

## Секция 1. Электронные средства и системы управления

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### **Multifunction Programmable Robotic Platform**

*The article describes the design of a three-wheeled robot platform with two driven wheels. The structure, the schematics, the components and the construction design of the device are considered. The attention is given to the principles of operation and functions of the platform. There considered the multifunction feature implemented by modular type of the platform that allows flexible reconfiguring of its hardware and operation mode. Special attention is given to a relevant application – automatic disinfection of rooms.*

**Keywords:** platform, device, base, robotic, disinfection.

#### **Introduction**

There are many robotic platforms with dimensions and applications like robotic vacuum cleaners, e. g., iRobot Create. Usually these platforms have at least one drive and some pivot points [1]. The mentioned platforms have just one sphere of application and the user cannot change it by his own will [2]. The point of this work was to design a universal three-wheeled robot platform with two driven wheels. The main feature of this platform is flexibility for the user to reconfigure its operational algorithm and its onboard equipment to provide wider applicability [3].

One possible application of the platform is described here in details. It is automatic disinfection of human inhabited areas like rooms, stores, selling floors, offices etc. at people absence time intervals. It especially makes sense in case of threats like coronavirus.

## Application

Consider such application as room disinfection.

There is a Russian industrial disinfection device “Yunior” based on a robotic platform (Fig. 1). Its features are large areas of coverage, production of disinfection vapor by the robot itself, ability to move across uneven surface by means of caterpillars [4].



Fig. 1. Russian disinfecting robot “Yunior”

This type of machine is too sophisticated for an average private user. So, the designed robot platform can replace it with maintaining the general functions in simplified manner as follows:

1. Instead of the industrial vaporizer, a nebulizer pressurized pack is supposed to be used. It is activated by means of mechanical pushing the release button with an electromagnetic drive.

2. The platform can be equipped with a set of UV LEDs to provide additional disinfection of the air around the device.

Operation modes of all pieces of the onboard equipment can be flexibly programmed.

Compare the efficiency of the designed robot and “Yunior”.

The disinfecting agent is sprayed for 1 second every 10 seconds. The evaporation rate is 1 g per second that makes 6 g (60 ml) per minute at the given regularity. The net weigh of one spraying can is 200 g, so it takes 33 minutes 20 seconds to empty it. Adding the second spraying can doubles the spraying time at the same rate.

The industrial vaporizer operation time is also 1 hour with full tank [5]. Its spraying potential is 200-300 ml per minute which is 5 times greater than

the previous one. It is too much for an average user, so the designed device perfectly fits.

## Design

The platform is based upon the blocks with standard schematics. The structure diagram is given in Fig. 2.

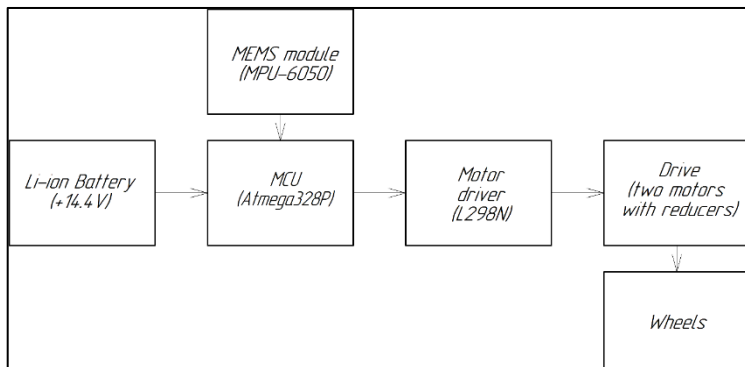


Fig. 2. Multifunction robotic platform structure diagram

A brief description of the blocks is given further:

1. The power supply is a 14.4 V Li-ion battery like those used to power hand drills.

2. At the microcontroller board (Arduino Nano), 14.4 V from the battery is converted into 5 V. Then two these voltages are applied to the two-channel drive controller L298N which can stand current up to 3 A.

3. Control algorithm is implemented as firmware of the microcontroller board MCU ATmega 328P-AU [6].

4. Each driven wheel is put in motion by its own collector motor equipped with a gearbox. The motors receive control signals from the drive controller.

5. IMU GY-521 with three-degrees-of-freedom gyroscope and two-degrees-of-freedom accelerometer is a feedback sensor that makes it possible to estimate Euler angles and yaw-pitch-roll ratings of the platform. It increases the accuracy of positioning the robot in space [7].

Electrical schematic diagram is given in Fig. 3. Power supply voltage of 15-17 V is applied from an external battery via X1 connector. It energizes the circuit. Control signals [8] (PWM and logic state of motors' rotation directions) from MCU D1 (Arduino Uno/Nano) are directed to L298N DC motor driver D3 with protection diodes VD1...VD8. Driver D3 forms the corre-

sponding signals for the motors that are connected via X2 and X3 connectors. LEDs VD9...VD12 are needed to illuminate the platform. Gyroscope-accelerometer unit D2 (GY-521/MPU6050) is needed to measure the platform rotation degree relative to Earth. SA1 is an ON/OFF switch, SB1 is a reset button.

