

## Bluetooth-based wireless target controller

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### Abstract

Shooting training is one of the basic training subjects of the special police team, and it is an important guarantee for the special police team members to complete the difficult task. In order to improve the actual shooting level of the special police team, it is necessary to make full use of various shooting training equipment, in which the target machine controller is the core unit. Now many supporting controllers are relatively simple in function, only the hidden target and the target time can be set, but the target cannot be randomly displayed, the video capture component before the target is not considered, the impact point cannot be displayed in real time, and the human-machine interaction experience is not good, which meets the needs of special police training at this stage. In the current social production and life, people's information exchange is getting closer and closer, and the smart phone has the advantages of the openness of the system platform, the portableness of the network information, and the scalability of the hardware function, and the penetration rate is getting higher and higher. Therefore, this article starts from the reality, selects the Android mobile phone that is now popular, and designs and implements a wireless Bluetooth target controller based on Android. The drone controller can wirelessly control the side-turning target aircraft of the special equipment detachment and the up-down target machine through an application running on the Android mobile phone. During the shooting training, the variable hidden target and the target time can be flexibly set to simulate the shooting conditions of different scenes in actual combat, and the target can be reported in real time and the shooting can be corrected. This paper presents the main program module flow chart, using STC12C5A60S2 microcontroller, Bluetooth and DTU data transmission module as the hardware platform of the target controller, and based on the hardware platform for Android mobile phone target controller application software development, the target machine controller system has the characteristics of simple structure, reliability, stability and convenient operation. It improves the efficiency of shooting training on the basis of making full use of the original shooting training equipment, and can adapt to the needs of various shooting trainings, effectively improving the special police team. The practical ability of the catastrophe. The innovation of this paper is to combine the Android smart-phone device terminal with the target machine system, control the existing target machine, and transform the existing equipment to improve the shooting efficiency and enhance the team's combat effectiveness.

### Keywords

Android, target drone, Single chip microcomputer, Bluetooth.

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## 1. Introduction

Shooting training is one of the basic training subjects of the special police team, and it is an important guarantee for the special police team members to complete the task of overcoming difficulties[17]. In order to improve the actual shooting level of special police officers, it is necessary to make full use of various shooting training equipment, in which the target controller is the core unit. The side-turning target machine and takeoff target machine currently equipped by the special police detachment of Guangzhou Public Security Bureau were purchased in 2007[8]. At that time, the function of the matching controller was relatively simple. It could only set hidden target and display target time, and it could not display target randomly, without considering the video acquisition module before target, and could not display the impact point in real time. The human-computer interaction experience was not good, and it could not meet the training needs of the special police at this stage.

## 2. Research Status and Significance of Wireless Bluetooth Target Controller Based on Android

In the current social production and life, people's information exchange is more and more close, and smart phones have the advantages of open system platform, portability of network information, expansibility[13] of hardware functions and so on, and the popularization rate is getting higher and higher. So this paper chooses the popular Android mobile phone to design and implement a wireless Bluetooth target controller based on Android. The target controller can wireless control the side-turning target machine and takeoff target machine of the existing equipment of the special police detachment through the application program running on the Android mobile phone. In shooting training, variable hidden target and display time are set flexibly to simulate shooting conditions in different scenarios in actual combat, and the shooting can be reported in real time and corrected in time[1]. This paper presents the flow chart of the main program modules. The STC12C5A60S2 single chip computer, Bluetooth and DTU data transmission module are used as the hardware platform of the target controller. Based on the hardware platform, the software development of the application program of the Android mobile phone target controller is carried out. The target controller system has the characteristics of simple structure, reliable stability and easy operation. It makes full use of the original shooting training[7]. On the basis of the equipment, the efficiency of shooting training is improved, and it can meet the needs of various shooting training, and effectively enhance the combat ability of the special police team to overcome difficulties.

