EFFICACIOUS IDLE-STOP SYSTEM IN AUTOMOBILES USING INTELLIGENT TRAFFIC CONTROL ALGORITHM

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***Abstract*— This paper introduces efficacious idle start stop system which uses mild hybrid vehicle technology and intelligent traffic control to improve fuel economy in automobiles.The proposed system simply relies on the existing Idling Stop System and wireless vehicular communication to use the hybrid technology effectively . The idle stop system , working via the vehicle computer automatically turns the engine off and on, when the vehicle stops and starts up respectively, saving approximately 5-10% [1]fuel. The proposed traffic control system with wireless interface sends the stopping time to the vehicle based on which the Engine control unit (ECU) decides on effective idle stopping. This optimizes the idle stop technique while avoiding terse and pointless stopping of vehicle during very brief stops. It can also be used to channelize the traffic to create a green Light tunnel,thus resulting in fewer stops, less travel time, and most importantly sums up the idling time to make use of idling stop system efficiently.**

***Keywords*— Engine control unit(ECU), Dedicated short range communications , Mild hybrid vehicle .**

I. INTRODUCTION

In recent years, the problem of global warming has seriously become a worldwide concern. It involves issues such as the sea-level-rising problem. During the last 100 years, the global mean sea level has risen between 10 and 25 cm (18- cm average)[2]. Man's livingenvironment has changed through heat waves or extreme weather. e.g. the catastrophic floods that hit the European continent in 2002 and the unusual high temperatures seen for prolonged periods in the summer of 2003[3]. To slow down the speed of our living environment's deterioration, the reduction of CO_2 emissions has become urgent. As one of the major sources of CO_2,vehicle exhaust emissions have become more serious due to the rapid increase in the numbers of vehicles in the world.

This CO_2 debate and the need for higher efficiency vehicles has led to the development of this advanced start-stop/idling-stop system, also called mild hybrid systems.Barth *et al.* carried out experiments [4] indicating that, during an idling period, the engine would consume more fuel and release more CO_2 emissions than in a cruising period.**.** The key elements of the start/stop system are an integrated starter-generator (or starter-alternator), an array of sensors including the battery, neutral-gear, wheel-speed and crankshaft sensors, a 12V DC/DC converter and the ECU. Angular sensors are ideal for capturing wheel speed, pedal position, rotor position and neutral gear position information to derive the proper start-stop strategy. The ECU most commonly called the powertrain control module (PCM) controls a series of actuators on an internal combustion engine by reading values from a multitude of sensors within the engine bay, interpreting the data using multidimensional performance maps and adjusting the engine actuators accordingly.**Thus idle stop controller stops an engine idle when a driver signals for such a stop and restarting it when the driver removes his or her foot from the brake. The engine control unit (ECU) controls the actuators(starter, valve timing) with input parameters (Engine temperature, cabin temperature, battery status, steering angle, seat belt connection, brake pedal position, accelerator pedal position, clutch pedal position, gear shift , wheel speed) from sensors and using traffic information from the intelligent traffic controller** This system can be designed using existing car components so that it could be installed quickly and cost-effectively and be adapted to different engines and vehicle types by individual automotive manufacturers.

A study in [5] indicated that starting an engine from rest has higher emission rate than idling. So a Robust and adaptive ECU is required to take strategic decision on Idle stopping .To minimize the waiting time and avoiding unnecessary stop-and-go driving, an intelligent traffic controller is used .It sends the waiting time to the ECU and based on the acknowledgement signal from the vehicles on a particular lane , the instantaneous traffic volume is calculated . The waiting time and the traffic volume can be best utilized to create a green light tunnel for smooth travel and then reduce CO_2 emissions.

II. MOTIVATION AND PROBLEM STATEMENT

Earth day network on every year has a no idling campaign in various institutions and organizations. The "stop idling" movement, which calls for engines to be turned off in stationary vehicles aims to reduce air pollution and global warming by controlling emission of exhaust gases such as carbon dioxide, and also to contribute to energy conservation and noise pollution reduction. Running a car without going anywhere just doesn't make any sense as idling emits more CO2 per minute than driving because the engine isn't operating at its peak temperature. A campaign to get drivers to stop idling car engines has been underway for more than ten years in Japan. The Japan Ministry of Environment started the effort in June 2002[6]. Large quantities of "stop idling" stickers were distributed by the Environment office, to be posted on trucks and taxis. According to studies from the Environment Agency and the automobile industry, a car's engine idling for 10 minutes produces about 90 grams of carbon dioxide and consumes 0.14 liters of fuel. If all the approximately 68.6 million cars owned in Japan were left to idle for 10 minutes, they would spew out 6,170 tons of carbon dioxide and consume as much as 9.6 million liters of fuel. Conversely, if all cars left their engines running for a minute less each day--or 365 minutes less a year--about 225,200 fewer tons of carbon dioxide would be emitted, and 350 million liters of energy saved. Even assuming each car is used only 200 days per year, this measure would bring about a 123,400-ton drop in carbon dioxide emissions and 192 million liters in fuel savings.