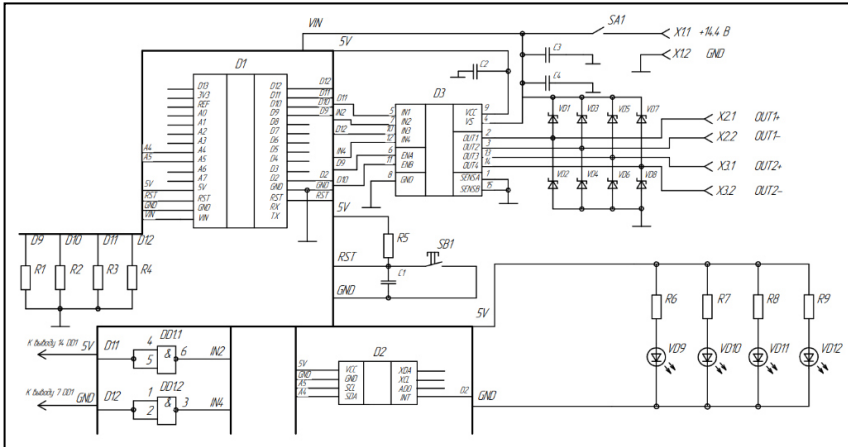


Fig. 3. Multifunction robotic platform electrical schematic diagram

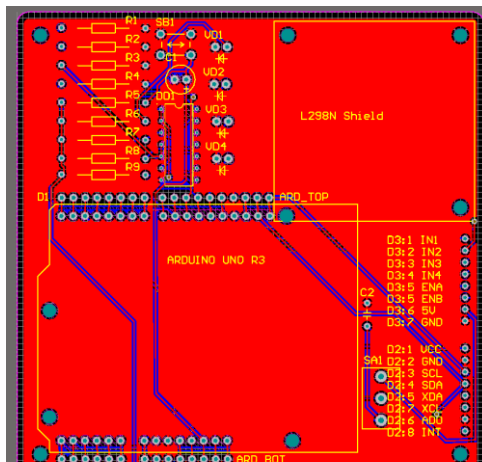
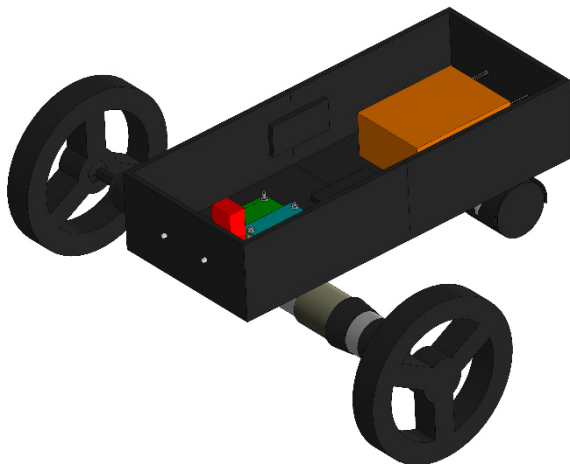


Fig. 4. Multifunction robotic platform printed circuit board

The device PCB layout is given in Fig. 4. It has several PLS-male connectors to provide easier docking of external modules. Some elements like VD1...VD8, C3, C4, etc. are not to be mount on the Fig. 4 PCB as they are located at L298N separate PCB.

The body of the platform is 3D-printed (see the computer model in Fig. 5) [9]. Drives' mounting brackets are not shown conventionally.



*Fig. 5.* Approximate 3D image of the robotic platform

The reason of using hand drill motor sets with integrated gearboxes is their ability to accelerate and provide with significant torque. The corresponding hand drill batteries are suitable for being power sources.

Wheels can be either 3D-printed or chosen from standard ones [9]. The third wheel is not supposed to be driven directly as long as its function is to stabilize the platform horizontally [10].

The robot platform features [11]:

1. The robot can be programmed to drive along certain paths or choose the optimal path with presence of random obstacles.
2. The platform can carry various equipment and payload to perform specific functions.
3. The platform carrying capacity is up to 2 kg.
4. It can move only over the flat surface.
5. The potentially achievable linear motion speed is up to 14 km/h (in case of 700 RPM motor spin rate and 15 cm diameter of driven wheels).

Therefore, modular design of the platform provides its functional flexibility [12].

### Research of platform functions

Even though the concept of the described device is not brand new in robotics (there are such platforms as iRobot Create, iRobot Create 2 etc.), the platform provides numerous applications:

- Automatic room disinfection;
- Mobile air freshener;
- Mobile irrigation device;
- Mobile insect repellent (enhanced repellency surface);
- Cargo platform [4, 13];
- Multi-purpose remote controlled mobile platform [14];
- Automatic homing turret.

### Conclusions

The designed multifunction robot platform performs the variety of functions that fit an average private user's needs with no excessive performance. The device suits the private rooms or apartments of about 60 square meters.

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## **Многофункциональная программируемая роботизированная платформа**

*В статье приводится процесс разработки двухколесной роботизированной платформы с двумя ведущими колесами и третьим опорным. Приведена структура устройства, его схемы и компоненты. Уделено внимание принципам работы и функциям платформы. Рассмотрена применяемость платформы в различных сферах жизнедеятельности и частный случай её применения в качестве устройства для дезинфекции помещений*

**Ключевые слова:** платформа, устройство, основание, роботизированный, дезинфекция.