

Full Length Research Paper

Detailed analysis of consumption of the transport device by the mobile device

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This paper deals with the gathering of GPS data and other personal information that are used to calculate the consumption of motor vehicles. To create a basic test application for the measurement consumption (Microsoft Visual Studio, 2008), C # programming language was used. The application is designed for devices based on Windows Mobile. For testing, a few PDA devices with integrated GPS module were used. The application calculated the consumption of refuel liters (yet entered by the user) with regard to mileage, which was determined from the read coordinates of a GPS module. This information is then stored in a SQL database for further analysis. To minimize errors will aid in using the algorithms to calculate the distance in 3D space. The application reached accuracy using a suitably chosen sampling interval. The result is a relatively simple test application for the Windows Mobile platform.

Key words: GPS NMEA, distance calculation, windows mobile, measurement consumption.

INTRODUCTION

With rising fuel prices (Figure 1) (Gas Price, 2010), the study became a very topical issue of their consumption. Therefore, it was decided to prepare a study and testing application on the subject "Detailed analysis of the means of transport by mobile devices". GPS service is provided free and because devices are relatively cheap nowadays, the system is available to anyone interested. Even though a range of applications supports the GPS system, monitoring of consumption in relation to the GPS, is offered by none of these programs. In this study, a PDA with an integrated GPS module was used. For increased sensitivity and a reduction of the error of measured data, an external active GPS aerial was used. Communication between the GPS module and software is via the standard NMEA 0183 (Yahya et al., 2009; NMEA, 2010). At PDA, an application that reads the GPS data, calculates the length of the route and monitor the quantity of the refuel fuel that was programmed.

These data are stored in a database, which expand the

options for further analysis. The driver has a tool that he uses to monitor the different effects on fuel consumption, and the correct way to drive and monitor the technical condition of the vehicle. The application is programmed in C # and is designed for Windows Mobile version 5 and 6. With the support of the operating system, Windows Mobile 7 is currently envisaged. In the study's case, there is no map application for the standard PDA device that uses an interactive user access. It offers more expansion options and it links GPS systems with the vehicle. The effect on the total distance traveled will be the sampling frequency. Low sampling frequency should result in a retrieval of shorter distance, especially on a route made up of many turns. Straight lines replace sections of the sampling points. The sampling frequency is set at 0.5 second which is the time at which the vehicle travels 13.5 m at a speed of 100 km/h. This period should be sufficient; however, it is not expected that we will move at this speed in a complex sinuous terrain.

