DOI: 10.20998/2079-0023.2023.01.15
UDC 004.42:004.45

O. M. RYBITSKYI, Postgraduate, Kharkiv National University of Radioelectronics, Kharkiv, Ukraine, e-mail: oleksandr.rybitskyi@nure.ua, ORCID: https://orcid.org/0000-0002-8508-7269
V. V. GOLIAN, Candidate of Technical Sciences (PhD), Docent, Kharkiv National University of Radioelectronics, Kharkiv, Ukraine, e mail: vira.golan@nure.ua, ORCID: https://orcid.org/0000-0001-5981-4760
N. V. GOLIAN, Candidate of Technical Sciences (PhD), Docent, Kharkiv National University of Radioelectronics, Kharkiv, Ukraine, e-mail: nataliia.golian@nure.ua, ORCID: https://orcid.org/0000-0002-1390-3116
Z. V. DUDAR, Candidate of Technical Sciences (PhD), Professor, Kharkiv National University of Radioelectronics, Kharkiv, Ukraine, e-mail: zoia.dudar@nure.ua, ORCID: https://orcid.org/0000-0001-5728-9253
O. V. KALYNYCHENKO, Candidate of Technical Sciences (PhD), Docent, Kharkiv National University of Radioelectronics, Kharkiv, Ukraine, e-mail: olga.kalynychenko@nure.ua, ORCID: https://orcid.org/0000-0003-1466-3967
D. M. NIKITIN, Postgraduate, Kharkiv National University of Radioelectronics, Kharkiv, Ukraine, e-mail: dmytro.nikitin1@nure.ua, ORCID: https://orcid.org/0000-0003-4388-4996

USING OBD-2 TECHNOLOGY FOR VEHICLE DIAGNOSTIC AND USING IT IN THE INFORMATION SYSTEM

This article considers the research of OBD-2 technology for interaction with on-board vehicle systems, the creation of a unified system that can work with different makes and models of cars. The history of OBD-2 technology, its development, existing standards and their implementation in modern cars is described. Basic diagnostic functions are described, with which you can get information about the car, as well as perform its settings and send various commands to it. In addition, the hardware part of the scanner, its technical features, nuances of interaction with it and the purpose of each of its pins are considered. Also reviewed couple models of scanners that can be used to develop this system. Conclusions are drawn on the practicability of their use, taking into account their capabilities. Existing software analogues, their main functions, advantages and disadvantages are considered. The general concept of interaction with the car via OBD-2, the interaction algorithm and step-by-step analysis of the interaction between the scanner and the car are also considered. The software part of the interaction between the car and the scanner, special codes used to send requests and responses, their further analysis and interpretation in a human-friendly form are considered. The possibilities for the unification of these codes for different car manufacturers and the common code base to create a universal system that will be suitable for different cars from different car manufacturers are highlighted. A model of the software system is proposed, which can embody a large set of useful functions for any motorist and will be compatible with a large number of modern cars equipped with universal diagnostic tools, while using an affordable scanner model without the use of expensive professional equipment.

Keywords: Car, on-board computer, computer diagnostics, scanner, OBD2, information system.

Introduction. Despite the rapid pace of development of the automotive industry, today a large number of cars are quite primitive and do not even have an on-board computer or have it, but it is endowed with a very narrow functionality. But at the same time, almost all modern cars are equipped with diagnostic ports that allow you to get a lot of useful information about the car.

OBD2 car computer diagnostics technology is a standard for diagnostics of various car systems performed by car control units. It was introduced in 1996 as mandatory for all vehicles sold in the United States of America, and subsequently for all other vehicles.

Now, more or less every car is equipped with this diagnostic port, and the number of those that are not equipped is so low that it can be written off as an error.

So we can say with great confidence that this technology is promising for research.

Today, there are a large number of similar programs that allow motorists to self diagnose their own car. But there is a number of certain disadvantages. All these programs can be divided into 2 types: professional software and those intended for general use.

Professional software usually has wide functionality and provides a large number of opportunities to the user. But this software, firstly, requires professional equipment, and secondly, it has a high cost. These factors negate any sense of mass use of this software.

Another category of programs are those that are intended for general use. It has a small cost, but the vast majority have narrow functionality, shortcomings in their work or simply an inconvenient and unintuitive interface.

Also, one of the most common problems faced by motorists is the problem of car theft. Standard alarms of all, without exception, car manufacturers are not reliable protection of the car. There are a huge number of illegal devices on the black market that allow thieves to overcome standard security measures and enter the car. Cars equipped with keyless access systems are especially prone to this threat. Thieves who have a special device for transmitting a signal from the key to the car can easily break into the car and steal it.

