Low Cost Intelligent Real Time Fuel Mileage Indicator for Motorbikes

Jaimon Chacko Varghese, Binesh Ellupurayil Balachandran

Abstract— The design of "Low Cost Intelligent Real Time Fuel Mileage Indicator for Motorbikes" is intended to developing a low cost device that can actively display the fuel mileage of a motorbike and display it in real time onto a display which is attached/placed on the dashboard of a vehicle along with other driver information system. A unique method and system has been devised for giving instantaneous mileage readings in real time during both driving conditions and idling conditions corresponding to the amount of fuel consumed and the distance travelled by the motorbike. This device can be added as an enhancement to existing motorbikes too which works on carburetor and even on bikes with fuel injection technology. The mathematical calculations done by humans to manually check the mileage of a vehicle can be automated with the implementation of this device. Also, the probable distance that can be travelled by the vehicle corresponding to the amount of fuel in the fuel tank can also be estimated. The method and apparatus in this device includes a flowmeter from which the amount of fuel consumed is sensed and given as the input signal to a microcontroller which in turn also receives the signals from vehicle speed sensors indicating the distance travelled. The microcontroller access the data obtained from both the sensors and computes numerical value which can be displayed onto a display unit digitally.

Keywords - driver information system; engine; flowmeter; fuel; low cost; mileage; motorbike; sensors;

I. INTRODUCTION

Fuel mileage in vehicles refers to the relationship between the distances travelled by an automobile to the amount of fuel consumed [1]. In the current scenario of hike in fuel prices, most of the vehicle drivers seek for economical fuel consumption. Moreover in today's world fuel saving is also an important factor. For a developing country, where people are more obsessed with mileage, manual mathematical calculations are carried out to know the mileage of a particular vehicle. In conventional fuel mileage calculation method, the results are obtained by two successive refueling of the tank [2] and also by the in vehicle parameters [3]. The drawback of this process is that the results obtained will be after a day or two and also it is time consuming. Thus demand grows for capability to display fuel mileage consumption in real time and real ECU which is cost effective [4] [5].

Currently fuel mileage indicators are made available to latest motorbikes running on fuel injection technology only and these are not accessible in carburetor based motorbikes [6]. Considering these situations we have developed a low cost unique method and system for getting instantaneous mileage readings in real time corresponding to the amount of fuel consumed and the distance travelled by the motorbike. This device can run on carburetor based motorbikes and also can be added as an enhancement to existing motorbikes too. The mileage readings will be shown for both the actual driving conditions and during idling condition.

II. PROPOSED SOLUTION

This project focuses on creating a device which can help to actively display the fuel mileage of a motorbike in real time. It involves the making of the system to provide a mileage indicator which is reliable, easy to read and of dependable/compatible overall design. It also involves the process of utilizing the compatible speedometer/odometer apparatus of a motorbike without interfering with its operation [7], so as to permit installation of the mileage indicator in any existing vehicle or engine without much existing alteration.

The system will comprise a flowmeter, a control unit and a display unit. Fig 1 shows the block diagram of the proposed system. A novel flowmeter of minor size is designed and is made to fix in between the fuel tank and the engine [8] [9]. This flowmeter will be accountable to receive the fuel from the fuel tank and provide it to the engine.

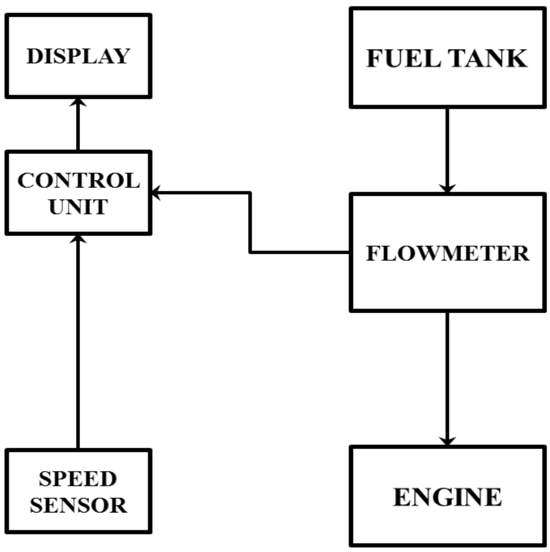

Figure 1. Block diagram

The control unit comprises a travelled distance interpreter [10], a consumed fuel amount calculator which is based on the flowmeter and a fuel mileage calculator; for calculating fuel mileage based on the travelled distance and the consumed fuel [11] [12]. The fuel mileage display will display the mileage of the motorbike in real time.