Problem description

The final definition of the problem area is the area at the

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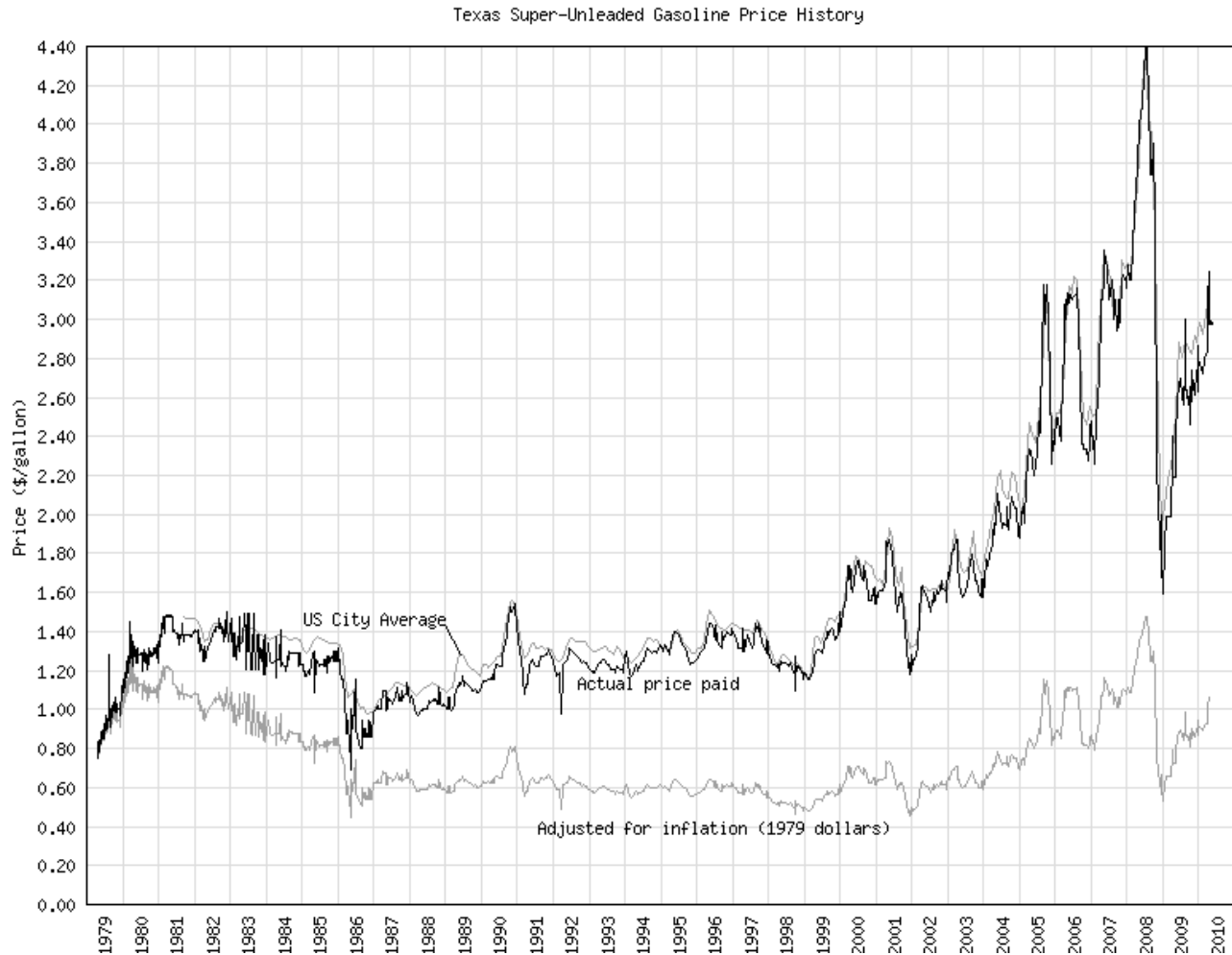


Figure 1. Historical price development of fuel (GasPrice, 2010).

market, where commercial navigation is not offered with the functionality to monitor the consumption and status of the vehicle tank which is a part of the application. There are some applications that are focused on the target group of truck transport (Lee et al., 2008), but in this case, the information is evaluated remotely or after the route. The study's proposed solution offers the possibility to implement such applications for mobile devices running Windows CE or Windows Mobile. Thereby, it is trying to cover a wide range of users with minimal investment.

The leading manufacturers of navigation systems do not use the calculation for determining the current velocity in 3D space, this problem is especially in tourist navigation. The navigation used, is off-road motorcycle or a car off the road.

The sub-problem is the determination of consumption, without taking data from the user or car. A trial is made to achieve the unified calculation, which would be a determination of the actual consumption under the acceptable error.

Principle of positioning

If the user devices determine their location using the GPS system, they have to obtain information from satellites (Greaves and Somers, 2003). Each satellite transmits a radio signal that carries information about the position of satellites in orbit (so-called ephemeris). By the time the information was posted, the satellite identification codes and range find codes. Communication is only one-way, and the user segment can only receive the signal.

Geographical coordinates uniquely determine the position of any point on the globe. These are spherical coordinates, when the positions of the spherical surface defined by the radius and two angles are between the vector and the origin. Coordinates origin is the center of the Earth. The angle φ between the equator and the parallel is called latitude. For the upper hemisphere of the positive angles, the angles are known as the northern width (N) and the southern hemisphere as the southern width (S). The angle λ in the prime meridian is called the longitude, and it similarly distinguishes the longitude of