## 3. Overall scheme design

### 3.1 Requirement Analysis

By disassembling and analyzing the original target controller, it is found that the original target controller is composed of 51 single-chip computer, relay and control program written in 51 single-chip computer[10]. The control principle is that the original target controller connects the target machine wirelessly with the control signal line, sets the display time and hidden time respectively through the buttons on the panel, sets whether or not the cycle operation is through the circular buttons on the panel, directly controls the target machine's action through the hidden target buttons and the display target buttons, and sends out the program start instructions through the start buttons; when receiving the hidden target instructions, 51. The digital output foot of MCU sends out a high-level control relay to absorb and a short-circuit control signal line, so that a low-level signal will be received at the target end of the control signal line, and the target machine will turn sideways to realize the hidden target[11]. When receiving the display target instruction, the digital output foot of MCU 51 sends out a low-level control relay to release and open the control signal line, so that the control signal line is in control. The target terminal of the signal line will receive a high-level signal, and the target machine will turn forward to realize the display target[12]. The working state of the original target controller is displayed by "hidden target", "display target", "cycle" and other indicators on the panel, but there is no time to display in the countdown process of hidden target or display target. Through

the disassembly and analysis of the original target machine controller, this simple and clear control mode can be used for reference, laying a good foundation for the next development and transformation.

After collecting and synthetically analyzing the opinions of shooting instructors, the shortcomings of the original target controller are as follows:

The time interval of hidden target can not be set quickly, and the time interval is solidified in the program and can only be fine-tuned. The next boot-up should be reset, and the target can not be randomly set.

In the process of hidden target and display target of target controller, the time schedule can not be displayed in real time, and the instructor can not grasp the timer intuitively.

Occasionally there will be no response when the start button is pressed, which needs to be set repeatedly.

It can not show the impact and hitting of the shooting in real time. In training and assessment, the target can only be reported by observation mirror or manual method. According to the collected opinions and the actual training, the functional requirements of the target controller are analyzed:

According to the special police detachment training program in 2015, the shooting time required for shooting subjects is: the precision shooting subjects of pistols and miniature submachine guns are required to be completed in 60 seconds, while the application shooting subjects of pistols and miniature submachine guns require shooting three rounds at an interval of three seconds, and then shooting three rounds at an interval of six seconds[3]. This requires that the target controller can quickly set and display the hidden target time in real time. In the five skills of special police in the Ministry of Public Security, the shooting subjects of long and short guns in Biwuzhong require that 13 targets be hit in 240 seconds in sequence. However, the original target controller can only set a maximum time interval of 99 seconds limited by two encoders, which is the first problem to be solved.

In shooting training, because shooting training is repeated at the same time interval, problems such as mechanization and programming of training are easy to occur. Some players will make mistakes in shooting without showing the target, and practice shooting to death. In order to grasp the fleeting fighter in actual combat, special police officers need to have fast judgment and shooting ability, which requires random target display in shooting training to exercise their adaptability. However, the original target machine controller does not have this function, but is controlled by the instructor by pressing the button manually[18]. There are two shortcomings in this way: one is that it will be greatly influenced by the instructor's human factors, and it is prone to the regularity and habitual problems of time interval; the other is that the instructor needs to press the button repeatedly in training, so that he can not concentrate on finding problems and correcting erroneous movements. Make it up. This is also the second problem to be solved in this paper.

In shooting training for low-level shooters, instructors need to analyze the details of each shooting action and the impact point of each bullet in order to quickly find problems and correct them; in shooting assessment, they need to grasp the hit situation in real time to prevent cheating[14]. In order to achieve these functions, we need a video acquisition device in front of the target, which also transmits the video to the instructor in real time for reference. This is the third problem to be solved.

Combining with the actual conditions of shooting training, the non-functional requirements of target machine controller are analyzed:

**Real-time.** The target controller should respond to the Android application program in real time. The video transmission should be real-time, with small delay and fluency, so as to ensure that the instructor can master the effect of shooting training.

**Reliability is guaranteed.** Since the shooting training is performed at the outdoor shooting range and is carried out all year round, the hardware parts of the target controller are required to have a certain rainproof capability and can work outdoors for a long time.

Compatibility is good. Android applications can run on various brands and models of Android devices, and can be used by many instructors.