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The readings will be displayed in two ways; during running conditions and during engine idling condition.

III. COMPONENTS

The main components required for the functioning of the above proposed solution are elucidated below.

A. Flowmeter

A flowmeter is an instrument used to measure nonlinear, linear, volumetric or mass flow rate of a gas or liquid. Positive-displacement flow meters accumulate a fixed volume of fluid and then count the number of times the volume is filled to measure flow. Other methods to indirectly calculate flow, depends on forces produced by the flowing stream as it overcomes a known constriction. Flow can be measured by measuring the velocity of fluid over a known area.

B. Electronic Fluid Valve

Electronic fluid valve is a fluid valve that is electronically controlled to obtain open and closed position of the valve. The valve changes it states between open state and closed state based on the electrical signal applied to the terminals of the electronic fluid valve.

C. Microcontroller

A Microcontroller has all of the essential blocks to read, write information to the display, control and store data. In addition to simple ON/OFF inputs and outputs, many microcontrollers have abilities such as measuring analog signals, performing pulse-width modulated output, counting input pulses, and many more.

D. Solenoid Driver

Solenoid driver is a circuit which is used to drive the fuel solenoid from the battery with the control signal from the microcontroller. Since the microcontroller can supply only a 5Volt signal at 100mA, this is necessary [13].

E. Level Sensors

Level sensors detect the level of substances that flow, including slurries, granular materials, powders, and liquids [14]. All such substances flow to become essentially level in their containers (or other physical boundaries) because of gravity. The substance which has to be measured can be in its natural form (e.g. a river or a lake) or inside a container. These measurements can be achieved either continuous or with point values. The former measure level within a specified range and determine the exact amount of substance in a certain place, while the latter only indicate whether the substance is above or below the sensing point. Generally the point value sensors detect levels that are excessively high or low.

F. Speed Sensors/Distance Sensor

Speed sensors provide information to the microcontrollers about the speed of a component and the change in speed of a component. Vehicle speed sensor is used to determine the speed of a vehicle [15]. The microcontroller uses the vehicle speed sensor to modify engine functions and initiate diagnostic routines. Different types of sensors have been used depending on models and applications.

G. LCD Display

A liquid crystal display (LCD) is a flat electronic visual display or a video display that uses the light modulating properties of liquid crystals. LCD displays utilize two sheets of polarizing material with a liquid crystal solution between them [16]. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them. Each crystal acts like a shutter by either allowing light to pass through them or blocking the light. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images which can be displayed or hidden. The LCD displays are available with the following display sizes 16x2, 16x3, 16x4, 20x2, 20x3, 20x4 with 5x7 pixels per character. It is based on the HD4470 display driver circuit.

IV. SYSTEM DESIGN

A. Flowmeter

The proposed fuel flowmeter assembly comprises of a leak proof housing which contains the quantity of desired fuel required for the estimation purpose. The housing may be constructed of any suitable material like glass or other transparent material which are impervious to fuel. Fig 2 shows a partially cutaway proposed fuel flowmeter apparatus.

