

## VBOX 3i, MATLAB, POLYNOMIAL APPROXIMATION

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## **ANALYZING DATA FROM GPS SYSTEM VBOX 3i IN THE WORKING ENVIRONMENT OF MATLAB**

**Summary.** This paper presents common information of a possibility to analyse some parameter of vehicle movement. Basic principle which is in use, the data of the vehicle movement is recorded via precise GPS logger and then the recorded data is analysed with a specialised software as MatLab. The results of such studies conducted in real conditions given conclusion for the reliability and the applicability of theoretical models or establishing new models of maneuvering.

### **1. INTRODUCTION**

Due to the increasing problem of people killed in road traffic accidents over recent years found that 76% of those killed by negligence of the driver is in violation of the speed and violations relating to the taking of improper maneuver [4]. It is therefore necessary to take measures and strategies to reduce the victims of road accidents. To define more precise definition of these measures is necessary an additional detailed studies of some important for safety reasons vehicle maneuver such as overtaking and overpassing. In recent years, particularly relevant for the study of motion parameters associated with maneuvering the car are modern GPS recording systems. Using these systems allows fast and easy to enroll parameters examined.

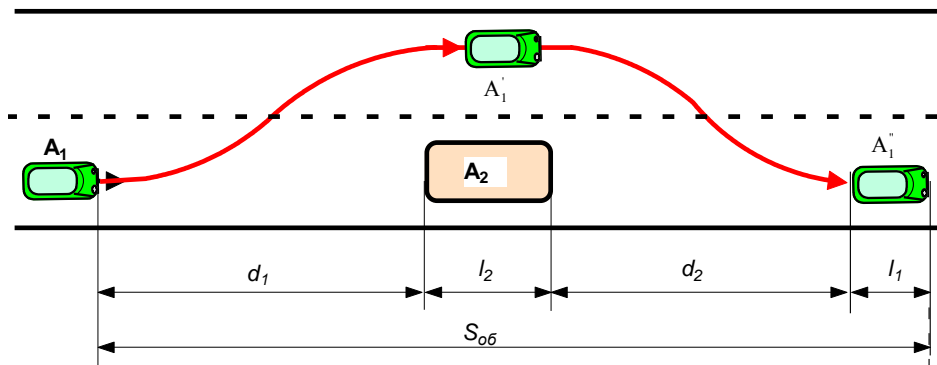
Then the data can be processed and analyzed using specialized software, which can be confirmed the reliability and applicability of theoretical models and can create new models for movement of vehicles in any maneuvers.

The goal of this paper is to present modern method for processing and analyzing data from GPS data logger VBOX 3i in the working environment of MATLAB.

### **2. PREREQUISITES AND MEANS FOR SOLVING THE PROBLEM**

To obtain a precise vehicle trajectory during maneuvers such as overtaking or overpass under different conditions (Fig. 1) is very appropriate to use the logged data of coordinates of the vehicle. For more accuracy of logged coordinates it is used VBOX 3i data logger with 100Hz GPS system.

By analyzing the logged coordinates of the path of the vehicle during these maneuvers it can be obtained relationships between speed and parameters of the maneuver (fig.1.). They depend of the safe distance at the beginning of maneuvering -  $d_1$ ; the safe distance at the end of overtaking -  $d_2$ ; the total path needed for the maneuver -  $S_{06}$  at different speeds of the vehicle.



**Fig. 1.** Basic parameters for safe maneuvering: where  $S_{06}$  is the path needed for the maneuver, m;  $l_1$  – the car length, which made the maneuver, m;  $l_2$  - the obstacle length, m;  $d_1$  – the safe distance at the start of overtaking, m;  $d_2$  – the safe distance at the end of overtaking, m.

**2.1. Used test equipment and software**

The VBOX 3i represents the 3rd generation of GPS data logging system from Racelogic Ltd. Using a powerful new GPS engine, the VBOX 3i can log GPS and other data at 100Hz. The logged data is stored directly onto a compact flash card for easy transfer to a PC. It can log several parameters of movement of the vehicle. The main data are coordinates and time and other are derived parameters as vehicle speed, acceleration, rotation and etc [1].