A. *Problem Statement*

Despite creating awareness, manual idle stopping could not gain ground among commercial drivers as it accounts for clumsy driving. With the use of electronics in automobiles, automatic idling stop systems were introduced in some vehicles. Devices of this type have been tested since the mid-1970s, when the Toyota Corporation fitted a Crown sedan with an electronic device that would automatically switch off the engine after sitting stationary for a few seconds. Later , National Highway Traffic Safety Administration (NHTSA) in the US raised questions about non-hybrid Honda vehicles equipped with the company's 'Idle Stop' transmissions in February 2001 due to concerns over the "sudden lurching forward of a vehicle in an automatic restart" – rather than the "gradual creeping forward found in current transmission design. Moreover car batteries with greater capacity and highly durable motors are necessary if engines are to be turned off frequently while drivers wait for traffic lights to change or traffic jams to ease, but the private-use cars currently on the road are not designed for this type of use.Sometimes it is pointless to stop the engine when the idling time is such that the energy saved is more than the energy needed to start the engine from rest.

In the last two decades, hybrid and mild hybrid vehicles emerged to be common and well accepted. Johnson Controls says that the number of vehicles equipped withmicro-hybrid technology (a.k.a. stop-start or idle-stop) will at least triple within five years as automakers strive to develop vehicles with improved fuel efficiency.

Also **Intelligent transportation systems** (**ITS**) are emerging applications which, without embodying intelligence as such, aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.

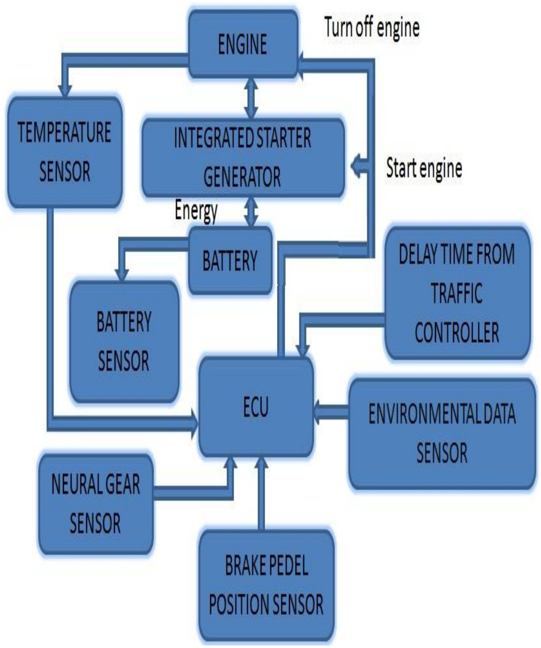
Since Intelligent transport systems can vary in technologies applied, we introduce a Novel ITS which sends the waiting time to the vehicles at vicinity and requests for an acknowledgment from the vehicles. The vehicles heading towards the intersection sends a signal back to the ITC and the ECU manipulates the waiting period using an algorithm making strategic decision for efficient idle stopping.

. Furthermore, [4] implied that the most common reason for engine idling is a stop-and-go driving style which usually happens when parking or passing through intersections, e.g., taxies that wait in queues to pick up passengers in taxi pickup points and vehicles that wait for traffic lights at intersections. To minimize the waiting time and avoiding unnecessary stop-and-go driving, the acknowledgment signal from the vehicles in each junction is used to study the traffic flow pattern.The ITC then processes the obtained data to create a green light tunnel wherein the heavy traffic corridor flows without stopping at the cost of low traffic lanes blocked.

III. SYSTEM MODEL

In this section , the model of the Novel hybrid vehicles and traffic light controllers are discussed.Here all vehicles are equipped with on-board units (OBUs) which are used to collect information from the traffic lights and send information such as such as the moving directions(e.g., go straight, turn right, or turn left)and emergency signal. OBUs are applied to send traffic flow information to traffic lights by wireless communication. In traffic control center, traffic lights' cycles are dynamically adjusted based on the received detected traffic flow information by a certain traffic light control algorithm.