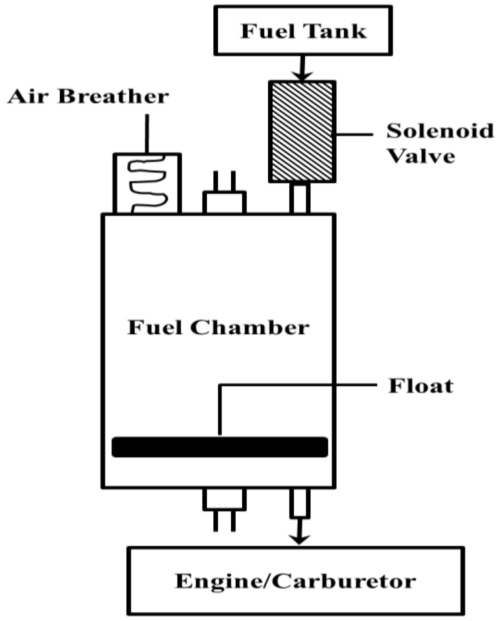

Figure 2. Flowmeter

A sensing unit is attached to the flowmeter in the fuel line and it provides a signal to a gauge which registers fuel flow. Two level sensors are available which senses the level of the fuel at the higher and lower ends and in turn directs the information to the microcontroller. The sensors detect the level of the fuel through the help of a piston present inside the fuel meter. When the float reaches the top level, the sensor detects it and closes the fuel fine flow to the flowmeter. Now the fuel from the flowmeter flows to the carburetor to the engine. When the fuel in the flowmeter gets emptied i.e. the float comes down, the sensors detects this and opens the fuel line thereby filling the flowmeter again.

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Likewise, this process continues and the information from the sensors is received by the microcontroller for processing.

B. Electronic Fluid Valve Design

The complete electronics of a motorbike is based on 14 Volt charging system and a 12Volt battery. The solenoid based fluid valve was selected keeping these factors in mind. The commercially available Fuel Solenoid valve was used for meeting the purpose. The Fuel Solenoid valve operated based on a supply of 12V and was able to operate smoothly at switching frequency of 1 KHz. The solenoid also operated in Normally Closed condition which was necessary for the design proposed.

C. Microcontroller Design

The project was based on designing a low cost setup to calculate the mileage of the vehicle. Also it needs a good microprocessor to process the information and display it within minimum refresh interval. The program for the ECU ended up being between 4k to 8K. Considering all these factors the AtMega8 AVR series microcontroller was chosen among the other available microcontrollers. The other factors which influenced the selection of the microcontroller includes the easiness to write and program, lower cost of the microcontroller, a good speed of processing, and availability and compatibility with similar microcontrollers in the series.

D. Solenoid Driver Design

The solenoid driver required the ability to drive a 12Volt solenoid at 650mA [17]. Also the switching frequency was below 1. Hence the best driver circuit to handle such an application was chosen to be a 5Volt relay to drive the 12volt solenoid. The circuit was designed in such a way that the 5Volt trigger from the microcontroller was enough to switch on the relay and power up the 12 volt fuel solenoid directly from the battery. The additional protection circuits were used to prevent the Back emf from acting back to the battery.

E. LCD Display Design

The basic requirement of the project is to display the mileage of the vehicle and this requires a single line display only. Hence a 16x2 display is sufficient to display the desired information to the user. While incorporating additional information like the amount of fuel remaining, distance that can be travelled with the amount of remaining fuel, speed of the vehicle, time and engine rpm etc., the display may be changed to 20x4 or preferably a graphic LCD may be used. In this paper we forwarded with the 16x2 line display.

F. Control Unit

The vehicle fuel mileage meter consists of the fuel mileage display for showing the fuel mileage, the control unit for controlling the display of fuel mileage on the display based on the distance travelled and the amount of fuel consumed. Fig 3 shows the control unit of the proposed solution and its rule.

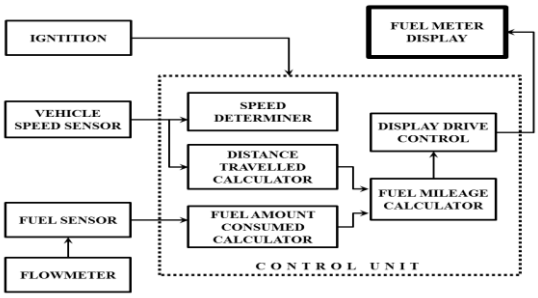

Figure 3. Control Unit

The control unit consists of a speed determiner to determine whether the vehicle speed exceeds a predetermined threshold based on information from a vehicle speed sensor, a travelled distance calculator for calculating the distance travelled based on information from the vehicle speed sensor, a fuel amount consumed calculator for calculating the amount of fuel consumed based on the information from the flowmeter, a fuel mileage calculator for calculating fuel mileage from the travelled distance and the consumed fuel amount calculated by the travelled distance calculator and the consumed fuel amount calculator, and a display drive controller for drive control for displaying fuel mileage calculated by the fuel calculator on the fuel mileage display.