**Fig. 2.** VBOX 3i 100Hz GPS Data Logger

The logged data on compact-flash card can be easy transferred to the working environment of the software VBOX Tools.

Then the obtained data can be presented graphically and numerically in the table by the software VBOX Tools [2]. The data listed in Table 1, which are recorded by the system VBOX 3i gave the possibility to analyze the recorded trajectory of these maneuvers. The basic vehicle coordinates are geographical latitude in minutes and longitude in minutes.

Tab. 1

View of some data recorded by the system VBOX 3i presented of software VBOX Tools

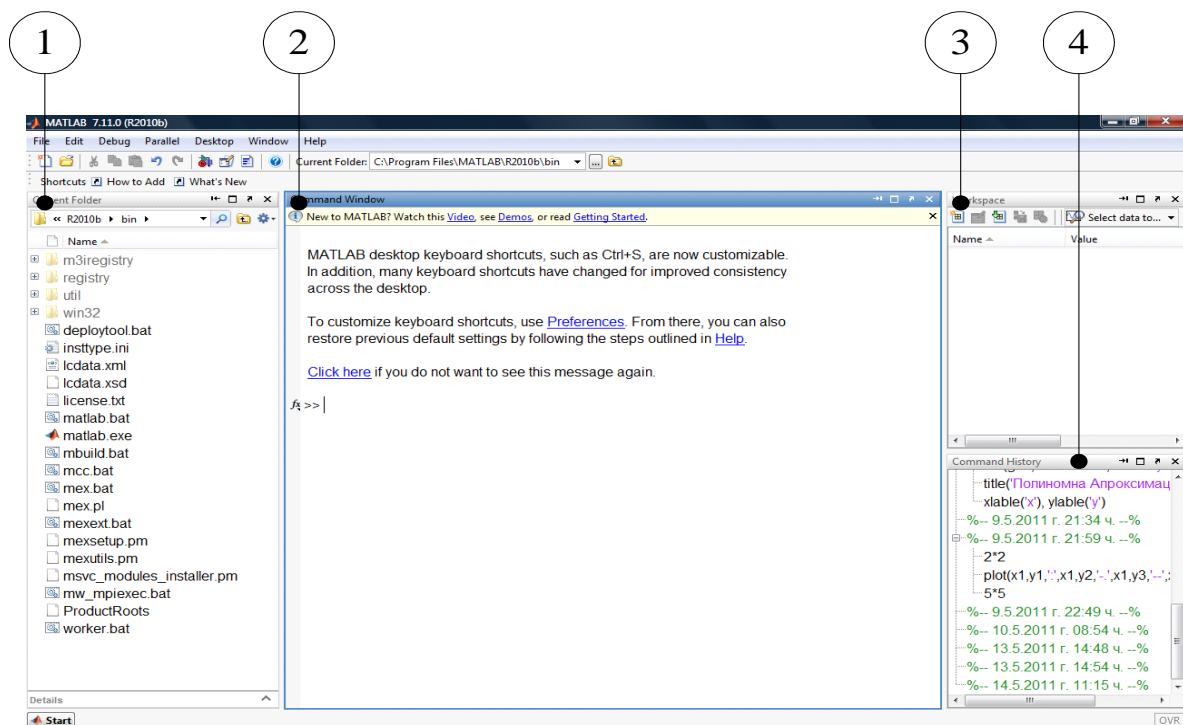
Run Time	0 Minutes 03.83 Seconds
Cursor (metres)	7,29
<input checked="" type="checkbox"/> Speed (km/h)	12,13
<input checked="" type="checkbox"/> Latitude (Minutes)	2630,936
<input checked="" type="checkbox"/> Longitude (Minutes)	-1558,193

The disadvantage of software VBOX Tools, is that it can not analyze the trajectory of the path traveled by car and also coordinates are shown with the extension to three decimal places (Table 1). This is a prerequisite for the error to 1.8 meters in position to analyze the data if the coordinates taken from software VBOX Tools [5]. This disadvantages can be resolved by using more precised data for coordinates and use software MatLab.

## 2.2. Specialized software MATLAB

MATLAB, whose work environment is shown in Figure 3 is a widespread program of the company "The MathWorks, Inc". It offers tremendous opportunities to perform calculations, conversions and analytical quality graphical representation of results of studies [3]. MATLAB integrates opportunities for analytical transformations, numerical calculations and graphical presentation of results.