The setback in the conventional Hybrid vehicles can be avoided by incorporating the information from the network of traffic controllers.Normally [7] the software in the vehicle computer will analyze all relevant data transmitted from the vast array of wired sensor fitted in the vehicle and when the brake pedal is pressed, the electronic control unit senses the touch and switches off the engine by cutting fuel intake by the engine. The environmental data sensors help in sensing external environmental conditions i.e. external temperature, humidity etc and only when the conditions are satisfactory, facilitates the automatic stop. Now there are other points to be required while idle stopping.This system will be more pragmatic if the idling time / standstill time is considered by the ECU before actuating the fuel injector valve.



A. *Model of electronic control system for auto start/stop system*

B.Intelligent traffic controller

Here a specific traffic control unit at an intersection is considered. The system is a 32-bit microcontroller-based intelligent road traffic controller with a distributed architecture. It consists of a master controller and two or more slave controllers. The traffic junction plan resides in the master controller and the slave controller is fixed at each side of the junction. The signal lamps are driven from the master controller and the slave controller of the respective signal poles. The number of slave controllers required depends on the junction geometry, e.g. for a four-arm traffic intersection, one master controller and four slave controllers will be required.

The instantaneous red light /waiting time is sent to the vehicles at the junction using wireless communication between the slave and the vehicles .the vehicles inturn sends the acknowledgement to the slave controllers . The slave controller,from the signals from the vehicles calculates the traffic at the junction in a particular direction. The master controller obtains the no of vehicles at the intersection and uses an algorithm to decide the traffic flow pattern while communicating with the network of the traffic controllers . Thus this intelligent traffic control algorithm is also an adaptive system .

C. Vehicular communication

Dedicated short-range communications are one-way or two-way short- to medium-range wireless communication channels specifically designed for automotive useand a corresponding set of protocols and standards. The United States Federal Communications Commission (FCC) in the USA allocated 75 MHz of spectrum in the 5.9GHz band for DSRC to be used by Intelligent Transportation Systems. The delay time can also be obtained from satellite radio giving information about traffic and weather but since it uses adaptive traffic control strategy, DSRC is most preferred for accommodating the machine to machine communications of multiple traffic light units. Moreover communications between the individual sealed traffic light units should be strictly controlled. Transmission and reception between units must be continuous and secure from remote tampering or interference to ensure drivers do not receive a signal to proceed when it is not safe to do so. Should any interference be detected, the lights should immediately default to red.

ATC provides seamless operations between intersections with minimum delays, summed up idle time and drive times. It is a plug-and-play system that works with existing traffic control cabinets and controllers. It flexibly adapts to the actual traffic conditions based on real-time inputs and algorithmic decisions and calls up the traffic signal state that best serves actual demand while coordinating its decision with other intersections. It does so by dynamically co-coordinating traffic control over a wide area in order to control traffic flows on the road network. The coordination between adjacent traffic signals involves designing a plan based on the traffic volume (number of vehicles), trends over time, delay and queue data and introducing a system to link the signals together electronically. Its main hardware components are Vehicular communication(DSRC) , a 32 bit processor and communication between individual traffic controllers .

1) The delay time at any instant is transmitted to all the vehicles approaching the intersection by the traffic light units at each junction

2)The On board unit in vehicle uses the delay time for idle stopping and returns an acknowledgement to the master traffic controller.3) Local coordination is achieved by linking traffic controllers, detectors by dedicated cables (telephone-type) or wireless communication with the central computer.

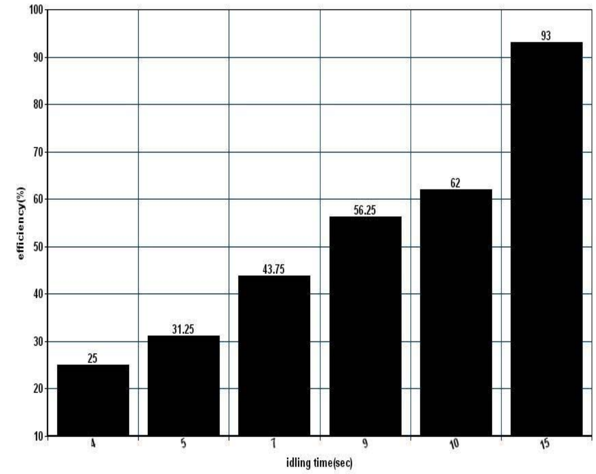
4) The processor with the help of the obtained data, time distance diagram operates the adjacent traffic controllers to create progression along an entire corridor by using green tunnels. The lane with more traffic volume is made into a corridor where Platoons of vehicles gather and are then released without slowing down or stopping. The green tunnels' duration and frequency is varied such that the traffic from all sides is regulated. As a result the idling time at each junction is summed as the idling time to create a corridor.