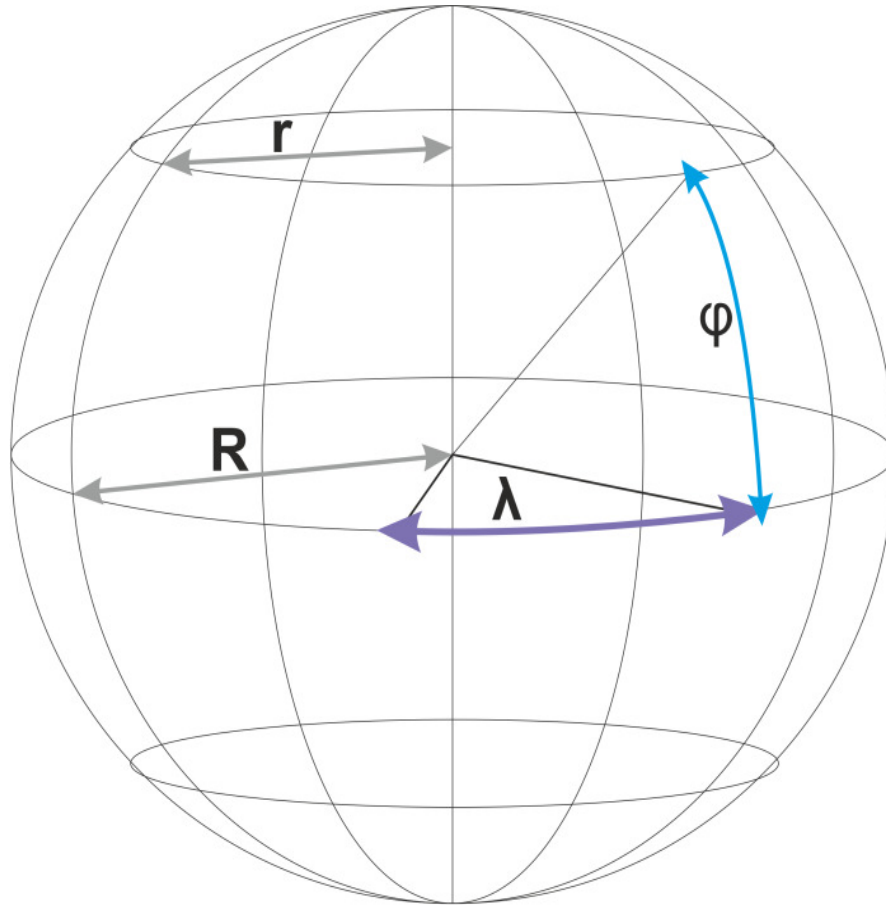


Figure 1. Determination of coordinates (R , Earth radius; r , radius in concrete point; λ , latitude angle; φ , longitude angle).

the East and West (E-W) hemisphere (Point B in Figure 2, is the coordinates of N and E). The last coordinate, which is the radius of the earth, did not show the same result.

In selecting the appropriate option of calculating the distance between two points is appropriate to consider the following factors:

1. Shape of the Earth (calculation in the plane, calculation of the globe and calculation of the ellipsoid).
2. The effect of altitude (the higher altitude is larger radius).
3. Effects of different altitudes.

As a basic sampling rate for sensing positions, the time interval of 0.5 s was chosen. It was a relatively long time, but it was chosen because applications were used at less powerful PDAs. The car, which has a running speed of 100 km/h, runs in this time distance of 13.5 m. The coordinates of points distant circle (180 m) were measured, then the appropriateness and accuracy of different algorithms was verified to calculate the distance (Huang et al., 2010).

Calculation type A

One of the ways to determine the distance between two points is to convert the spherical coordinates to Cartesian coordinates. The distance in the direction of meridians (N-S) is determined from the coordinates and the latitude of two points (β_1 and β_2), while the distance in the direction of parallel lines (E-W) is determined from the coordinates and the longitude of two points (α_1 and α_2). Pythagorean theorem is used to calculate the total distance. The calculation is performed in the plane and subsequently enriched by the difference in height, which is achieved in calculating the area.

The arc length of a circular slice 1° is determined in the direction of the meridian / N-S /

$$l_{\circ N-S} = \frac{2\pi R}{360} = 111226 \text{ m} \quad (1)$$

where R is the radius of the earth.

