoring system for diesel engine in truck and bus. Speed Limiter Integrated Fatigue Analyser (SLIFA) system can save the historical of the speed record, fatigue, rpm, and body temperature of the driver.

INTRODUCTION

Road fatal accidents are on the rise and the percentage is higher than average during holiday periods. Almost 1.3 million people died on the streets every year and it seems like the streets are terminal killers, anybody could become a victim, young or old, poor or rich, all are prone to accidents on the highway [1]. In year 2015, Jakarta had recorded 556 people who were killed in road accidents approximately reached 6,231 cases due to drivers' reckless driving or over speeding, fatigue and several other cases related to attitude. The enforcement by the Traffic Police continues to be an expressly important step that must be implemented against speed violators in order to improve the traffic safety of the community [2]. A good idea to control the speed and driver fatigue while operating a vehicle is to conduct electronic control of fuel supply connected with the fuel injection pump which will fit into the engine combustion chamber. Integrated control circuit can be designed with sensors to control the speed limits of conventional engines and on acceleration pedal when the engine is based electronics such as Electronic Control Module (ECM) according to the needs of safety and regulation. The Indonesian government regulation stipulates that the speed limit provision on urban arterial roads is 40 to 50 km/h and the maximum pedestrians only is 30 km / h while for highways, the maximum speed is at 70 km/h [3]. The Sensor driver fatigue

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which will detect the fatigue of the heartbeat paired in panel dashboard is directly connected to the driver by highlighting to the body which in integrated with a speed sensor on the transmission power train that has been linked to engine stop the motor mechanical for conventional diesel engines as well as on the pedal acceleration for machine-based electronic or Electronic Control Module (ECM) with a maximum speed of 30 km / h when the heart rate sensor input 80 / bpm.

PREVIOUS INVESTIGATIONS

Sensor driver fatigue which will detect the fatigue of the heartbeat paired in panel dashboard is directly connected to the driver body which in integrated with speed sensors on the speed sensor transmissions that have been linked to engine stop the motor mechanical for conventional diesel engines as well as on the pedal acceleration for machine-based electronic or electronic control module (ECM) with a maximum speed of 30 km /h what if the heart rate sensor input value 80 / bpm. Based on previous research, the investigation of transportation safety issues, especially on diesel engines for trucks and buses more concentrated on system limiting speed and reducing the speed of the vehicle as well as the cause and effect of accidents that arise. Several scientific publications have studies on the issue that relating to the vehicles speed control system. The following paragraph is to give a brief summary and critical of previous publications. Paine presented in its publication on the classification of speed devices showing the advantages and disadvantages of each type. He found that properly the designed *ISA* (Intelligent Speed Assistance) system can be highly effective in encouraging motorists to obey the speed limits where it should be encouraged by government [4]. Kameswari *et al* presented a design to control the speed of the automobiles at remote places for fixed time. Their proposed model used a microcontroller unit that receives the pedal position and then transfers appropriate signal to the Electronic Control Unit (*ECU*) that in turn controls the automobiles' throttle position [5]. They stated that their theoretical study needs further extension to consider more than one vehicle. In the early seventies of the past century, Ford Motor Company assigned patents concerning maximum vehicle speed limiter for a vehicle that has a pedal connected to a carburetor throttle valve through a linkage means [6, 7, 8]. The patents were based on mechanical and/or electromagnetic-circuit systems. Other inventors produced patents for engine maximum speed limiter with operator control. The control may be carried out by setting the upper limit of engine speed and then not be exceeded once a key-operated switch has been activated to an "off" position [9]. Other method of control can be applied by a programmable device that interfaces with the vehicle and identifies the operator who is allowed to set the maximum speed limit [10,11]. Some researchers discussed the impact of speed limit on the reduction of crashes and pedestrian fatalities in city of Zurich [11], South Australia [12], USA [13] and India [14]. Very recently, Hanowski *et al.* objected to identify the impacts of implementing road speed limiters (*RSL*) in commercial vehicle fleet operations. Their study included data from 20 truck fleets, approximately 138,000 trucks, and analyzed more than 15,000 crashes. Their findings showed strong positive benefits for *RSLs* and that the cost of the technology is negligible and would not be expected to be cost-prohibitive for fleets/owners [17]. Some researchers also concerned the acceptance of intelligent speed adaptation by car drivers. Mäkinen and Varhelyi reported field trials with in-car speed limiter, their investigations covered three European countries, the Netherlands, Spain and Sweden representing different regions and driving cultures [18]. Abraham analyzed speed data from Ontario highways using the standards of the Institute of Transportation Engineers and proved that the speed limits on these highways should be increased [18].