Today, a large number of motorists own not the most modern cars, which do not even have such a vital option as an on-board computer. This is a very functional tool that allows the driver to get rid of a very large number of different worries. But people don't only fill cars with fuel. Lubricant, antifreeze and other special fluids need to be replaced in it.

This led me to the idea of researching the technologies of computer diagnostics of the car to create a system that would allow any motorist to receive information about his car on his own, which was previously available only at specialized stations.

The purpose of the research is to study the possibilities of OBD-2 technology and its application in a software system that is an analogue of a car's on-board computer, to study the possibilities of integration with services that provide the necessary information for car diagnostics, to design a motorist's assistant system that provides car diagnostic functions.

Proposed model. Analyzing similar programs, we can conclude that today there are a large number of software products on the market that provide real-time computer diagnostics of the car using universal OBD reading devices.

But most of these products are aimed primarily at professional auto mechanics who are engaged in car diagnostics, have professional equipment and extensive knowledge in the field of car diagnostics and its structure.

This means that such products are not suitable for use by the masses of motorists, since they have neither expensive equipment nor professional education. They generally do not use such professional tools.

In addition, such solutions often cost a lot of money and their purchase is simply unprofitable for an ordinary car enthusiast who needs to get some basic information about his car.

Research begins with the development of the program. A research program is a document that regulates all stages, stages of preparation, organization and conduct of a specific study. The research program contains theoretical substantiations of methodological approaches and methodical methods of studying a certain phenomenon or process.

In the research of the study, the main possibilities of OBD2 technology for computer diagnostics of the car were studied. The main goal was to study the possibility of creating a system that would allow diagnosing any modern car, while having a universal car scanner without of using of OEM equipment.

Results and discussion. A standard OBD-II diagnostic connector is used to connect to the car. Most of the serial cars produced after 1996 are already equipped with such a connector. Although such a diagnostic connector is standardized, it supports several protocols of different engine control systems at once, that is, different contacts on the connector are physically used, which the scanner communication module must know. Accordingly, different brands of cars may have different internal busses for obtaining diagnostic data from the engine management side.

One way or another, but all specialized solutions are more advanced industrial products, compared to the usual device for reading diagnostic codes based on the ELM327 microcircuit of the Canadian company Elm Electronics. ELM327 is a universal converter of protocols used in diagnostic tires of cars into a serial protocol of the RS-232 type.

Interaction with ELM327 is carried out by standard AT-commands supported by the chip. You just need to organize the exchange of text messages using the RS-232 protocol. Namely, a low-level physical connection via USB, Bluetooth or Wi-Fi is implemented using RS-232 serial protocol conversion chips. That is, to turn a car into an IoT device, it is enough to connect the ELM327 chip to the OBD-II diagnostic connector and at the output of this chip, for example, put a serial interface converter in Bluetooth or Wi-Fi. Then, you can "read" car diagnostics from your smartphone or computer. However, there are more than enough such ready-made modules or blocks on the market. And their price on AliExpress ranges from a few dollars to thousands for professional devices.

The most common interface CAN (Controller Area Network) is used for interaction with the car. At one time, the CAN standard, proposed by Bosch, made significant progress in the development of systems for automotive electronics. If the car in the Internet appeared only recently, then the concept of the network inside the car has existed since the mid-80s. The idea is very simple, and just as Ethernet made a break-through in computer networks, CAN became the basis of reliable communications inside the car.

CAN bus is an automotive bus developed by Robert Bosch that is mostly adopted in the automotive and aerospace industries. CAN is a serial bus protocol, with the connection of individual systems and sensors as an alternative to the usual multiwire bundle. Allows you to connect automotive components in a single wire called a data bus network with a high speed of information transfer. Before the CAN bus was released, cars had a large amount of wiring that was necessary to connect various electronic components. That is, it is a bus that connects various blocks and components in the car and allows them to exchange information in real time.

Previously, in cars, tires of various modules and devices converged to the central engine control unit. The serial CAN bus made it possible to implement independent intelligent modules that communicate with each other actually using a network protocol. At the same time, the amount of wiring inside the car is significantly reduced.

Data transmission in the CAN bus resembles a publisher-subscriber model, where each device on the bus has a unique identifier, and when one device transmits data, all the others listen and make a decision based on this identifier - whether it need that data to receive and processing or not.

Moreover, there are two different CAN nets. One works with a higher speed (1 Mbit/s) and is used to monitor the engine and interconnect the ECU. The other one is used to communicate the rest of the parts of the vehicle such as doors, seats or lights and works with less speed (250 Kbit/s).[1]

It is this feature that allows the user to connect a diagnostic scanner through a special port and receive real-time information about his car, read errors, etc.