According to Figure 3, all the meridians and circular arcs of the meridians for the same angles have the same

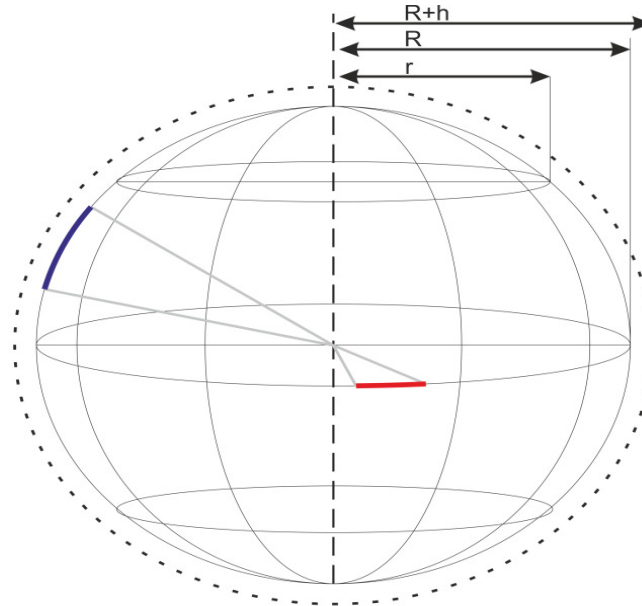


Figure 3. Calculated sections (R, Earth radius; r, radius in concrete point; h, altitude).

length (Blue section in Figure 3). This calculation can be done only once and for all further calculations, be considered to be constant.

A certain distance (X) in the direction of the N-S is calculated for the specific two points.

$$X_{B_2B_1} = \frac{2\pi R}{360} (\beta_2 - \beta_1) \tag{2}$$

β is a positive number for south latitude, and a negative for South. Here, numbers are entered in degrees and decimal degrees (but not in other formats as degrees: minutes: seconds). Some systems allow numbers to be entered only in radians. Then it would be necessary to transfer or change the formula.

The arc length of a circular slice ° is determined in the direction of parallel lines / E-W /

$$1^\circ E-W = \frac{2\pi r}{360} \tag{3}$$

$$r = R \cos \beta \tag{4}$$

where r is the radius of the parallel lines for latitude β (β can substitute for β_1 and β_2). Figure 3 shows that each parallel line has a different length, and thus the arc length of circular arcs for the same angle is different at different parallel lines (The red marked part of Figure 3). Length for 1° E-W is constant only in a certain place. The calculation would not be done again and again, but only

at certain intervals when the vehicle reaches the latitudes that already require a new calculation.

The distance (Y) is determined in the E-W direction for two points specifically.

$$Y_{A_2A_1} = \frac{2\pi R \cos \beta}{360} (\alpha_2 - \alpha_1) \tag{6}$$

α is a positive number for Eastern longitude, while it is a negative number for the Western longitude.

The total distance (D) is calculated as:

$$Z = (h_2 - h_1) \tag{7}$$

$$D = \sqrt{(X^2 + Y^2 + Z^2)} \tag{8}$$

where h is the altitude (Skorpil, 2008).

Calculation type B

Calculation B is a simplified version of calculation A in Krhutek (2009). The difference is the calculation of the length of the curve for a circular slice 1° in the direction of parallel lines (E-W).

$$1^\circ E-W = \frac{2\pi R}{360} \cdot \frac{90 - \beta}{90} \tag{9}$$

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Table 1. Comparison of the resulting distances calculated from the aforementioned procedures.

Calculation type	Real distance (m)	Calculated distance (m)	Absolute diversion (m)	Relative diversion (%)	Diversion per 100 Km (m)
A	180	1,797,253	0.2747	0.15	150
B	180	1,788,084	1.1916	0.66	660
C	180	1,797,253	0.2747	0.15	150

calculating power, replaced by correlation.

Calculation type C

This algorithm is known as the Great Circle and it calculates the distance between two points as the shortest distance on a spherical surface. Here, the spherical to rectangular coordinates are not calculated. This method of calculation used, for example, that of Garmin.

$$V_{hrz} = R \cdot \arccos(\sin \beta_2 \cdot \sin \beta_1 + \cos \beta_2 \cdot \cos \beta_1 \cdot \cos(\alpha_2 - \alpha_1)) \quad (10)$$

The total distance (D) is calculated as:

$$D = \sqrt{V_{hrz}^2 + Z^2} \quad (11)$$

where V_{hrz} is the distance between two points with the same altitude at the spherical surface (Garmin, 2009).

Comparison of calculation types

Table 1 show that the calculations of A and C are equally accurate, and the difference between the actual and the calculated distance is about 150 m to 100 km. The difference between calculations A and C in the process of testing was 0.004% at a distance of 100 km. The worst calculation for B is seen where the difference between the actual and calculated distance is a distance circa of 660 m to 100 km.