SPEED LIMITER INTEGRATED FATIGUE ANALYSER (SLIFA)

Speed Limiter Integrated Fatigue Analyser (SLIFA) is an electronic device that is designed with the intention to terminate the fuel consumption. This device will enter the combustion chamber by using a relay circuit breaker on the switch solenoid embedded in the Fuel injection pump on diesel engines for trucks and buses when the input sensor read speed over speed and heart rate unreadable fatigue, Figure 1.

Types of Speed Limiter integrated Fatigue Analyser (SLIFA)

There are various types of integrated Fatigue Speed Limiter Analyser (SLIFA), in accordance with the existing accelerator control on diesel engines for trucks and bus with conventional engine and Electronic Control Module (ECM) or engine, which has been based on electronic system.

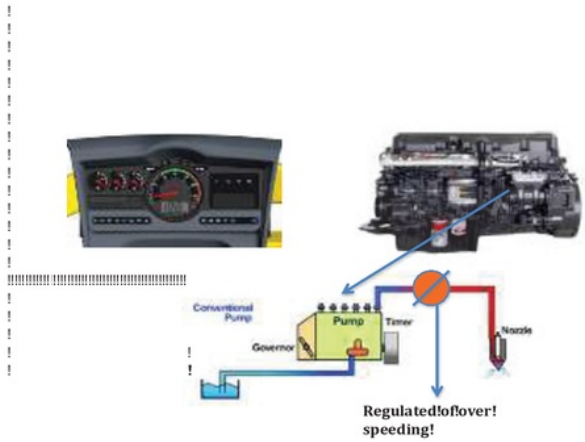

FIGURE 1. The functions of the Speed Limiter Integrated Fatigue Analyser (*SLIFA*).

Types of Speed Limiter integrated Fatigue Analyser based on the conventional accelerator control technique

General type and its basic model still use electronic components and only in use in conventional diesel engines operating with the following characteristics:

(1) The working principle is based on input over speed and heart rate.
(2) Accelerator control mechanical.
(3) Using a cable connected from the motor to the mechanical engine stop on the injection pump control rack.
(4) Cut of fuel through a solenoid valve, which is mounted, on the injection pump.
(5) In complete 85dB buzzer to give a warning sound.

Types of Speed Limiter integrated Fatigue Analzer based on the Electronic Control Module (ECM) accelerator control technique.

The fundamental difference of this type is the input voltage difference on pedal accelerator to the solenoid control rack the injection pump, rate limiting speed and input the value of the heart rate that was obtained into the main input. Thus, it will forward the voltage difference of the pedal accelerator to the fuel system with the aim cut off the current flow to the solenoid which connect into component injection pump / control rack with its operational characteristics as follows:

(1) Pedal accelerator based on electrical system as input and reset Speed Limiter Integrated Fatigue Analyser (SLIFA).
(2) Working Principle is based on the difference in resistance on the input voltage into the fuel cut-off solenoid relay engine.
(3) Fuel cut off based on the voltage difference that exist on pedal accelerator with a higher value 5 Volt DC and will be reduced in accordance with the speed that will be set in accordance with the regulations of the speed that has been set, with a speed of 70 km/h value of the voltage on the pedal accelerator to 3.5 Volt Dc.
(4) Equipped 85db buzzer sounds a warning faction.

PRESENT PROPOSE SPEED LIMITER INTEGRATED FATIGUE ANALYSER (SLIFA) MODEL

Design of Speed Limiter Integrated Fatigue Analyser (SLIFA) has several advantages which Speed Limiter Integrated Fatigue Analyser (SLIFA) easy to install on all diesel engines in conventional diesel engine-based Electronic Control Module (ECM). The device has a detection sensors heart rate at the driver in synchronize the sensor barrier speed on Speed Limiter Integrated Fatigue Analyser (SLIFA), in doing development Speed Limiter Integrated Fatigue Analyser (SLIFA), some things of particular concern are some minimum and maximum speed

will be the key, as this will determine the calculation speed gear transmission, brake system, engine brake, hand brake and engine stop condition.

Engine Specification of the Present work

The main specifications of the engine that used in the present investigation are listed in Table 1.

