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NUMERICAL METHOD FOR AUTOMOBILE SPEED DETERMINATION

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Abstract

It is important to know the actual speed and mileage of an automobile. Fuel consumption, drag and exhaust emissions, may be estimated with enough precission versus speed. The paper is presenting a method for determining the speed and for the assessement of errors both for speed and mileage of an automobile, comparing the precision results of the stientific research devices, versus the indications of on-board meters. Measurements took place upon a Romanian built automobile. Results enable better estimating of variables depending of automobile speed.

1. Scientific devices utilised

The automobile is provided with the normal system for speed and mileage, as shown in Fig.1.

Fig.1. Speedometer and mileage counter of the automobile

The stientific device for registering the automobile speed is presented in Fig.2 [1].

Fig.2. Speed and mileage stientific apparatus with no mechanical touching to the ground

Displays of measuring devices are presented in fig.3.

Fig.3. Displays of the measuring devices

Aparattus were set and programmed with a mobile keyboard of their own as shown in fig.4.

Fig.4. Setting the scientific devices for tests

A halogen lamp throws a beam of light on the road surface as presented in fig.2. The device includes a video camera which takes 2000 frames per second. The measuring principle and the aparattus lay-out are presented in fig.5 and fig.6 [2]. The device's precision is 2 per thousand (or 0,2%), compared with the precision of 2 % of the 5-th wheel system touching the road, previously used in such determinations (wheel bounces on pebbles, road fractures etc.).

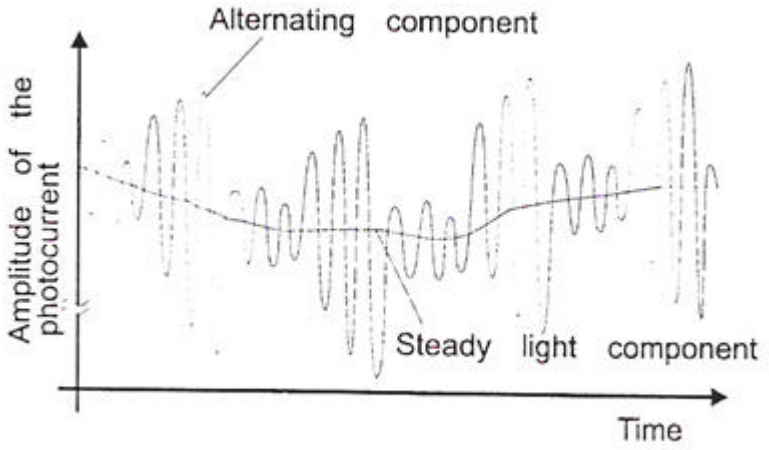

Fig.5. Principle of light beam measuring

General lay-out of the measuring device is presented in fig.6, both optical mechanical part and electronic part.

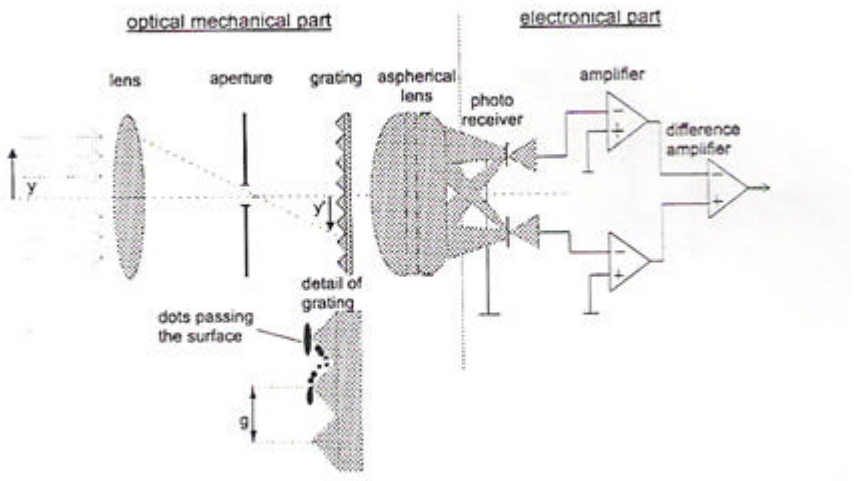

Fig.6. General lay-out of the measuring device

2. Results obtained

Tests were performed upon a Romanian built automobile, general mileage being 8,000 km. Speeds being of high values, measurements were performed on the Sun freeway (Bucharest—Drajna), where maximum allowed speed is 130 km/h. However, maximum speed reached was 170 km/h, bending official speed limitation for a couple of kilometers.

The obtained results are presented in table 1.

Table 1.

Measurements results

No.	Speed on automobile meter [km/h]	Real speed registred [km/h]
0	1	2
1	20	-
2	30	23 (-23.3 %)
3	40	34 (-15 %)
4	50	43 (-14 %)
5	60	52,5 (-12.5 %)
6	70	62 (-11.4 %)
7	80	71 (-11.25 %)
8	90	81 (-10 %)
9	100	91 (-10 %)
10	110	102 (-7.3 %)
11	120	111 (-7.5 %)
12	130	121 (-6.9 %)
13	140	130 (-7.1 %)
14	150	140 (-6.6 %)
15	160	151 (-5.6 %)
16	170	161 (-5.3 %)

Overall distance, measured over 75 km with the scientific device, was 77.5 km on automobile mileage meter.