The main method of computer diagnostics is the connection of special scanners that are connected to car electronics and read data in digital form.

First, computer diagnostic tools are used to read not only the error codes, but also all the digital data that is directly related to the problem that occurred. Here you need to understand that the scanner can fully decipher detected malfunctions.

At the second stage, all these data need further confirmation. And above all, the car's electronic systems need to be thoroughly checked to ensure that it is fully operational

Next, the scanner displays the data in real time. This function can be used to check signals from sensors and other controls to detect malfunctions.

Interaction of the scanner with the car. Modern cars are not only mechanical parts, it are also many electronic units. It monitor the operation of various systems and units, monitor their condition, and track their errors in operation. Reading these metrics makes computer diagnostics and troubleshooting possible.

The multifunctional adapter, which connects to a standard OBD-2 port, supports cars of various makes and models. Special software for them contains in the database both standard error codes that are common to most cars, and codes that are unique to each brand.

In addition to reading fault codes, the latest OBD-2 scanners offer several options for tuning the vehicle's electronics.

The OBD2 scanner can analyze both the entire on-board network and individual systems. The ability to monitor such parameters as engine speed, speed, oil and antifreeze temperature, oil and fuel pressure, intake manifold and exhaust manifold pressure in real time.

Within the OBDII diagnostic standard, there are 5 main communication protocols between the electronic control unit (ECU) and the diagnostic scanner. Physically, the auto scanner is connected to the ECU via the DLC (Diagnostic Link Connector), which complies with the SAE J1962 standard and has 16 pins (2x8). Below is the layout of the contacts in the DLC connector on the Figure 1, as well as the purpose of each of them.

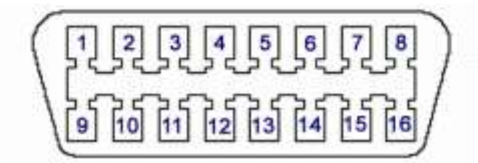

Fig. 1: Pin assignment in the DLC (Diagnostic Link Connector)

Pins list:

1. OEM (manufacturer's protocol);
2. Bus + (Bus positive Line). SAE-J1850 PWM, SAE-1850 VPW;
3. Defining by manufacturer;
4. Body grounding;
5. Signal ground;
6. CAN-High line of CAN Highspeed bus (ISO 15765-4, SAE-J2284);
7. K-Line (ISO 9141-2 and ISO 14230);
8. Defining by manufacturer;
9. CAN-Low line, CAN Low speed bus;
10. Bus - (Bus negative Line). SAE-J1850 PWM, SAE-1850 VPW;
11. Defining by manufacturer;
12. Defining by manufacturer;
13. Defining by manufacturer;
14. CAN-Low line of CAN Highspeed bus (ISO 15765-4, SAE-J2284);
15. L-Line (ISO 9141-2 and ISO 14230);
16. Power supply +12v from the battery.

The assignment of undefined contacts is at the discretion of the vehicle manufacturer. Next, we will consider in detail the format and physical layer of each communication protocol within the OBDII standard.

The OBD-II system uses 9 measuring modes, each one of them allows the access to the ECU data in the vehicle check Table 1. In order to request data, it is necessary to use PID [Parameter Identification] codes. Each PID is related with a specific measurement of the modes 1 and 2 of the OBD-II system. For instance, if the real-time datum of the vehicle speed is requested, the mode 1 should be chosen and the PID “0D” has to be used. [2]

Table 1 – OBD measuring modes

Mode	Features
01	Collecting updated data: it allows the real-time access to the ECU inputs and outputs.
02	Access to frozen data frames: the ECU takes a sample of the values related with the emissions at the exact moment when a failure arises.
03	Gathering of the failure codes: it allows to extract all the DTC [Data Trouble Codes] stored in the ECU memory.
04	Code erasing and failure in the stored values: it allows to delete all the stored codes in the ECU, including the DTC and the saved data frame.
05	Tests results in the oxygen transductors: it allows the access to the test results performed to the oxygen transductors.
06	Tests results of other transductors: results of the diagnostics in components not submitted to constant surveillance.
07	Pending failure codes sampling: it allows to read all the pending DTC from the ECU memory.
08	08 Components operating control: it permits the execution of tests in the actuators.
09	Vehicle information: it allows to request the VIN [Vehicle Identification Number].

Within the OBDII standard, there are 5 data exchange protocols between the ECU (electronic control unit) and the diagnostic scanner.

SAE J1850 PWM on the Figure 2.