TABLE 1. Main specifications of the present engine

Item	Specification
Type	4 Stroke Diesel Engine 6 cyl inline
Bore x Stroke (mm)	112 x 130 mm
Max Speed	102 km/h
Max Torque (kg/rpm)	76/ 1500
Max Output (Ps/rpm)	260/2500
Fuel System	Fuel Injection Pump Inline
Displacement	7684 cc

ACCELERATOR DIESEL ENGINE SYSTEM

Flow Diesel Fuel System

The main basic principle of Speed Limiter Integrated Fatigue Analyser (SLIFA) works to cut fuel flow that will be sent to combustion chamber and to the injection pump which in its existing component rack control solenoid.

Engine Stop Motor and Mechanism

The engine stop motor is visible on the front of the cabin on a truck or bus that is placed not far away with the position of the engine as seen in, which is connected with the mechanism of a shaft intended to pull the cables connected to the injection pump, then the mechanism cable will attract rack control lever to the off position. That the pedal accelerator would not be functioning when the speed reaches above 70 km/h because of the position of engine stop active by encouraging position control rack to the off position, this happens in a moment because when the pedal accelerator off and speeds of less than 70km/h condition of engine stop going back to normal and the fuel will be sent back into the injection pump, if the input of the pedal accelerator electronic control, the engine stop motor is connected to the Electronic Control Module (ECM) and Speed Limiter Integrated Fatigue Analyser (SLIFA) work to cut off the engine based on the input magnitude of the difference detainees accelerator pedal.

Speed Sensor and Gear Transmission

Speed sensor in connecting with the aim to detect the transmission output speed that is connected to the speedometer, with its attached Speed Limiter Integrated Fatigue Analyser (SLIFA) the speed sensor as an input to provide speed information pulse is then restricted in accordance with the regulations in need, just as the speed can be adjusted with a minimum speed of 30 km / h for the detection of fatigue and maximum speed limit to 70 km/h.

Design Steps

The design process of the present control mechanism or pedal accelerator manual and electrical system Engine or Electronic Control Module (ECM) can be summarized in the following steps:

(1) Considering the maximum value of the force (F_r) that is required to limit the pulling movement of the accelerator wire.
(2) Finding the required motor torque (T_m) based on the parameters and specification engine.
(3) Connected adaptor control, and jumper the cable speed sensor rear and front if motor cut of engine ready in the diesel engine, base on manual or Electronic Control Module (ECM).

(4) If the transmission is not equipped with a speed sensor then performs fabrication by making a bracket for sensor speed that will be paired.

PRESENT SPEED LIMITER INTEGRATED FATIGUE ANALYSER (SLIFA) CIRCUIT

Electronic circuit Speed Limiter Integrated Fatigue Analyser (SLIFA), Figure 2 engineered and rafts to control the operation of the engine stop motor has been installed in the fuel injection pump. So, if this circuit works on a machine with a control mechanism also known as this circuit would serve to resist movement of the accelerator cable, and when installed on a machine-based Electronic Control Module (ECM). Then, if there are different grades resistant accelerator pedal with the resistant value of the speed sensor cable is connected to the engine stop motor will be active and when the fuel does not get into the engine combustion chamber. So the end result is to limit the engine speed according to the speed setting that is expected, in a block circuit diagram. The magnitude of the different input resistance is located at the accelerator pedal.

FIGURE 2. The picture of the present Speed Limiter Integrated Fatigue Analyser (SLIFA) Circuit

Components of the Present Control Circuit

The main components of the present control circuit can be listed as:

(1) *IC data program,* function to change the frequency of the signals from the speed sensor into a voltage.
(2) *IC Comparator* serves to be the driver of the program ic, ic output of the comparator would provide a voltage signal to the transistor base.
(3) *Micro Controller (Arduino),* functions for all sensor data processing Speed Limiter Integrated Fatigue Analyser (SLIFA).
(4) *Data Logger,* function for all sensor data processing Speed Limiter Integrated Fatigue Analyser (SLIFA) a module that is used to send data to the SD Card.
(5) *SD Card,* function for saves the data speed, heart rate, and temperature.
(6) *Relay* a component that functions for voltage breakers in the event of over speed that will break the current engine stop control.
(7) *Heart Rate Sensor,* placed on the dashboard and a highlight in the body of the driver to detect driver fatigue.
(8) *Temperature Sensor,* temperature detection function driver's body temperature.
(9) *Speed Sensor,* function to detect the speed of the vehicle in place on the transmission output.
(10) *RPM Sensor,* function to detect the run the engine
(11) *Buzzer 85db,* functions as an alarm when drivers exceed the speed and fatigue detection.