Above all, the target controller developed in this paper needs to achieve the following objectives:

- (1) The function of controlling the time of hidden target and display target: the time of hidden target and display target can be set arbitrarily in 0-999 seconds, and the target can be displayed randomly in a predetermined time period (usually 1-9 seconds).
- (2) Setting up single shooting and cycle shooting functions of hidden target and display target to meet different needs of training and assessment.
- (3) It can display the working state in real time and show the countdown of the display target and hidden target.
- (4) Each component has certain outdoor working ability and must be stable and reliable. Android application has good platform versatility.

### 3.2 The working principle of the system

The working principle of the system is shown in the figure:

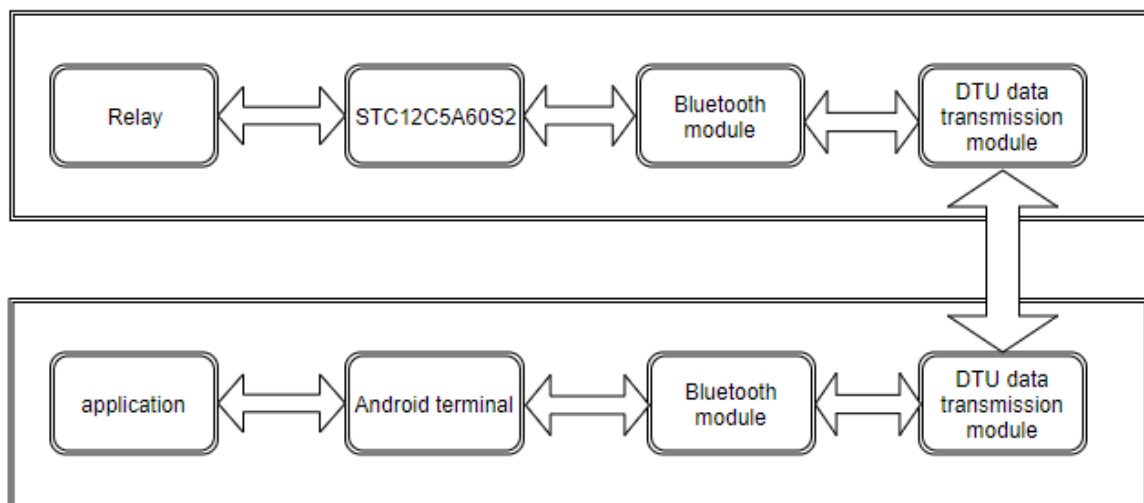


Figure 1. The working principle of the system

- (1) STC12C5A60S2 MCU is the basic control platform module of the whole target controller system[15]. It plays the role of connecting Android mobile phone in the system. It responds to the instructions made by the instructor in the Android terminal application and controls the target machine in real time through relay module and target signal line.
- (2) Bluetooth module is the wireless communication channel between STC12C5A60S2 MCU and Android mobile phone, and it is the data channel to transmit Android application control instructions[16].The function of this module is to receive the operation instructions of Android application through Bluetooth network, and at the same time send the control instructions to STC12C5A60S2 MCU in real time.
- (3) The relay module is the intermediate unit between the STC12C5A60S2 MCU control platform and the target machine. It is an important component to achieve the goal of controlling the target machine[9]. The action of the relay module is to control the level change of the digital output foot of Arduino MCU through the program in the control platform. The module realizes the direct control of the target machine by STC12C5A60S2 MCU.
- (4) The Android application program is installed on Android terminals such as Android smartphones to realize human-computer interaction between instructors and target controller and control target machine.