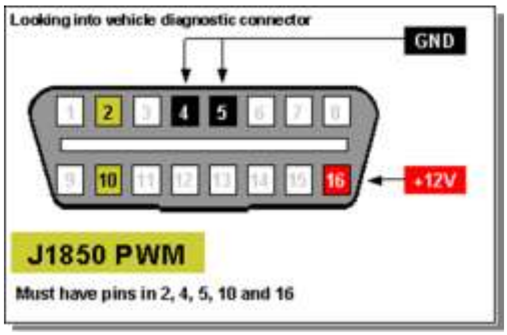

Fig. 2: SAE J1850 PWM protocol connection diagram

There are two types of J1850 protocol. The first of them is high-speed and provides a performance of 41.6 KB/s. This protocol is called PWM (Pulse Width Modulation). It is used by Ford, Jaguar and Mazda. For the first time this type of communication was used in Ford cars. In accordance with the PWM protocol, signals are transmitted over two wires connected to pins 2 and 10 of the diagnostic connector.

SAE J1850 VPW (Variable Pulse Width) on the Figure 3. The VPW protocol supports data transfer at a rate of 10.4 KB/s and is used in General Motors (GM) and Chrysler vehicles. It is very similar to the protocol used in Ford vehicles, but is significantly slower. The VPW protocol provides for data transfer over a single wire connected to pin 2 of the diagnostic connector.

ISO 9141-2 on the Figure 4.

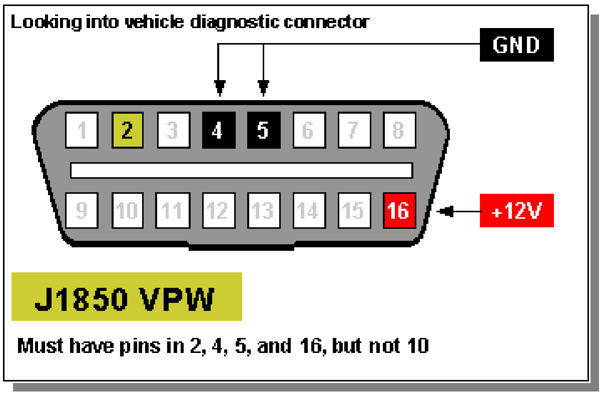

Fig. 3: SAE J1850 VPW protocol connection diagram

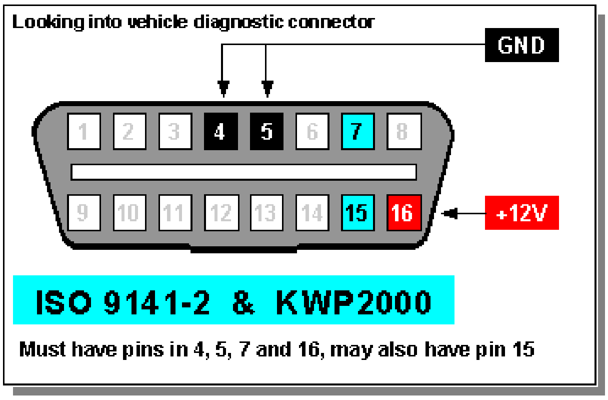

Fig. 4: ISO 9141-2 protocol connection diagram

Applies to most European and Asian vehicles and some Chrysler vehicles. The ISO9141 protocol is not as complex as the J1850 standards. While the latter require the use of special communication microprocessors, ISO9141 requires conventional serial communication microprocessors, which are found on store shelves. Uses pin 7 (K-line) and optionally pin 15 (L-line).

ISO 14230 KWP2000 (Keyword Protocol 2000).

Physically identical to ISO 9141. Also uses pin 7 (K-line) and optionally pin 15 (L-line).

ISO 15765 CAN (250 kBit / s or 500 kBit / s) on the Figure 5.

The CAN protocol was developed by Bosch for automotive and industrial applications. Unlike other OBD protocols, its variants are widely used outside of the automotive industry. CAN was not OBD-II compliant for vehicles in the US until 2003, but as of 2008, all vehicles sold in the US must support CAN. Within OBDII, it uses 2 pins: 6 and 14. It is the fastest and most modern.

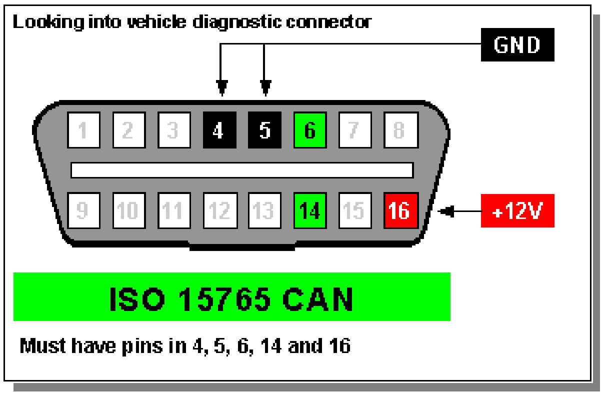

Fig. 5: ISO 15765 CAN protocol connection diagram

Existing software. TOAD is short for Total OBD & ECU Auto Diagnostics. It is an OBD diagnostic software that performs vehicle diagnostic systems and provides diagnostic reports. It monitors electronic sensors in the engine, transmission and emissions system [3].