The program works with four main windows. The first (Fig. 3 pos.1) is the "Current folder", it displays a list of all files in current directory to which the system has direct access. The second (Fig. 3 pos.2) is a "Command window" in which commands are introduced to the right of "Screen Tips" character (prompt ">>") and which derive numerical results. The third (Fig. 3 pos.3) is a "Workspace" where all variables are defined are preserved. The fourth is the the "Commands history" of in the system MATLAB remembers all entered commands not only the current session, but from previous sessions.



**Fig.3.** Operating environment of the program MATLAB, where 1 - Current folder, 2 - Command window, 3 - Workspace 4 - Command History.

## 2.3. Processing of coordinates data in the working environment of MATLAB

Disadvantages of VBOX Tools software can be solved through the introduction and processing of logged data for coordinates of the vehicle system VBOX 3i in the working environment of "Matlab". This is done by loading the transforming vbo / matlab file.

Fig. 4 presents an example of piece of data for the recorded coordinates of the vehicle in Matlab.

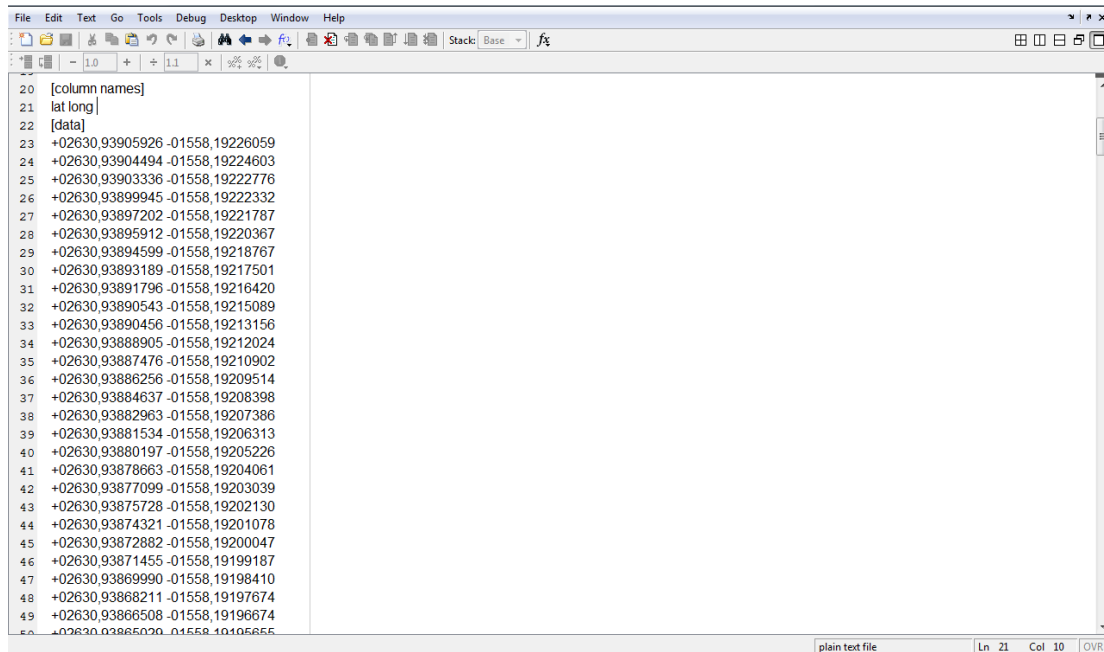


Fig.4. Recorded data of the vehicle in the working environment of Matlab

This coordinates in minutes are shown in decimal numbers with an extension to the eighth decimal place, which is a prerequisite for higher accuracy in data processing.

By functions "polyfit" proxy data and interpolation coordinates (Fig. 5) can be presented as a mathematical function [3].

This mathematical function represents for example a polynomial of n - th degree.

After entering the data in the "Command window" of Matlab and then input function as "p4 = polyfit (x, y, 4)" (shown in fig.5) are displayed numbers, which are coefficients of a polynomial of fourth degree.