In all cases, the error minimized by a high sampling frequency (2 Hz - 0.5 s), is an integral part of the measurement. In the case of lower sampling frequency, for example 5 s, here the error is much greater because of the lack of "tracing" the route profile. This test was conducted on a short sampling of a dissected passage. A mistake at the distance of 100 km cannot be estimated with reasonable accuracy, because it depends on the rugged terrain (Qiao et al., 2006).

Table 2 shows the error in the rugged terrain, where the difference is circa 300 m to 9 km. This error is caused by deficiently tracking the terrain and worse reception signal. Error in this terrain (even in the same section) can

reach up to 50% in case of signal failures. This phenomenon can be prevented by implementation of the data from accelerometer, which will control at least some profile passages.

Realization of prototype solution

To implement an overall solution, it is necessary to study a wide range of issues from determining the consumption of the vehicle over the accuracy of GPS devices to the error rate and speed of application itself. In all parts of the design and implementation, the standard used methods were kept with procedures and equipment. Also, test calculations / relationships were started, which were prepared during the development process to facilitate the survey data. An example might be a formula for determining the current consumption of the vehicle from potential attached data (technical certificate, GPS, user) without having to interfere in the management systems of the vehicle.

The standard to determine the average consumption of vehicles

Fuel consumption of motor vehicles is an integral part of the characteristics of today's cars. To measure the fuel consumption, certain standards were been set up. Until 1996, consumption was expressed in the form of three values. The first belonged to the consumption speed of 50 km/h, which simulated the urban driving cycle. The second and third value featured a ride out of town at speeds of 90 and 120 km/h, respectively. Arithmetic average of these three values was calculated by the average consumption. To eliminate various weather conditions and rolling resistance on different surfaces, consumption was measured on a rolling stool. After 1996, the new European driving cycle (NEDC) was opened, which included three values of consumption for urban, extra-urban and combined cycles. In addition, associates with the fuel emissions were produced to test the car that has traveled 3000 to 15 000 km. This newly indicated the consumption that was calculated with the driver (75 kg) and the load (100 kg). Tests included cold starts to vehicle, which were not included in the former consumption.

Table 2. Practical checking of route counting Td in relation to sample rate.

	Distance (km)		
	Real distance	Sample 5 s	Sample 0.5 s
Distance (smooth terrain) (km)	6.5	6.2	6.4
Distance (rough terrain) (km)	8.9	6.4	8.6

**Figure 4.** Screen shot examples of application (main measurement screen, satellite position, setup/refill fuel options).

Measurement of fuel consumption methods

Measurement of fuel can be accomplished in a number of ways. The simplest indicator is the fuel gauge on the dashboard of the vehicle, but this method is not accurate. Another choice is the connection to the CAN bus system or FMS, which uses a float in the tank. The information thus gathered will be considerably more accurate. The control unit is able to make an extra variety of information that can be used to refine the fuel consumption (flow, engine speed, etc.). The car control unit is equipped with interfaces for the connection. Every car does not use the data bus, so this option is not feasible all cars. Another option is an installation of the external float in the tank, which is able to accurately measure the fuel level than the current one. This method is used when the original float is inaccurate or cannot connect to the system data bus.

Another possible solution is to add flowmeter to the fuel chain. The flowmeter is installed between the tank and engine. This method is certainly more accurate than measuring with a float tube. Measuring with flowmeter is often used in industrial machinery, where it is not so important to the distance traveled, but to the hour of work.

To measure the fuel consumed in the application, the user interface was used, which was based on storing refuel liters of fuel. The accuracy of this method depended on the filling and petrol stations. As the gathered liters were displayed with two decimal places, the application became sufficient (Webdispecink, 2010).

Implementation of solution (Mobile application development)

The function is a continuous measurement of the consumption of motor vehicles, which is based on retrieving information from the GPS and refuels liters of gasoline dispenser pump. The application displays the speed, power, geographic coordinates and satellite distribution (Figure 4). Visual Studio 2008 from Microsoft was used as the program, while C # was chosen as a programming language. The information that is essential for the operation of this application are stored in a database that supports synchronization with the server to store databases.

