DOI: 10.35598/mcfpga.2026.030

Using ESP8266 to Control Collaborative Humanoid Robots

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***Abstract*—The article provides a justification for the choice of ESP8266 for controlling a humanoid collaborative robot. Technical characteristics are considered. The choice of a humanoid robot, as well as its characteristics, are also described.**

***Keywords*—humanoid robot, control system, control, ESP8266, collaborative robot.**

I. Introduction

The modern development of robotics is characterized by the active introduction of collaborative robots (cobots), which are able to safely interact with a person in a shared workspace. Of particular interest are humanoid robots, the design of which imitates the structure and movements of a person [1-4]. At the same time, the creation of such systems requires effective, compact and affordable means of control and communication.

One of the promising solutions is the use of the ESP8266 microcontroller, which combines computing capabilities and a built-in Wi-Fi wireless communication module. Low cost, ease of programming and broad support by the developer community make the ESP8266 a popular platform for creating robotic systems [3-5].

II. ESP8266 Main Characteristics

Collaborative humanoid robots are designed to perform tasks in direct interaction with humans. Unlike traditional industrial robots, they are equipped with safety control systems, sensor modules and adaptive control algorithms. The main functions: performing routine operations in production; medical and rehabilitation assistance; customer service; educational and research activities; supporting the elderly and people with disabilities.

The effective operation of collaborative robots requires ensuring reliable communication between actuators, sensors and the control system.

ESP8266 is a single-chip microcontroller platform based on the 32-bit Tensilica L106 processor with a clock frequency of up to 160 MHz. The main advantage of the module is the integrated Wi-Fi interface of the IEEE 802.11 b/g/n standard. Among the key characteristics of the ESP8266 are the following: support for Wi-Fi wireless communication; low power consumption; support for TCP/IP, MQTT and HTTP protocols; availability of GPIO, UART, SPI and I²C interfaces; compatibility with the Arduino IDE environment; low cost and availability. Thanks to these features, the ESP8266 can perform the functions of both a local controller and a communication gateway between the robot and external systems.

In a humanoid robot, ESP8266 can be used to implement the following tasks: wireless control of servo drives; collection and transmission of data from sensors; organization of interaction with cloud services; remote monitoring of the robot's state; ensuring communication with mobile applications and web interfaces. Thanks to support for the MQTT protocol, it is possible to implement the concept of the Internet of Things, within which the robot becomes an element of a single information network. This allows you to organize centralized control of several robots, analyze the received data and implement artificial intelligence algorithms.

A typical system architecture involves using ESP8266 to process commands received via Wi-Fi and transmit them to servo drives that are responsible for the movement of limbs, head and other parts of the humanoid robot.

III. ESP8266 Advantages ans Disadvantages

The main advantages of ESP8266 are: affordable cost; compact size; ease of integration; support for wireless technologies; the possibility of rapid prototyping.

However, the use of ESP8266 has certain limitations. In particular, the computational resources of the microcontroller may not be enough to execute complex computer vision algorithms, process large data sets, or run artificial intelligence models locally. In addition, the limited number of inputs and outputs makes it difficult to control a large number of actuators without using additional expansion modules [6-7].

IV. Robot Selection

The humanoid robot ViVi is chosen as an example. The general appearance of the humanoid robot ViVi is presented in Figure 1, and its technical parameters are presented in Table 1.

Fig. 1. ViVi Robot

TABLE I. TECHNICAL PARAMETERS OF THE HUMANOID ROBOT VIVI

Category	Characteristic/Parameter
Robot type	Humanoid, bipedal
Housing material	Plastic (3D printing)
Number of servo motors	17
Servo motor type	Micro Servo 9g (SG90 or similar)
Max. torque	~1.8 kg·cm (at 6 V)
Control system	MCU controller (ESP8266/STM32 or compatible)
Connection	Wi-Fi (AP mode)
Power	Li-Po battery (3.7 V – 7.4 V), via cable
Number of degrees of freedom (total)	17 DOF
Control protocol	PWM for servo motors
PWM frequency	50 Hz (standard for SG90)
Decision making	Local or via central script
Motion control	Servo position control, through preset angles
Command delay	~50–100 ms via Wi-Fi AP
Dimensions (H*W*D)	200*75*45 mm

CONCLUSION

The use of the ESP8266 microcontroller in control systems for collaborative humanoid robots is a promising direction in the development of modern robotics, combining the principles of the Internet of Things, wireless communications and intelligent automation. Thanks to the built-in Wi-Fi module, sufficient computing power to perform basic control functions and low cost, the ESP8266 allows you to create affordable robotic solutions for scientific research, the educational process and prototype development.

The analysis shows that the use of the ESP8266 provides an effective organization of wireless data exchange between individual components of a humanoid robot, in particular sensors, servos, mobile applications, web interfaces and cloud platforms. This makes it possible to implement the functions of remote monitoring, remote control, collection and analysis of telemetric data, as well as integrate robots into unified cyber-physical systems.

ESP8266 is of particular importance in the field of collaborative robotics, where the speed of information exchange, flexibility of configuration and the ability to adapt to changing operating conditions are critically important. Support for standard network protocols, in particular MQTT, HTTP and TCP/IP, contributes to the creation of scalable control architectures and simplifies the integration of robots with artificial intelligence platforms and Internet of Things services.

At the same time, the use of ESP8266 has certain technical limitations. The computational resources of the microcontroller are not enough to implement complex algorithms of computer vision, autonomous navigation, speech recognition or local execution of machine learning models. In this regard, it is advisable to use ESP8266 as a communication module or auxiliary controller in combination with more productive computing platforms.

Thus, ESP8266 is an effective tool for building distributed control systems for collaborative humanoid robots, especially at the stages of research, training and rapid prototyping. Prospects for further research lie in the development of hybrid architectures that combine the advantages of ESP8266 with modern high-performance microcontrollers and single-board computers, as well as in the implementation of artificial intelligence, digital twins, and cloud computing technologies to increase the level of autonomy, safety, and efficiency of human-robot interaction.

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