G. Fuel tank calibration

To display the remaining distance the vehicle can run with present quantity of fuel in the fuel tank, the fuel tank calibration must be done. For motorbikes which do not have a fuel tank sensor, a new technique can be employed. It includes the introduction of reed switch sensor into the fuel tank. Reed switch sensors can be used because of their inherent sealed nature and array [18]. Special reed sensors with an integrated resistor can be mounted on PCBs to give out a potentiometric feedback across two outputs as a foamed magnetic float moves along its length. The PCB tracks can be intended in such a way that a full tank gives high resistance and an empty tank gives low resistance, or vice versa. Reed sensors are the best devices to use in explosive environments like fuel tanks as they are hermetically sealed devices.

For motorbikes having fuel gauge, the calibration can be done by calculating the voltage gained due to the movement of the resistor by the float for each level of the fuel in the fuel tank [19]. Thus the remaining distance the vehicle can run can be easily calculated and can be shown in real time on the display.

V. EXPERIMENTAL SETUP AND PROCEDURE

A test facility as shown in Fig. 4 is fabricated.

A. Test Setup

The entire setup described was designed and implemented on a motorbike and was tested for reliability. The device was designed keeping in mind the various parameters related to the vehicle/motorbike in which the device was fixed. The various parameters which were used to calibrate the ECU used in the proposed system includes the tire size, the speedometer technical details, the odometer technical design details, the expected fuel consumption rate of the vehicle as declared by the manufacturer etc.

The tire size was estimated from the model number printed on the tire. Using a thread the diameter of the tire was known. Equation (1) was used to calculate the circumference of the tire where r is the radius of the tire.

$$\text{Circumference} = 2 \times \pi \times r \qquad (1)$$

The odometer and the associated crown wheel assembly inside the wheel was studied and observed. The result was obtained as 2.5 rotation of the worm gear per rotation of the crown gear. This observation was used throughout the program to obtain the calibrated distance travelled by the motorbike based on the rotation of the crown gear.

The number of rotation of the worm gear and the rotor inside the speedo meter is the same as this is being driven by the worm gear using a torsional speedo cable.

The optical sensor was designed based on the reflectivity principle so that it can be a non – contact based measurement. The sensitivity was set to sense white strip from a black strip at a response distance within 5mm. The sensor was fixed at a distance of 5mm from the rotating disc. The sensitivity was observed to be perfect at all speed of the rotor. Fig 5 shows the optical sensor attached to the odometer.

The speedometer was modified to integrate this optical sensor into it without disturbing any other part of the speedometer or its function. The sensors electrical connections were pulled out of the speedometer casing along with the other existing electrical wiring running through the vehicle.

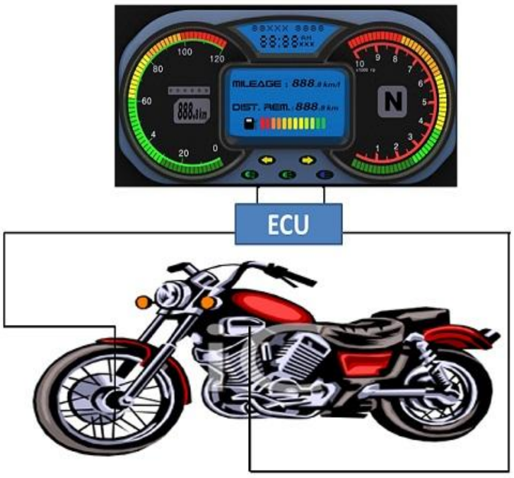

Figure 4. Experimental Setup

The ECU was designed to be compact and within the size of 10cm x 8cm so that this can be easily fixed in a location with sufficient room for the circuits and also this location was observed to be near the battery source which is used by the motorbike. The location near the battery also provided the circuit and ECU protection and shield from weather and other exposed condition. This location is also easily accessible so that any maintenance if required can be carried out easily. We were able to integrate the circuit into the provided with required level of protective enclosure. The additional electrical lines that needed to be added to the vehicle were easily added to the motorbike along with the existing electrical wiring. This helped to complete the wiring procedure with ease.

