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Radio Control System

Ivailo Georgiev, Anton Antonovski

Central Laboratory of Mechatronic and Instrumentation, 1113 Sofia

Theoretic basis

In contemporary radio control, systems for coding and transmitting of control command via communication channel, the methods of pulse modulation are widely used. The amplitude, frequency or duration of a square pulse sequence is affected. This means that amplitude pulse modulation, frequency pulse modulation or pulse width modulation of the pulse signal is used, which signal uses a high frequency harmonic carrier signal for the process of modulation. The disadvantage of this method is typical for all types of pulse modulation double transformation of the control signal. Despite of the fact that in this way high level of noise resistance is achieved, it complicates and makes more expensive the transmitter and the receiver.

In order to make the system cheaper and to save energy during the process of exploitation, a radio remote control system, which is based on an original method for organizing of radio communication [3], was developed in CLMI. According to this method, the binary digital information that has to be sent is divided into packages of *n* elements. The code sequence, which corresponds to a named package, is recorded in a separate register of memory. In order to be transmitted, an exact sequence is sent to the parallel input of the transmitter counter. In this way, the number of pulses, which it must count, is set. With a start pulse (which is also sent to the receiver) the pulse generator on the transmitter side is started. Its output signal comes to the counter input (serial input) of the counter. The starting pulse, received from the receiver, on its side starts the pulse generator of the receiver. Its output signal comes to the counter input (serial input) of the receiver-side-counter, which starts counting the pulses coming to the input pin.

The end-of-working of the transmitter counter is marked by a set of zeroes on its output. This event leads to the generating of a stop pulse that disables the serial input of the counter on the transmitter side, and is sent to the receiver. The received stop pulse stops the pulse generator on the receiver side. Because of this, the receiver-side counter remains in the state it was at the time the stop pulse was received. In that way on its output is set a code sequence that corresponds to the number of pulses counted. Because of the fact that the pulse generators on both sides are started synchronously and work at the same frequency, the sequence achieved matches the sequence used to initialize the counter on the transmitter side.

The described way of operating shows that by this method only two pulses per package information sent are transmitted: synchropulse – to start synchronously the pulse generators on the transmitter and the receiver sides, and a stop pulse (information pulse) – which corresponds to the zeroing of the counter on the transmitter side and the stopping of the counter on the receiver side. Therefore, the information characteristic of the transmitted signal is the period between the start pulse and the stop pulse. In this case the code sequence is not "sent" but "restored" by using the achieved state of the receiver-side-counter.

This method has some significant advantages:

- Each package of information, regardlessly of its length (every code sequence corresponding to a named command to the mechatronic system), is sent using only two pulses – one for beginning (start pulse) and one for end (stop pulse). The information characteristic of the signal is the period between the pulses. This minimizes the total amount of the emitted energy (the optimal operational state for the transmitter is achieved) and minimizes the time the channel is used.
- Because none of the pulse parameters (frequency, amplitude, and phase) carries significant information in itself, it is not necessary to transform the signal twice. In that case, the easier to organize one-way-amplitude-modulation is enough. The receiver is less complex and cheaper too. Because it is not necessary to monitor and analyze the parameters of the pulse, it could be designed as a plain signal detector.
- The frequency band widens.

Refer to [1] and [2] for further information about the concrete scheme designed in CLMI, its operational principles and the necessary settings.

In the following pages are applied the technical characteristics and the results from the tests as well as the connection with a PC.

Results from the tests of the system

The laboratory model, which was tested, has the following technical parameters:

- Carrier frequency – 10 MHz;
- Number of channels – 1;
- Feedback connection – n.a.;

- Operating voltage (transmitter side) – 12 V;
- Operating voltage (receiver side) – 12 V;
- Power consumption (transmitter side, stand-by mode) – 30 mA;
- Power consumption (receiver side, stand-by mode) – 30 mA;
- Time needed for the transmission of one command – 2.5–13.6 ms;
- Number of commands – 9.

During the development of the model we used standard, trade common and cheap CMOS – ICs. The number of passive elements is minimal. The operational instability of the first issue of the system necessitated the addition of extra modules, which led to its complication. These were for example the signal selector, based on IC 4060, the voltage converters 12/5 V and 5/12 V and others. They will not be necessary if quality elements are used.

The results from the tests revealed that this system matches the expectations for low power usage. The relation cost-reliability is good too. The laboratory model ensures flawless recognition of all nine commands, despite of the sometimes noisy environment. This demonstrates that satisfactory noise resistance can be achieved without feedback and special communication protocol.

Disadvantage of the tested model is the comparatively short range of the connection (approximately 10 m in a building) which is due to the low-quality elements used for the transmitter and the receiver. It is expected that by using standard integrated modules, which provide the necessary amplitude manipulation of the signal, the system quality will rise.

The characteristics of the system and the results from the tests outline its usage in the area of cheap, non-critical remote control systems, where the EMC – requirements, low power consumption and simplicity are significant.

Perspectives for future development of the system

The possible future usage of a system of this kind for remote control of more complex mechatronic objects supposes development in two ways: enhancing the number of commands and connection with a personal computer.

According to the method used (which is build up of discrete elements), enhancement of the number of commands can be achieved only through cascading connection of counters on the transmitter-side and the receiver-side. This will give the opportunity for expanding the period between the start and the stop pulse. Since this would have led to complete reorganization and complication of the system, without being a principle novelty, such an experiment was not carried out.

Alternative technical solution, which will lead to the same result, is the realization of the coder and the decoder with the usage of a microprocessor. This will decrease the size of the model but will increase the cost of the system as a whole.

Controlling the developed system with a personal computer makes it possible to use it for remote control of mechatronic objects according to a previously given program or under conditions, which require fast reaction. (Practical sense of developing the last variant there will be only if the system is equipped with a feedback connection.) As a preparation for such a development, a connection between the tested laboratory model and a PC was realized via parallel port. In this case, the standard on which the port is set is of no importance, because the controlling program writes the controlling code sequences directly in the port registers without using a specific protocol for data transfer.

As a summary, we can say that, having in mind the current hardware condition of the system, it utilizes optimally the possibilities given by the parallel port interface. That is why exactly the parallel port interface was chosen. On the other hand the future development of the system and feedback connection will make the usage of two-way interface (ECP for example) inevitable.

Though the concrete model does not need faster data transfer than it is possible through parallel interface, it is desirable the connection to be established through USB or IEEE 1394 (Firewire) in accordance with the contemporary trends. The USB interface is extremely promising for image transfer through the feedback channel. Another of its advantages is the possibility for power supply of the peripheral device from the host, which will eliminate the need of second power supplying device. Of course this will lead to significant changes in the system's hardware and will be an objective for further development.

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Система радиоуправления

Ивайло Георгиев, Антон Антоновски

Центральная лаборатория мехатроники и приборостроения, 1113 София

(Ре з ю м е)

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