For the fact that the GPS module is incorporated into the device, does not mean that there is no need for further external interface as regards its use. GPS device



Figure 5. Class diagram of the used library Microsoft, WindowsMobile, Samples and Location method.

is connected via a serial (COM) port and the baud rate is 9600 b/s. GPS equipment is used for income signals, on which transmitted information are seen respectively. It is this module's task to convert the signal to form sentences (Protocol NMEA 0183). Such phrases, as strings, contain the necessary information, but if it can be used in an application, it has to be parsed. It is therefore a division of the sentence to partial word - information.

There are several ways to obtain location information using a Windows Mobile device, where each brings different benefits. Windows Mobile 5.0 and 6 contain the so-called GPS Intermediate Driver (GPSID). Although the name suggests that it is a device driver, it is not a driver in the true sense. GPSID can be imagined as an abstract layer that is inserted between the HW GPS hardware and application that require GPS information. It is even possible to simultaneously observe two run independent applications with one device attached. About this feature, a "layer" or wrapper was provided and this option was not aided by the last version of Windows Mobile versions. Access to the GPS using GPSID experienced programmers may seem relatively cumbersome. Most programmers choose a simpler version, however, to use wrapper DLL libraries. GPS class is designed for hardware communication (Figure 5). Its position then ensures job with receiving information, and Class Satellite provides information relating to the received satellite signals (MSDN, 2010).

In this application, library "Microsoft.WindowsMobile.Samples.Location.dll", which enabled low-level API GPS to be accessed, was used. For this reason, there was nothing to parse. For the project, the library is beneficial in several key points:

1. Operates the connection settings of the GPS module.
2. Restores partial information from the NMEA phrases.

3. Creates a layer of communication for multiple applications with one GPS module.

To access the GPS class, an object must be created. GPSGetPosition in class GPS ensure the creation of an object of class GpsPosition. Then it refers to the class of satellite. By these steps, the feature and methods of classes that are used in this work are available. Subsequently, the used variables and components are defined, followed by the method that starts the application. It binds to the 'start' button and is named by convention C # (subject_action) as start_Click. This method in their body is called the "StartGps" and it retrieves information from the database. Although in this method, they can be called actions, which are done by "StartGps", but it would preclude (in the event of any future extension of the code) some clarity. The "StartGps" is first tested if the GPS is running, but if not, it starts it. It assigns the value "enabled" to a timer, which is brought into operation. The timer is the heart of the program in this application. The method "mainTimer_Tick", which is performed every 500 (ms), is the element that retrieve GPS information (longitude, latitude, altitude, time, speed, etc.). These information are used for further calculations (distance and average speed) or they are directly visible on screen. Due to the fact that the calculation of distance traveled is hard for this application, a program has been created in another class from which it creates two instances. The first fills the current coordinates, while the second maintains the coordinates of the previous point. Subsequently, this method called GetDistance, retrieve the objects. The method calculates the Td (partial route) between the two positions from GPS and returns the result. To calculate the positions, method A was chosen, which was described in detail in the principle of positioning. Due to

Table 3. Date and time.

Dat	Date of registered events
Cas	Time to hold events

Table 4. Routes.

Td	Partial route (km) is the loaded distance calculated from GPS coordinates registration before a turn on the PDA
Tc	Total route (km) is the sum of TD, $Tc = Tc + Td$. Item is cleared by RTS flag
Tp	Full line (km) is loaded between two signs PLN (tanking)

Table 5. Tanking.

Ld	Partial liters (L): The amount of tanking fuel. Enter service after each refueling
Lc	Total liters (L): The sum of Ld; $Lc = Lc + Ld$. Item is cleared by RST flag
Lp	From full liters (L): The amount of refuelling fuel between the two flags PLN
Lz	Rest liters (L): Estimate the remaining fuel in the tank

Table 6. Averages.

Pc	Average total $Pc = Lc / (Tc/100)$. (l/100 km) has meaning only after a longer period.
Pp	Average consumption (l/100 km) between two signs PLN $Rp = Lp / (Tp/100)$ RST. The value is valid only after the second flag enters PLN and resets after flags PLN+RST
Tp	Average consumption by technical certificate. Tp replace value Pp with flag PLN, if the value RP is not zero.

certain inaccuracies in the GPS system, a "noise" was created. This noise may manifest itself by changing the specified position even if the receiver is in one place. Usually, it is the size of the error in the order of meters. Another error usually occurs when the device is run with its first positioning. This error may also move in hundreds of meters. As a result of these mistakes, the study tried to treat conditions with the loading distance. The distance is calculated from the three coordinates: longitude, latitude and altitude. For the calculation, the following relationship, which was used in the system math library, was used to rewrite the software design.