Take for example, a commuting in the peak hour involving 5 intersections. The adaptive traffic control (ATC), a plug and play system can be used to observe the traffic at each intersection and control the traffic based on the flow and no of vehicles from each direction. Without ATC the commuter would have to stop for at least 30 seconds at each intersection where as ATC system works to reduce traffic congestion and also sums up the idling time at a single junction which is less than the cumulative stopping time at each individual junction. During the non peak hours, the waiting time in the traffic signal is less than 10 seconds and the idle stopping the engine in this case would be pointless. Wireless communication with the traffic signal controller can provide prior information on the waiting time which can be used by the ECU of vehicle to decide on idle stopping.

From the example table below, it is seen that during the peak hours the proportion of vehicles from both side is 3:2 .Thus it is best to create a green tunnel through intersection 1 and 2 from east to west. At the same time some vehicles have to idle stop for time which is than cumulative of the wait time at intersection 1 and 2 but greater than the individual wait time at each intersection.

Peak Hours	**No of vehicles from east and west**	**No of vehicles from north and south**	**Non peak hours**	**No of vehicles from east and west**	**No of vehicles from north and south**
inter-section 1	20	10	**inter-section 1**	10	6
inter-section 2	25	9	**inter-section 2**	8	7
inter-section 3	10	15	**inter-section 3**	5	2

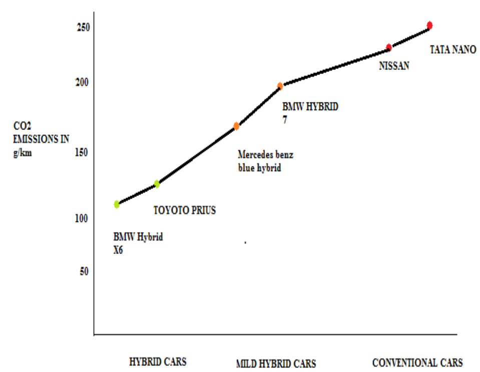
However during the non - peak hours the traffic is nearly uniform and tunneling is not advisable but here there is a possibility of ineffective idle stopping .For a time less than 10 sec, excluding 4 sec (2sec stopping and 1.5 sec starting) only 6 seconds idling is prevented at the cost of complexity. .ATC enables the Engine control unit to use stop time from traffic signals as a parameter to decide on idle stopping.



IV. Performance analysis

The graph below shows the carbon footprint of various four wheelers based on the technology used. Conventional cars emit CO_2 at higher rates (225 g/km) compared to other vehicles. The use of mild hybrid shows significant reduction in CO_2 emission (25% lesser than non-hybrids). On the other hand full hybrid vehicles produce very low CO_2 (105 g/km) in exhaust.

But it's easier to implement mild hybrid in the existing vehicles and is also the cheapest method to abate Global warming compared with Strong Hybrid vehicles.



The performance of mild hybrid vehicles increases manifold when ITS is implemented on these systems. The following segment gives a clear picture of the potential of ITS on traffic flow regulation.

Say a vehicle is approaching an intersection. As it nears the traffic light, the OBU receives the waiting time continuously and returns the acknowledgement to the traffic controller .When the vehicle stops at the traffic light ,the sensors sends the vehicle state information to the ECU. The ECU processes the information from the array of sensors and as a final step reads the waiting time obtained. If the final waiting time is greater than predefined optimum working time of the system,it actuates to stop the vehicle.

Typical idle stopping mechanism takes about 2-3 sec for deciding and stopping the vehicle and takes 1.5-2 seconds to start the vehicle. Thus stop start is efficient if the **idling time is greater than at least 10 seconds** from braking and cruising of the vehicle.Various analysis results show that carbon emissions reduce by **0.3 grams of CO_2** by enacting ITS on mild hybrid vehicles

V. Conclusions

This paper presents idle stop system, a fuel economy improving technology and intelligent traffic control algorithm to effectively use this system as well as to regulate traffic flow in urban areas. Data from intelligent traffic signals overcomes the drawback of conventional hybrid engine as it makes strategic decision for idle stopping. With automakers striving to develop vehicles with improved fuel efficiency, mild hybrid vehicles is proven to be the easy , cheap and best design to reduce the carbon footprint.

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