Design of an All-In-One Billing Meter for Three Wheelers in Sri Lanka

B.G.L.T. Samaranayake

Department of Electrical and Electronic Engineering, Faculty of Engineering, University of Peradeniya

Introduction

There is a massive trend in the Sri Lankan society to use Three-Wheelers in the absence of a reliable and punctual public transport service. This has been the practice for the past decade or so and the future is uncertain about of changing the situation. However, still there is no transparent charging system (billing system) for the above three-wheeler taxi services. As a result, clients have to satisfy with whatever the hire demanded by the three-wheeler driver. Hence there is a severe threat of abusing the service and charge unjustifiable amounts of money, and in fact this has been the experience by most of the clients, irrespective of the area of operation of the taxi service in the country. Therefore, there should be a viable technical solution to protect the client and make him pay only the desired amount.

Concerning the owners, since there is no stipulated per kilometer charging system, there is no way for the owner of the three-wheeler (as he may not be the driver in most of the cases) to double check the day's collection, with the number of kilometers the vehicle has traveled. Hence a reliable mechanism is needed for the owners to keep track of the distance traveled and fuel consumed against the income presented by the driver.

As far as the road network of the country is concerned, in most of the cities, they get flooded with traffic jams especially during the peak hours. In such situations, three-wheelers may have to be kept in queues with their engines on but at zero road wheel speeds. If the vehicle is issued with a fixed amount of fuel, then obviously the distance it can travel reduces compared to that of without traffic jams. Then the driver may find it difficult to convince the owner, at end of the day, the reason why the income dropped while having consumed the entire amount of fuel he has been given. In that case, there should be a technical evidence for the driver to prove his honesty.

Focusing mainly on the above needs of the clients, owners and drivers, an all-in-one billing meter, has been designed for the three wheelers in Sri Lanka, which will have some additional technically sound features, which will promote the meter to out perform such meters in the import market. The design is presented in the paper.

Methodology

The meter uses a pulse counting technique using Hall effect sensors to derive the number of turns of the road wheel, while its prevailing effective wheel diameter will be taken online via coupled electronic and optical methods to derive the distance travelled. This offers mechanical cable free, maintenance free, long-term operation. Vehicle inclination is also sensed to derive whether it is on an ascent or a descent and the engine idle time is the feedback to evaluate the fuel waste during traffic jams. The above parameters are used in an onboard micro controller to execute the relevant calculations. Low cost seven segment displays which can be viewed from distance both by the driver and the clients, is used for the human machine interface with a simple up-down and push button touch panel with mode changing to display the relevant parameters. Further, the same interface touch panel is used to enter the per kilometer charge by the authorities, which is password protected. In addition, it adapts appropriate noise handling techniques to overcome noise interference in the two-stroke and four-stroke internal combustion engine environment.

Results and discussion

Measure and display the distance of the trip

The distance traveled is calculated by counting the pulses generated in the coils due to the rotation of the permanent magnets (PM) connected to the driving shaft of the road wheel. The same pulse count is used to derive the speed of the three wheeler. The arrangement of PMs and the corresponding pulse pattern are shown in Figure 1 (a) and Figure 1 (b) respectively.

Display the accumulated distance

The designed meter to be fabricated is shown in Figure 2. The top row of the display shows the distance traveled for a given trip in kilometers, which may be set to zero at the beginning using the SET button. The same row can be used to display the total distance traveled since fixing the meter. The DISTANCE or ODO modes can be selected using the MODE button. The second row shows the instantaneous speed in km/h, while the bottom row shows the hire. This hire gets updated automatically based on every 100m traveled and / or the engine idling time since the beginning of the trip.

Password protected access to edit the billing rate by the authorities of the governing area

This is accomplished using the same display panel as shown in the Figure 2 but in a different mode entered using the MODE button.