Benefits:

- provides wide possibilities of diagnostics;
- error reading in real time;
- makes it possible to clean blocks of cars from errors;
- has the function of saving a snapshot of block data at a certain point in time;
- compatible with almost all makes and models of cars.

Disadvantages:

- very high price;
- only compatible with Windows OS;
- requires a deep understanding and skills in car diagnostics.

PCMSCAN is a full-featured generic OBD-II scanner and diagnostic tool that supports a wide range of OBD-II hardware interfaces [4]. It allows viewing, graphing, logging and playback of real-time diagnostic data through the vehicle's OBD-II diagnostic port. It also allows you to view vehicle diagnostic trouble codes, real-time auto data, and other vehicle information.

PCMSCAN supports almost all modern cars.

Benefits:

- provides wide possibilities of diagnostics;
- error reading in real time;
- error clearing;
- compatible with almost all makes and models of cars that were released after 1996.

Disadvantages:

- only compatible with Windows OS;
- requires a deep understanding and skills in car diagnostics.

Scanners. BAFX Products Bluetooth Scanner – this scanner has one of the best ratings on the Amazon platform. It is compatible with Android and Windows and allows you to read Check Engine codes, reset/clear the Check Engine Light, read data from various car sensors, check if the car is ready to pass the emissions test and much more.

Panlong Bluetooth OBD2 Car Diagnostic Scanner – compact scanner from the Panlong company has a good rating on Amazon, plus it boasts an attractive price. It allows you to read errors and various car data that are not available on the instrument panel.

ELM327 – one of the most popular and widespread mobile scanners on the market, it provides the ability to connect using Bluetooth, supports Android and Windows. Also one of the cheapest. This scanner will be used for investigation.

All information from the car is sent using a special ELM327 adapter that connects via the OBD-2 port and transmits all data via Bluetooth. MCP-2551 is used for communication of ELM-327 with CAN. The communication with the ECU can be achieved with these two integrated tools. Wired or wireless communication can be used to transmit this communication to an external device. [5]

Before starting the computer diagnostics, you need to establish a connection with the scanner and execute the initialization commands.

Interaction with car. Access to ECU data with mobile devices of the drivers is performed by diagnostic device connected to OBD-II connector [6].

Once all the commands supported by the car have been defined, you can send requests and get the information you need. But to interpret it in a form acceptable to a person, you need to decipher the codes returned by the machine. That is, to have a certain base of all codes.

Each command has its own unique identifier, the response format, that is, the number of bytes it returns, the range of values, in which the response is returned.

As mentioned earlier, special codes are parameter identifiers that are used to request diagnostic information from cars. The SAE J1979 standard defines a standard list of such codes, but manufacturers are free to add their own specific codes. Also, manufacturers may not use all the codes regulated by the standard SAE J1979.

General schema of interaction depicted on Figure 6.

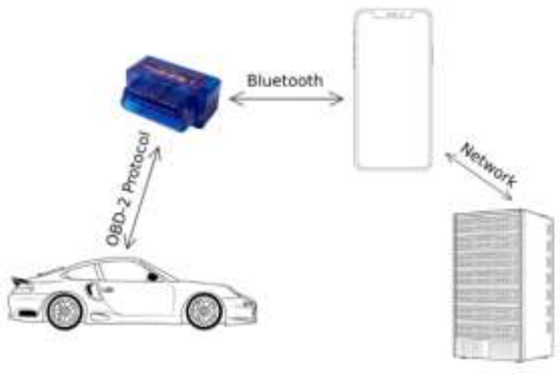

Fig. 6: Schema of interaction with car

First of all, it should be noted that all data from the car will be transmitted using a special adapter ELM327, which connects via the OBD-2 port and transmits all data via Bluetooth. [7]

To get started you need to perform initialization commands, here are the main ones you need to get started:

- ATZ - Resets the adapter to the factory settings;
- ATL0 - Disable line breaks;
- ATE1 - Echo on;
- ATH1 - Headers on;
- ATSTFF - Set the timeout to maximum;
- ATDP - [Describe the current Protocol] The scanner is able to independently determine the protocol of the vehicle to which it is connected;
- ATSP0 - [Set Protocol h] Command to select the protocol in automatic mode.