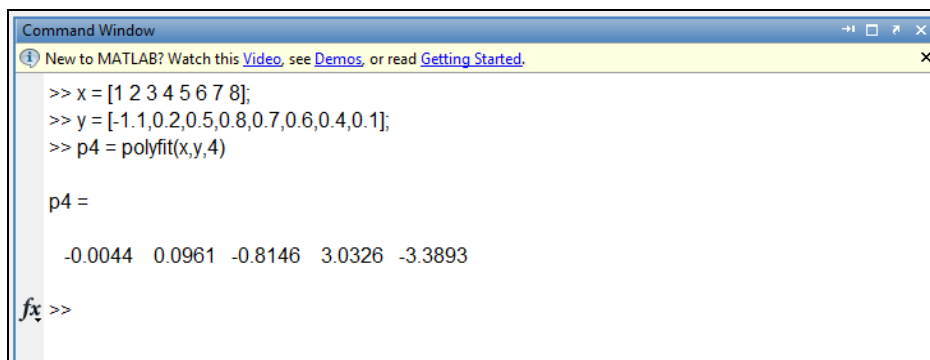
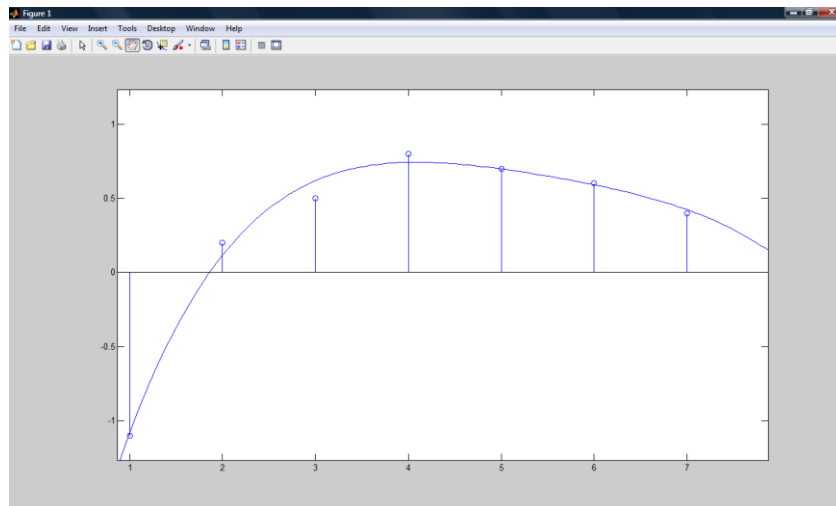


Fig. 5. Presentation of the elements of the polynomial in polynomial approximation.

The data shown on fig. 5 in MatLab presents in the form of equation (1).

$$p(y) = -0,0044x^4 + 0,0961x^3 - 0,8146x^2 - 3,0326x - 3,3893 \tag{1}$$

Other advantages of the software Matlab are the functions, which are easy in use for graphical presentation of results. Such is the function "plot". The results of this function are presented in fig. 6.



**Fig.6.** Presentation of the elements of the polynomial in polynomial approximation - where points are shown in table data line is a polynomial function of equation (1)

Through the MatLab functions can be verified theoretical models of the elements of trajectory of vehicle movement and gave the possibility to obtain new theoretical relationships during maneuvers associated with the change of direction.

### 3. CONCLUSION

An application of VBOX 3i 100Hz GPS Data Logger are presented and its capabilities to record movement parameters of the vehicle, and its specialised software VBOX Tools.

It is shown a possibility of a methodology way of processing and presentation of location data recorded by the VBOX 3i in the working environment of MATLAB to improve accuracy of positioning.

Analyzed are the main functions "polyfit" and "plot" of the system using MATLAB, which can be processed and recorded to provide details of the vehicle when maneuvering.

Primary research in this environment show satisfactory results on the accuracy of presentation of the trajectory of the vehicle.

This gives rise to a conclusion that the obtained analytical dependencies for these maneuvers will be useful for practical use.

Using similar analytical dependencies for maneuvers of the vehicle, allow to predict processes in road traffic and to improve road safety.

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### References

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4. Web site: [www.mvr.bg](http://www.mvr.bg)
5. Web site: [www.racelogic.co.uk](http://www.racelogic.co.uk)