### 3.3 Target Machine Controller Workflow

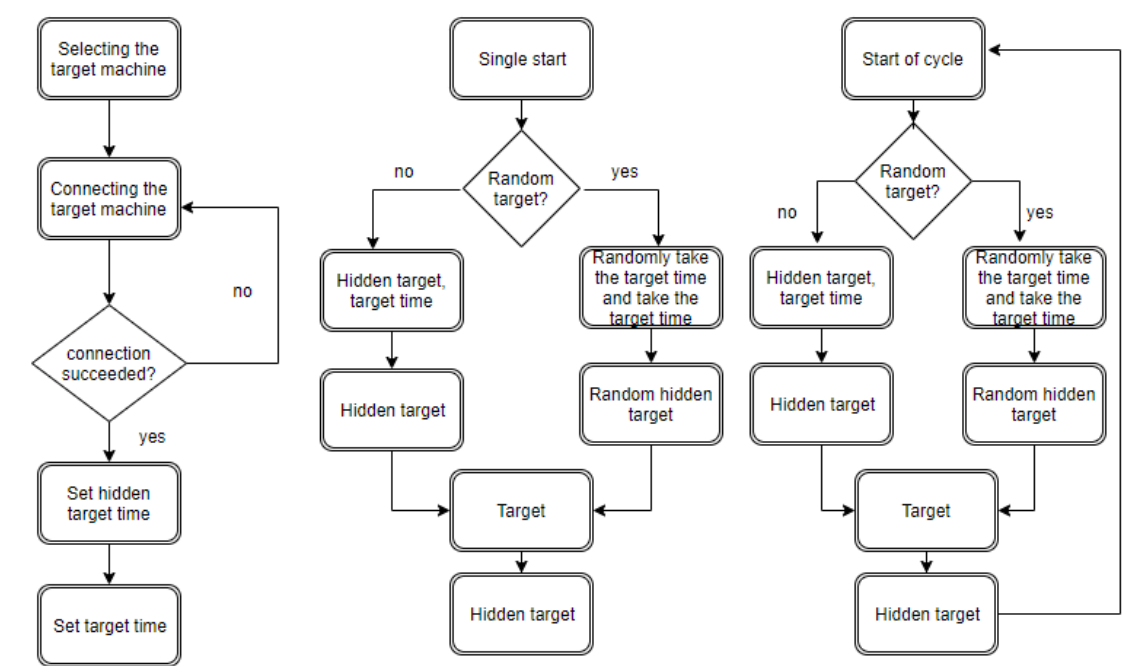


Figure 2. work process

The specific workflow is as follows:

- (1) Turn on the power supply, select the target machine (there can be one or more target machines), and select the target controller (according to the MAC address of Bluetooth module).
- (2) Connect the target machine. After successful connection, the controller of the target machine will immediately control the relay to suck in and cause the hidden target of the target machine, so as to inform the instructor that the target machine has been connected successfully.
- (3) Setting the display time, hidden time and whether or not to shoot at random.
- (4) Starting with a single move, the target machine turns the hidden target sideways, the hidden target time reaches the target machine's forward turn display target, and the display target time reaches the target machine's latent target sideturn, and the single process is completed. When the target is hidden and displayed repeatedly in training, the system will automatically repeat the process of hiding and displaying the target by pressing the start button of the cycle.

### 3.4 Overall composition of the system

The hardware system of the target controller consists of STC12C5A60S2 single chip computer, Bluetooth module, relay module and DTU data transmission module.

- (1) STC12C5A60S2 MCU and Bluetooth module.

Considering the integration and stability, STC12C5A60S2 single chip computer is selected to control the target machine through Bluetooth through DTU data transmission module.

The schematic diagram of STC12C5A60S2 module:

- (2) Relay module

Relay is a device that controls a large current output by inputting a small level signal. Relay module is very important in the control application of MCU. Because the digital input and output of STC12C5A60S2 can not be controlled directly.

In this paper, Android devices send control signals to STC12C5A60S2, and STC12C5A60S2 sends a high-level signal to the relay module to make the relay suck in and control the target machine to turn sideways[6]. After demand analysis, it is found that only one control signal needs to be controlled, so the single relay module is chosen here. Relay, also known as post, is an electronic control device[2]. It has control system (also known as input loop) and controlled system (also known as output loop).