Based on the above commands, you can generate an initialization string. It will look like this:

Special PID's commands are used to read diagnostic data. PID (Parameter id's) - codes used to require data from the ECU, like RPM in idle speed [8].

The main pads support all cars that have an OBD-2 port. There are also sets of commands for certain makes and types of cars. In our case, the study focuses on basic car diagnostics, so we use a basic set of commands.

Each car supports a certain set of floors. That is, when working with a particular car, you need to operate with a certain set of basic in order not to send the car requests that it does not support. To do this, you need to fulfill a special request, to which the car will return all the floors that it supports. This should be done immediately after the connection is established.

All queries and answers to them are executed in hexadecimal.

To install all supported floors, run a special command with the following code - 0100.

Suppose the car returned the following value - BB1E3211. Next, we translate the result into the binary number system.

BB1E3211(16) is equal to 10111011000111100011001000010001(2).

Using the general floor table shown in Figure 7, determine which ones are supported.

1	0	1	1	1	0	1	1	0	0	0	1	1	1	1	0	0	0	1
+		+	+	+		+	+				+	+	+	+				+
01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13
1	0	0	1	0	0	0	0	1	0	0	0	1						
+			+					+				+						
14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	20						

Fig. 7: Table of codes

Based on these data, we can determine that our car supports the following types: 01, 03, 04, 05, 07, 08, 0C, 0D, 0E, 0F, 13, 14, 17, 1C, 20.

Now we will use only supported commands to increase productivity.

This is usually not the whole list of floors, but only a small part of them, given as an example.

Car errors can also be different and there are separate commands for them. example:

- 03 - To display saved error codes;
- 0A - To display constant error codes.

As with other teams, car errors come in coded form, respectively, as in other teams, they need to be decoded to obtain the necessary information.

After the car responds to the request, you will need to decrypt its response and find the appropriate code in the database, and then display all the information about the error. [9].

The main advantage of OBD2 technology is the unification of ports, as well as standards for data transmission and interaction with them.

It was found that all modern cars, which are equipped with diagnostic ports of the OBD2 standard, have a universal standard of interaction with the car, as well as a certain unified set of commands, which is subject to the SAE J1979 standard, which allows creating a single interface for interaction with the car [10].

At the same time, there are nuances, such as the fact that automakers are free to deviate from this standard, to introduce their own innovations in their cars, but for my task of high-level diagnostics, this is not a problem. After all, based on open sources, the basic diagnostic commands are universal for most machines.

That is, if there is an open base of basic commands, as well as their interpretation, most modern cars can be diagnosed with a universal diagnostic device.

The end user needs to purchase an ELM327 type adapter, download a special application and use the system.

When developing a software product, it is advisable to use a flexible development methodology, because when writing a system, you need to be ready for changes in requirements and quick correction of shortcomings.

Since, according to the specifics of working with the ELM327 adapter, requests are sometimes executed for a long time, due to the fact that data transmission using the RS232 protocol occurs sequentially, it will be appropriate to use an asynchronous model of interaction with the adapter based on messages using broker messages.

The main problem is to check the correctness of working with this or that car, because the features of working with them may differ not even between brands or models, but even between complete sets of the same model, depending on the presence of certain electronic options [11].

So after developing a system with basic functions, a very important stage is testing on different makes and models of cars. The proposed system will greatly shorten the time to detect vehicle trouble condition [12].

Obviously, it is impossible to test the product on a significant percentage of all cars. Therefore, it will be advisable to organize open beta testing after closed testing, to encourage owners of different cars to cover a larger percentage of tested cars and collect data on defects related to specific models for their further elimination.

Conclusions. As a result of the article, a scheme of research was developed on the basis of which a software system will be developed, which will provide opportunities to use OBD-2 technology to diagnose the car. It will also contain the functions of the on-board computer, collect statistics. Also, was researched history of that technology development, as well as the features of its use in software systems were analyzed

Different models of scanners currently on the market were compared and the most affordable and suitable for this task of high-level car diagnostics was selected. The scheme of interaction with the car is considered using special commands that allow you to get any information about the vehicle in real time.

The practical significance of the obtained results is that the model of interaction of the car with the help of OBD-2 technology with the program proposed in the article is a theoretical basis for the development of a system analogous to the on-board computer of the car.