In general, measuring errors are interpreted from relative error point of vue. Qualitative interpretations are presented in table2.

Table 2.

Measuring errors for different determinations ant qualitative interpretation

No	Relative error %	Precision assesement
0	1	2
1	0…1	Laboratory
2	1…3	Technical
3	3…5	Brute
4	> 5	Uncceptable

3. Discussions

Speed is indicated with errors between 5 and 23 %. Higher errors were reported at low values, due to the fact that the automobile speedometer indicates about 20 at zero value (stand still). Excepting for 20 and 30 km/h, where errors were too important, it is possible to represent actual speed function of on-board meter speed, indicated by the automobile speedometer, as shown in fig.7.

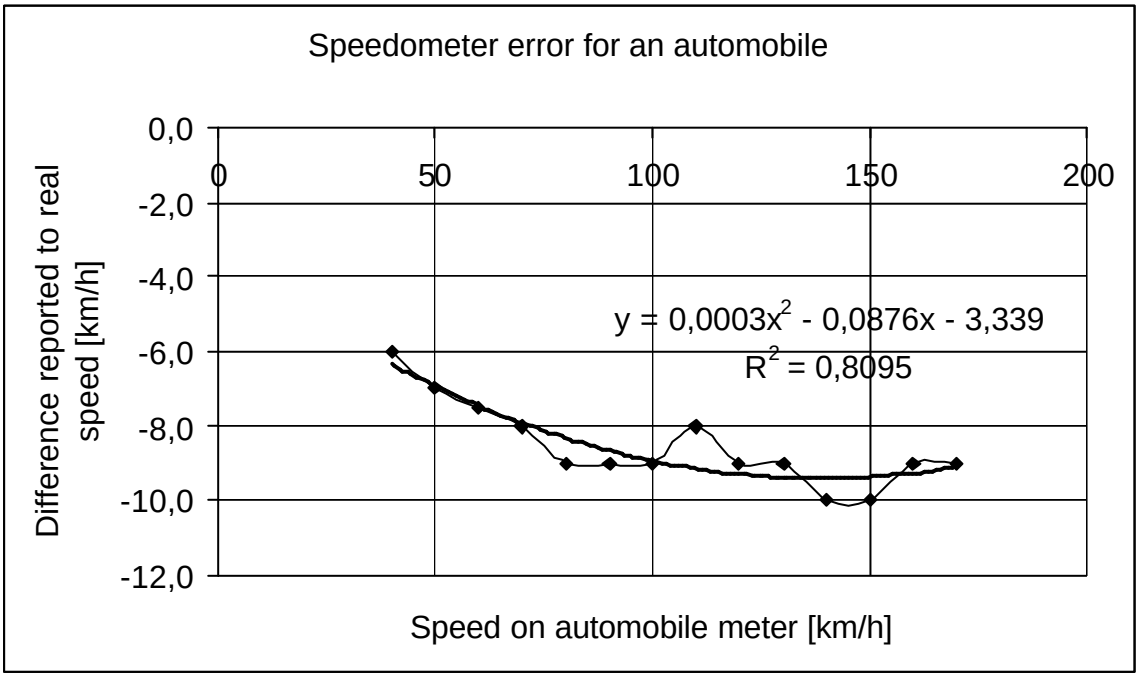

Fig.7. Speedometer error for an automobile

On the chart it is shown the equation representing difference from speed indicated by the automobile speedometer reported to real speed. Coefficient of regression for the polynomial of second degreee is 0.8095.

As regarding the total distance measurement, overall error is +3.33%.

It may be proposed a simple method for the manufacturer of the speedometer as follows.

The only fact of just changing the marked values on the bord panel, by lowering these values with 10 units, would give the following hypothetic results as presented in table 3.

Table 3.

Measurements results

No.	Speed on automobile meter [km/h]	Real speed registred [km/h]
0	1	2
1	10	-
2	20	23 (+15 %)
3	30	34 (+13.3%)
4	40	43 (+7.5%)
5	50	52,5 (+5 %)
6	60	62 (+3.3%)
7	70	71 (+1.4%)
8	80	81 (+1.25%)
9	90	91 (+1.11%)
10	100	102 (+2%)
11	110	111 (+0.9%)
12	120	121 (+1.7%)
13	130	130 (0%)
14	140	140 (0%)
15	150	151 (+0.66%)
16	160	161 (+0.6%)

In this case, the average error would be +3.58 % compared to the initial -10.25%, about 3 times less in general value

4. Conclusions

In the field of low speeds, general error is higher, between 15 and 23%. For other speeds, over 50 km/h, relative error is under 10 %. In absolute values, in the range of speeds below 60 km/h, speed indicated by the automobile speedometer is generally 7 to 8 km higher that the actual real speed, and over 70 km/h it is indicated a speed higher with 9 to 10 km/h than the real speed. Adjustements must be made for a closer indication of the speedometer, as example for fuel economy calculations, regarding both speed and mileage. As an example, for a trip from Bucharest to Brasov, the automobile mileage will indicate 173.6 km, instead of the real 168 km mileage. Also, on roads were speed limit is 60 km/h, if the speedometer of the automobile indicates 60 km/h, the real speed of the automobile is only 52.5 km/h. Knowing the actual speed of the automobile enables drivers and fleet owners for better assesement of some automobile characteristics, such as fuel consumption, overall mileage and exhaust emissions, if previous determinations were made on the respective automobile, as well as respecting traffic speed regulations.

Bibliography

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