Program of the Micro Control

In the program development system Speed Limiter Integrated Fatigue Analyser (SLIFA) consists of two (2) modules, which module 1 (one) is a module that was developed by Micro Control Arduino, and the module is working to control the sensor that is in the system Speed Limiter Integrated Fatigue Analyser (SLIFA) such as speed sensors, RPM sensor, temperature sensor and heart rate sensor that is mounted on the circuit Speed Limiter Integrated Fatigue Analyser (SLIFA), function module is to record the data of the sensor value issued with an SD

Card. In the development of module 1 (one) using the C programming language, where the program is already in the bundle in the Arduino, and then to monitor and process data from the value that is issued by the sensor Speed Limiter Integrated Fatigue Analyser (SLIFA), developed module to 2 (two) with the aim that the data can be in the show into a report monitoring and data storage estate can be stored on a memory card / SD card, so that with the work Speed Limiter Integrated Fatigue Analyser (SLIFA) can monitor in real time and can be a material analysis of an investigation when a truck and a bus occurred accident on the road highway.

INSTALLATION OF THE SPEED LIMITER INTEGRATED FATIGUE ANALYSER (SLIFA) ON THE ENGINE TRUCK AND BUS

Speed and Fatigue Calibration Test

Before installing in units of trucks and buses, the Speed calibration is necessary to reset the data speed between the speeds out of the transmission output via the pulse speed sensor with the value of the voltage available at the speed limiter sensor in circuit Speed Limiter Integrated Fatigue Analyser (SLIFA).

Table 2, the result of the calibration test will be referred for the installation of speed limiters in trucks or buses, so the installation of speed limiter should not require the release of the propeller shaft.

TABLE 2. Result the Calibration Test

No	Voltage DC (V)	Speed (km/h)	Frequency (Hz)
1	0	0	0
2	1.0	20	83.3
3	1.8	30	125
4	2.5	40	166.6
5	2.8	50	208.3
6	3.0	60	249.9
7	3.5	65	270.8
8	3.8	70	21.6

Installation Procedure on The engine Truck and Bus

Speed Limiter Integrated Fatigue Analyser (SLIFA) installation procedure is as shown in the schematic circuit, by performing the following steps:

(1) For diesel trucks and buses that would be installed when the Engine stop the original motor of the machine then only need to connect cable on-breakers of fuel system.
(2) After the first point has been done then it is connected with a cable to the box Speed Limiter Integrated Fatigue Analyser (SLIFA) to the process in an electronic circuit and forwarded to the speed sensor on the transmission output.
(3) The data pulse from the speed sensor would be sent to the speed sensor back and would be connected to the motor engine stop relay.

IMPORTANT REMARKS ON THE PRESENT

There are some important remarks that have to be recorded concerning the present control system, namely:

(1) Speed limiter Integrated Fatigue Analyzer (SLIFA) had been successfully implemented and tested and have been observed the speed that has been in lock with the stage of 30 km / h, 60 km / h and 70 km / h.
(2) Heart rate sensors that have been paired to control driver fatigue could also serve as input for connecting with the speed limiter.
(3) Reporting on Speed Limiter Integrated Fatigue Analyzer (SLIFA) System managed to release information data and stores the data in real time i.e. the minimum and maximum speed, RPM data, the data of temperature and heart rate of data.
(4) Experiments were carried out to make sure that there was no effect of the present speed control system

on the engine performance. Experiments revealed that there is no change on either the air/fuel ratio or the percentages of the exhaust components.

(5) It should be noted that the completed test is testing on operating truck with a full load and the terrain highway, so Speed Limiter Integrated Fatigue analyzer (SLIFA) success and could be applied to trucks and buses.

CONCLUSION

Based on the previous explanations and discussions, the following concluding points can be stated:

1. The present speed and fatigue control systems were successfully implemented and tested. The control system had succeeded in limiting the engine speed according to the pre-set vehicle speed limits and heart rate detection. Thus, the objective of the investigation was achieved.
2. Generally, the present mechanism has no noticeable bad effect on the engine performance. There was no change on during the fuel cut-off relay that worked in normal road conditions and up and downhill road conditions.
3. Mechanism in the fuel system on the truck in the test was done as the motor fuel cut-off was already available in the unit, so only needed to connect the cable to the fuel cut-off that could be connected with Speed Limiter Integrated Fatigue Analyser (SLIFA).
4. Speed Limiter Integrated Fatigue Analyser (SLIFA) successful System can work and can display accurate data on speed, fatigue, engine rpm, and the driver body temperature, and can print the data for investigative purposes.
5. It was a challenging job to design and implement modifications to existing systems.

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