Continuously display the due charge as the trip progresses, while taking into account the:

a). Air pressure of tires

Since the distance is calculated by counting the number of pulses as was shown in Figure 1(a), it is important that the correct effective road wheel radius is used. This is heavily dependant upon the flatness of the tyre as shown in Figure 3. Therefore it is measured and taken into account in the calculation of the distance so that it results in a more accurate distance calculation.

b). Amount of time spent on traffic jams

This is estimated by sensing the idling time of the engine since the beginning of the trip.

c).Elevation gradient of the road, i.e., traveling in mountainous vs., flat areas

This is detected by using the electromagnetic sensor arrangement as shown in Figure 4(a) and (b).

Calculate and display the fuel wasted due to traffic jams

This is done inside the micro-controller using the engine feedback on idling.

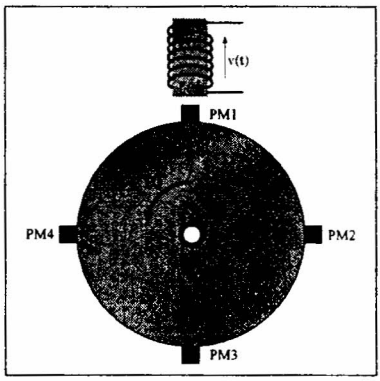

Figure 1(a). Rotation of the PMs connected to the shaft, which drives the road wheel

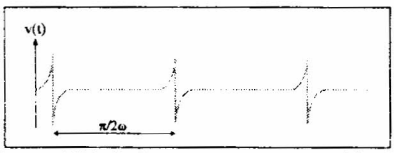

Figure 1(b). Pulse pattern generated in the coil.

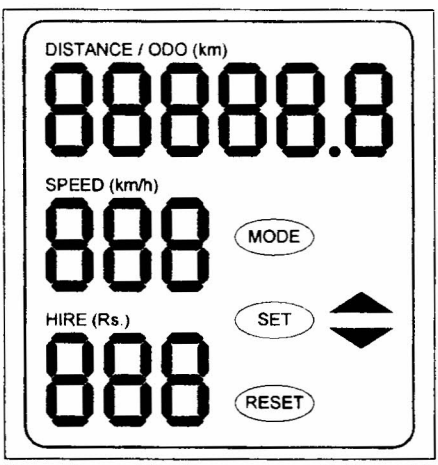

Figure 2. Display screen of the ALL-IN-ONE-BILLING METER

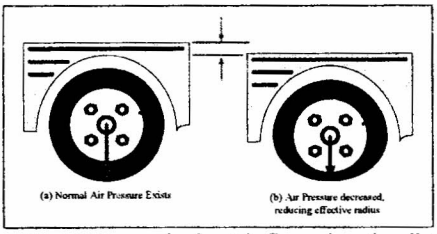

Figure 3. Effective radius of the road wheel influencing the distance calculation

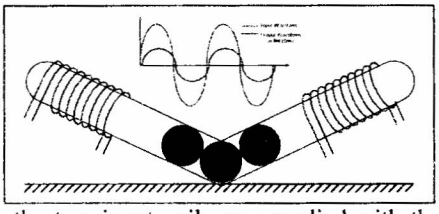

Figure 4(a). When the two input coils are supplied with the same sinusoidal input signal, two identical sinusoidal signals are induced in the two output coils, provided that the two coils are identical. The black circles are metal balls

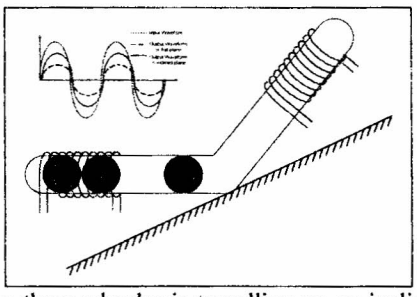

Figure 4(b). When the three wheeler is travelling on an inclined plane, the metal balls enter into the coil core increasing the magnetic coupling (reducing the reluctance). Hence the output coil with metal balls inside has a higher voltage induced compared to the coil without the metal balls. This difference is used to detect the elevation and decide the inclination.