References

1. Gallardo F. *Extraction and analysis of car driving data via OBD-II: Bachelor thesis: 09.18*. Ельче, 2018. 65 p.
2. Rodríguez A., Álvarez J., Rodríguez R. Implementation of an OBD-II diagnostics tool over CAN-BUS with Arduino. *Sistemas & Telematic*. 2018. Vol. 16, no. 45. P. 45–53.
3. *TOAD Pro Homepage: Perfect OBD2 Programming Software For Laptop.* URL: https://www.obdadvisor.com/toad-pro/ (дата звернення: 20.01.2023).
4. *PCMSCAN Features Homepage. Palmer performance engineering, inc*. URL: https://www.palmerperformance.com/products/pcmscan/index.php (дата звернення: 01.02.2023).
5. Süzen A.A., Kayaalp K. Web based tracking of vehicle fault and performance data on OBD II. *Techno-Science*. 2018. P. 13–16.
6. Türker G. F., Kutlu A. Survey of Smartphone Applications Based on OBD-II for Intelligent Transportation Systems. *Gül Fatma Türker Int. Journal of Engineering Research and Applications*. 2016. Vol. 6. P. 69–73.
7. Golian V., Rybitskyi, O. Methods, models and means of interaction with the car using obd-2 diagnostic systems. *InterConf*. 2022. P. 467-472.
8. Rimpasa D., Papadakis A., Samarakou M. OBD-II sensor diagnostics for monitoring vehicle operation and consumption. *Tmrees, EURACA*. 2019. Vol. 6. P. 55–63.
9. *OBD-II DTC List.* URL: http://www.totalcardiagnostics.com/support/Knowledgebase/Article/View/21/0/complete-list-of-obd-codes-generic-obd2-obdii--manufacturer (дата звернення: 10.02.2023).
10. Moniaga J., Manalu S., Hadipurnawan, D. Sahidi F. Diagnostics vehicle's condition using obd-ii and raspberry pi technology. *IOP Conf. Series: Journal of Physics*. 2018. DOI: 10.1088/1742-6596/978/1/012011.
11. Smith J., Johnson A. Integration of OBD-II Technology for Vehicle Diagnostic in Information Systems. *Proceedings of the International Conference on Information Systems (ICIS).* 2022. Vol. 1. P. 45–51.
12. Jhou J., Chen S. The Implementation of OBD-II Vehicle Diagnosis System Integrated with Cloud Computation Technology. *Intelligent Data analysis and its Applications*. 2014. Vol. 1. P. 413–420.

References (transliterated)

1. Gallardo F. *Extraction and analysis of car driving data via OBD-II: Bachelor thesis*. Elche, 2018. 65 p.
2. Rodríguez A., Álvarez J., Rodríguez R. Implementation of an OBD-II diagnostics tool over CAN-BUS with Arduino. *Sistemas & Telematic*. 2018, vol. 16, no. 45, pp. 45–53.
3. *TOAD Pro Homepage: Perfect OBD2 Programming Software For Laptop*. Available at: https://www.obdadvisor.com/toad-pro/ (access date: 20.01.2023).
4. *PCMSCAN Features Homepage. Palmer performance engineering, inc.* Available at: https://www.palmerperformance.com/products/pcmscan/index.php (access date: 01.02.2023).
5. Süzen A.A., Kayaalp K. Web based tracking of vehicle fault and performance data on OBD II. *Techno-Science*. 2018, pp. 13–16.
6. Türker G. F., Kutlu A. Survey of Smartphone Applications Based on OBD-II for Intelligent Transportation Systems. *Gül Fatma Türker Int. Journal of Engineering Research and Applications*. 2016, vol. 6, pp. 69–73.
7. Golian V., Rybitskyi, O. Methods, models and means of interaction with the car using obd-2 diagnostic systems. *InterConf*. 2022, pp. 467–472.
8. Rimpasa D., Papadakis A., Samarakou M. OBD-II sensor diagnostics for monitoring vehicle operation and consumption. *Tmrees, EURACA*. 2019, vol. 6, pp. 55–63.
9. *OBD-II DTC List.* Available at: http://www.totalcardiagnostics.com/support/Knowledgebase/Article/

View/21/0/complete-list-of-obd-codes-generic-obd2-obdii--manufacturer (access date: 10.02.2023).

10. Moniaga J., Manalu S., Hadipurnawan, D. Sahidi F. Diagnostics vehicle's condition using obd-ii and raspberry pi technology. *IOP Conf. Series: Journal of Physics*. 2018, DOI:10.1088/1742-6596/978/1/012011.
11. Smith J., Johnson A. Integration of OBD-II Technology for Vehicle Diagnostic in Information Systems. *Proceedings of the International Conference on Information Systems (ICIS)*. 2022, vol. 1, pp. 45–51.
12. Jhou J., Chen S. The Implementation of OBD-II Vehicle Diagnosis System Integrated with Cloud Computation Technology. *Intelligent Data analysis and its Applications*. 2014, vol. 1, pp. 413–420.