$$Td = \sqrt{(111.226 \cdot (\beta_2 - \beta_1))^2 + (111.226 \cdot \cos \beta_1 \cdot (\alpha_2 - \alpha_1))^2 + \left(\frac{1}{1000} \cdot (h_2 - h_1)\right)^2} \quad (12)$$

where Td denotes the partial route, constant 111.226 is the length of one degree, β is the latitude, α is the longitude and h is the altitude. Table 1 shows that despite the simplicity of the relationship used, calculation A reaches almost the same results as more complex calculations (calculation C). This is due to a short section measured route. In the calculations, a short distance will

be applied. Differences in the results for all types of formulas are minimal. Significantly, greater deviation would shed omitting altitude. It can thus be concluded that the successful formula will be satisfactory. Other parts of the program's view of satellites use the system library and related data (signal strength and id space) for rendering the deployment of satellites in the sky. This information is used from the back-loading of the DLL.

Database

Important information, needed for power calculations, are stored in a database. It is configured with a remote server support for database synchronization. For each database record, the date and time, distance traveled, and the approximate consumption liters about refueling and any flag (a full tank and reset) are not missing (Tables 3, 4 and 5).

After entering the flag of PLN (Table 7), a counter set up is entered on the maximum of the tank car / 63 liters. It is always reduced by the value entered. Partial route calculation is performed and the average consumption (tp) is reduced (Table 6). It is increased after entering the item Ld. Highlighted values are the inputs, which have to be necessarily registered in the database. Other items

Table 7. Flags.

PLN	It fills the service after a full tank
RST	Enter the service only after entering a flag of PLN. Resets most counters. The operator must specify this symptom with caution.

may be pro-rated. When viewing a database, they are unnecessary items.

Treatment of error conditions

If the calculated distance is too small, it is possible that the vehicle is stationary and the GPS provides the values that change in the accuracy of GPS. If the calculated distance is less than the lower limit (Dlim), then the shareholder does not attribute distance. So, the program is set to Dlim 5 m.

If the calculated value is too large, it is possible that the GPS gives wrong coordinates. This could happen at the exit of the tunnel. Such measurement is also necessary to exclude the distance, which will be 0 limit for the largest calculated route (Hlim) in the program set to 30 m for a speed of 90 km/h and 70 m for a speed of over 90 km/h.

Solution of boundary phenomena

The calculation will work for all coordinates (E. W. N. S). If the vehicle is moved at the equator and zero meridian, it would be necessary to coordinate with the appointing positive signs for E N and W S which are negative. If the vehicle passes through the 180th meridian, it would have to adjust α coordinates. The adjustment would be preceded by calculating the distance (Td) and allowed to be here with the absolute value of the difference coordinates.

Testing the realized solution

Testing was divided into several parts. The first part of the verification was the suitability of the selected sampling frequency. This was followed by the suitability test of the selected type of calculation, which was theoretically described before. The resulting test checked the accuracy of the estimated consumption, which was used to estimate when the tank will be empty. Testing was conducted at Fujitsu Siemens PDA with an active aerial, then the second HP PDA was done without the active aerial.

METHODOLOGY

Testing of individual components was carried out experimentally on

the same sections (in highway traffic and then in the normal flat terrain on the road). Eventually, in the dissected terrain, each measurement was repeated 20 times in order to identify possible sources of error.

The results of individual experiments will be in any case foul by error, because there are many parameters that cannot be controlled. Although, some of the parameters can be included in the calculations, it is almost impossible to use them in an application in such a way that the user would not be disturbed. These include parameters that could be seen from the vehicle control unit (gear, the exact weight of the vehicle, current consumption, ambient temperature, etc.). There are parameters that can not be found, but they affect consumption, such as wind strength and direction.

For this reason, the experimentally determined limit / degree for entry is weight. With the exact weight of the vehicle, a technical certificate can be found and subsequent loads are scaled as the number of people (1-x depending on the vehicle) and load (no, light, medium and heavy), in the case of determining the approximate.