Figure 5. Optical sensor attached to odometer

Figure 6. LCD mounted near the existing dashboard

The solenoid fluid valve chosen was the right size and could be easily installed in the fuel line from the fuel tank. The flow meter was designed to fit in the available space above the carburetor without interfering with any other equipment or part of the vehicle. The electrical connections were made along with the existing electrical lines running along the chassis of the motor bike.

The flow metering device was mounted right above the carburetor. The height of the flow metering device is around 4cm and could be easily mounted above the carburetor.

The LCD display which is used to display the mileage was fixed near the dashboard of the motorbike right in the middle of the handle bar, near the key slot. The size of the LCD matched the handle design and hence could be easily mounted in the available space. The data strip of the LCD was run along with the other electrical wiring in the motorbike. Fig 6 shows the LCD mounted near the existing dashboard.

VI. RESULTS AND DISCUSSION

The fuel mileage indicator was mounted on the motorbike as per the design and was tested under various test condition. The design was based on a standard motorbike and was hence compatible to be implemented on any motorbike with the variation only in the program to learn the vehicle design and parameters. The device was working normally under the standard test condition and displayed different values of the mileage under different condition.

A. Test Method

The motorbike was run at various speeds and under various load condition to analyze the mileage of the vehicle.

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The standard speeds we used during the test were 10, 20, 30, 40, 50, 60 and 70 km/hr. The load condition was varied from a single person to two persons including the rider.

B. Test Result

The various results obtained are shown below. Table 1 shows the various values obtained at different speeds under various load conditions. Fig 7 shows the graph of the mileage obtained when running at various speeds with load condition with a single person. Fig 8 shows the graph of the mileage obtained when cruising at speeds with 2 person load condition.

TABLE I. Mileage Obtained At Different Speeds Under Various Load Conditions

Speed (km/hr)	Mileage (kmpl)	
	Single Person Load	*Two Person Load*
10	51	48
20	53	50
30	55	53
40	59	57
50	58	56
60	54	50
70	49	45

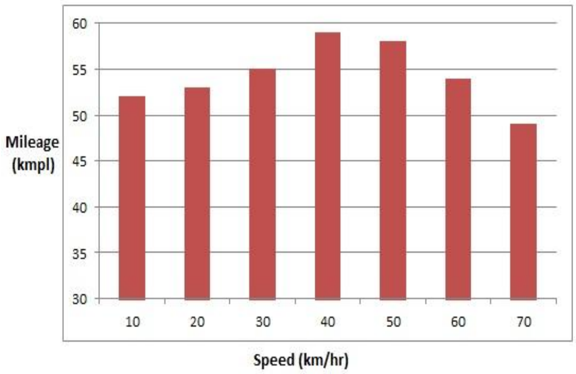

Figure 7. Mileage obtained during load condition of a singe person

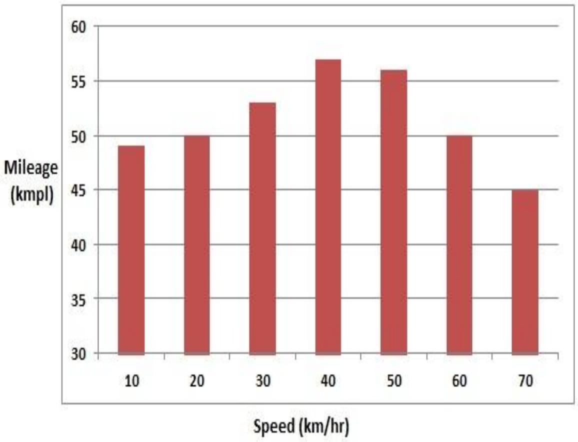

Figure 8. Mileage obtained during load condition of a two persons

The maximum mileage of the motorbike and the necessary driving condition required to achieve the maximum mileage was analyzed and found out. The device currently needs to be programmed based on the motorbike in which it is implemented. The future design should be able to be programmed and calibrated even after being fitted / mounted on the motorbike.

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