Received 15.05.2023

УДК 004.42:004.45

О. М. РИБІЦЬКИЙ, аспірант кафедри програмної інженерії, Харківський національний університет радіоелектроніки, м. Харків, Україна, e-mail: oleksandr.rybitskyi@nure.ua, ORCID: https://orcid.org/0000-0002-8508-7269
В. В. ГОЛЯН, кандидат технічних наук (PhD), Харківський національний університет радіоелектроніки, доцент кафедри програмної інженерії, м. Харків, Україна, e-mail: vira.golan@nure.ua, ORCID: https://orcid.org/0000-0001-5981-4760
Н. В. ГОЛЯН, кандидат технічних наук (PhD), Харківський національний університет радіоелектроніки, доцент кафедри програмної інженерії, м. Харків, Україна, e-mail nataliia.golian@nure.ua, ORCID: https://orcid.org/0000-0002-1390-3116
З. В. ДУДАР, професор, кандидат технічних наук (PhD), Харківський національний університет радіоелектроніки, завідувач кафедри програмної інженерії, м. Харків, Україна, e-mail zoia.dudar@nure.ua, ORCID: https://orcid.org/0000-0001-5728-9253
О. В. КАЛИНИЧЕНКО, кандидат технічних наук (PhD), Харківський національний університет радіоелектроніки, доцент кафедри програмної інженерії, м. Харків, Україна, e-mail olga.kalynychenko@nure.ua, ORCID: https://orcid.org/0000-0003-1466-3967
Д. М. НІКІТІН, аспірант кафедри програмної інженерії, Харківський національний університет радіоелектроніки, м. Харків, Україна, e-mail: nikitin27959@gmail.com, ORCID: https://orcid.org/0000-0003-4388-4996

ВИКОРИСТАННЯ ТЕХНОЛОГІЇ OBD-2 ДЛЯ ДІАГНОСТИКИ АВТОМОБІЛІВ ТА ЇЇ ВИКОРИСТАННЯ В ІНФОРМАЦІЙНІЙ СИСТЕМІ

У статті розглядаються дослідження технології OBD-2 для взаємодії з бортовими системами автомобіля, створення уніфікованої системи, яка може працювати з різними марками і моделями автомобілів. Описана історія технології OBD-2, її розвитку, існуючі стандарти та їх втілення у сучасних автомобілях. Описано основні діагностичні функції, за допомогою яких можна отримувати інформацію про автомобіль, а також виконувати його налаштування та надсилання йому різних команд. До того ж розглянуто апаратну частину сканеру, його технічні особливості, нюанси взаємодії з ним та призначення кожного з його пінів. Також розглянуто кілька моделей сканерів, які можна використовувати для розробки цієї системи. Зроблено висновки про доцільність їх використання з урахуванням їх можливостей. Розглянуто існуючі програмні аналоги, їх основні функції, переваги та недоліки. Також розглянуто загальну концепцію взаємодії з автомобілем через OBD-2, алгоритм взаємодії та покроково розібрано взаємодію сканера і автомобіля. Розглянуто програмну частину взаємодії між автомобілем і сканером, спеціальні коди, що використовуються для надсилання запитів та відповідей, їх подальший аналіз та інтерпретація у придатний для людини вигляд. Висвітлено можливості щодо уніфікації цих кодів для різних автовиробників та бази загальних кодів для створення універсальної системи, яка буде підходити для різних автомобілів різних автовиробників. Запропоновано модель програмної системи, що зможе втілити в собі великий набір корисних функцій для будь-якого автомобіліста та буде сумісною з великим числом сучасних машин обладнаних універсальними засобами діагностики у при цьому використовуючи доступну модель сканеру без застосування дорогого професійного обладнання.

Ключові слова: Автомобіль, бортовий комп'ютер, комп'ютерна діагностика, сканер, OBD2. Інформаційна система.

Повні імена авторів / Author's full names

Автор 1 / Author 1: Рибіцький Олександр Максимович, Rybitskyi Oleksandr Maksymovych
Автор 2 / Author 2: Голян Віра Володимирівна, Golian Vira Volodymyrivna
Автор 3 / Author 3: Голян Наталія Вікторівна, Golian Nataliia Viktorivna
Автор 4 / Author 4: Дудар Зоя Володимирівна, Dudar Zoia Volodymyrivna
Автор 5 / Author 5: Калиниченко Ольга Вікторівна, Kalynychenko Olga Viktorivna
Автор 6 / Author 6: Нікітін Дмитро Михайлович, Nikitin Dmytro Mykhailovych