RESULTS

Table 8 takes into account the implementation aspects, which have a considerable share of the suitability of the solution. It is clear that the best solution is with the control unit, but this solution does not come into consideration. Car manufacturers themselves would have to implement an interface, which probably will not be freely available, as there would be a great risk of failure. The feasible solution has been proposed by this study (PDA, GPS and calculation A). As it is already mentioned, variants A and C are equally accurate, but are preferable to the alternative algorithm variant A. It is also obvious that the calculation itself is not such a big influence on the resulting distance as the sample period.

DISCUSSION

Test sampling frequency and appropriateness of the chosen calculation was without complications and the solution was encumbered with an error shaping the profile path and then the actual method of calculation. The difference resulting from the distance is not so different from the actual distance traveled.

Due to certain inaccuracies of GPS and the formation of unwanted "noise", the calculated distance value was tested. This test involves a determination of the limits of two load distance. The lower limit is determined on 5 m, which provides for elimination of the fictitious load stopping distance of the vehicle while driving (traffic lights, intersection) (Agar et al., 2007; Mikulski and

Table 8. Results of measurement methods.

			Kind of measurements			
			Control unit	Calculated from GPS		
Terrain (Average speed)				Var. A	Var. B	Var. C
Distance (km)	Highway (130 km/h)	Actually	10			
		Sample 5 s		9.5	9.4	9.5
		Sample 0.5 s		9.9	9.8	9.9
	Ordinary road (90 km/h)	Actually	10			
		vz.5s		9.2	9.1	9.2
		vz. 0.5s		9.8	9.7	9.8
	Rugged terrain (60km/h)	Actually	10			
		Sample 5s		7.1	7	7.1
		Sample 0.5s		9.1	9.1	9.1
Type of solution		HW of car + SW + PDA / only for new vehicles	SW + PDA + GPS/for any vehicle			
Realization		Automotive	Anybody			
Solution price		Expensive development / extra pay per vehicle	Cheaper development/lower purchase cost			

Mlynczak, 2009). The upper limit, which eliminates the error in calculating the signal loss, is represented by two values. One is the speed of 90 km/h, whose value is determined on a 30 m distance and the other is used to rate the speed of 90 km/h with value 70 m. The upper limit is the main result of the sampling timer, and it is set to 0.5 s. Sampling in this application is the impact on the approximation of the travel route. Shorter intervals between samples are achieved by a better approximation, but with increased computational power, which is not a problem nowadays. The suitability of sampling 0.5 turns up more tests. For now, however, it seems satisfactory. The adverse event that the car quickly drove numerous switchbacks (which is unlikely), can be selected too slowly. During the testing, there was a problem receiving the signal. Despite the sensitivity of the device by the manufacturer, which is sufficient, there have always been problems with enormously long time TTF. The unsettled weather and rain did not accept the device signal strength and was unable to function. For these reasons, facilities for active GPS antenna have been added, which solved the problem. Application evaluation of the fuel, based on the amount of data, has emerged from the fuel dispenser. Thus, the dispenser is gauged quite accurately, while the problem is to determine the continuous consumption. The amount of consumed fuel is calculated by taking the average consumption during the previous refueling.

The last test of general application had a considerable variance, because in its current state, it is not possible to accurately measure the consumption of the vehicle (Ganti et al., 2010). For the relevant test of this functionality, it would be appropriate to extend the application of the

accurate measurement of the vehicle's actual consumption.

Conclusion

The main issue is to develop a custom application metering means of transport. To work with the GPS module, Microsoft library, Windows Mobile, samples, and location, which handle hardware and process GPS information, were used. The retrieved data from the GPS used to calculate the distance are the most important information for this application. They have been chosen and verified by the calculation which complied with accuracy at a distance of 13.5 m. This distance corresponds to the speed of 100 km/h sampling period, which is 0.5 s. This calculation would be appropriate for use in long distance (thousands of kilometers). The application provides good results when refueling of the tank is always in full or in longer-term evaluation. The biggest benefit is an increase in functionality to monitor and retrieve immediate consumption. Alternatively, it would be possible to use a suitable sensor (gasoline flow).

At the same time, the group had to be added to the interface between the engine control unit (or flow) and the PDA. The current configuration can be observed during long-term effects of consumption, depending on the distance traveled. Another possible extension could be an accelerometer, which would ensure the loading speed of change in the event of loss of GPS signal and the estimated distance (Beusen et al., 2008; Gonder et al., 2007).

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