It is usually used in automatic control circuit. It is actually a kind of "switch" control device that uses smaller current to control larger current. Because the digital input and output of STC12C5A60S2 can not directly control many high current or high voltage devices (such as electric heater, motor, etc.), the relay module is very important in the application of MCU control. In the design of this paper, the control signal of Android device terminal is transmitted to STC12C5A60S2, and then STC12C5A60S2 sends high-level signal to relay module, which makes relay suction control target machine turn sideways. This paper chooses itead STC12C5A60S2 single-circuit relay module, which has the following characteristics:

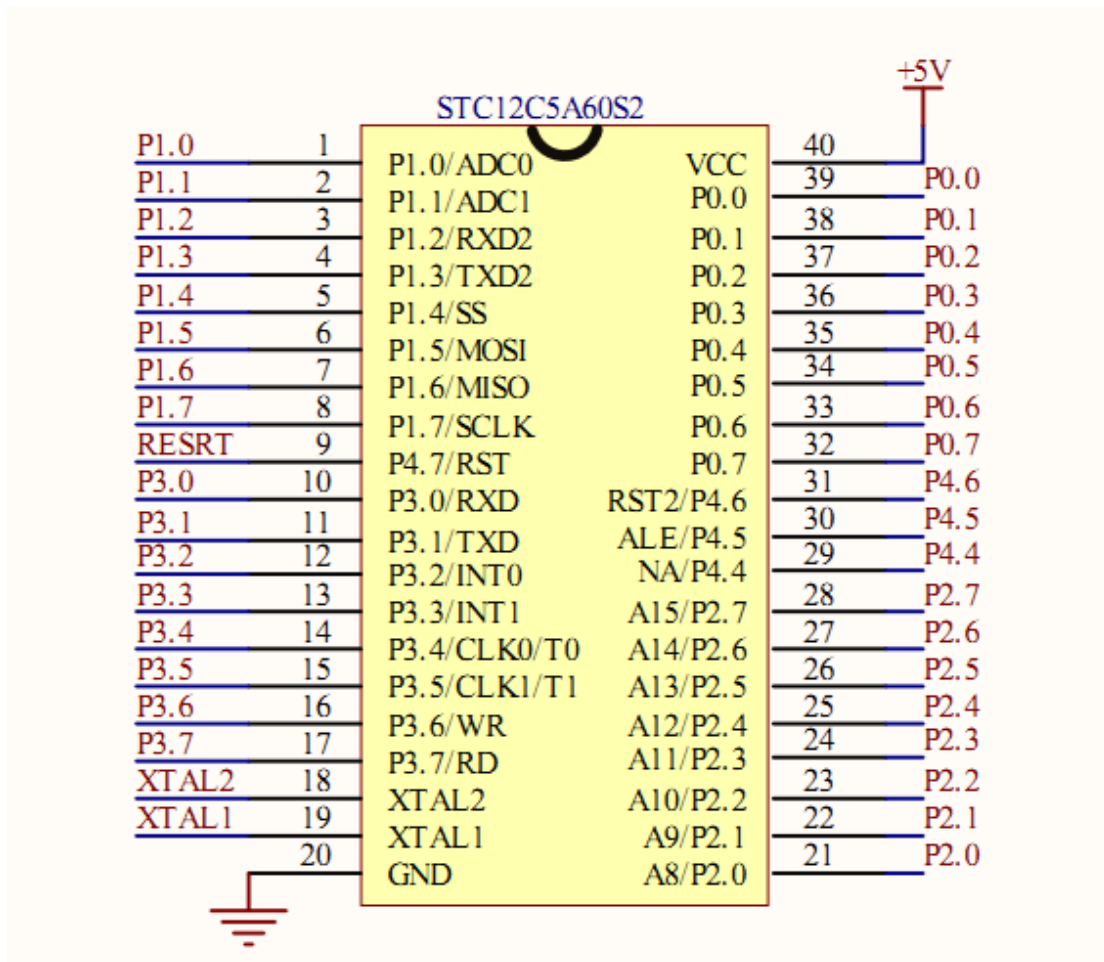


Figure 3. STC12C5A60S2 Module schematic

- (1) Plug and play, easy to use. Compatible with mainstream 2.54 spacing interface and 4P Grove interface;
- (2) Using M4 standard fixed holes, compatible with Lego, makeblock and other packages of the same M4 standard;
- (3) Self-contained protection circuit to prevent the relay's coil from being burnt out when disconnected; also has an isolation circuit to prevent the relay switch current from causing damage to the I/O port;
- (4) With LED status lamp, it can show whether it is connected at present (for NO and COM terminals,
- (5) The terminal with screw is used to facilitate wiring and disconnection.

The diagram shows the schematic diagram of the relay module.



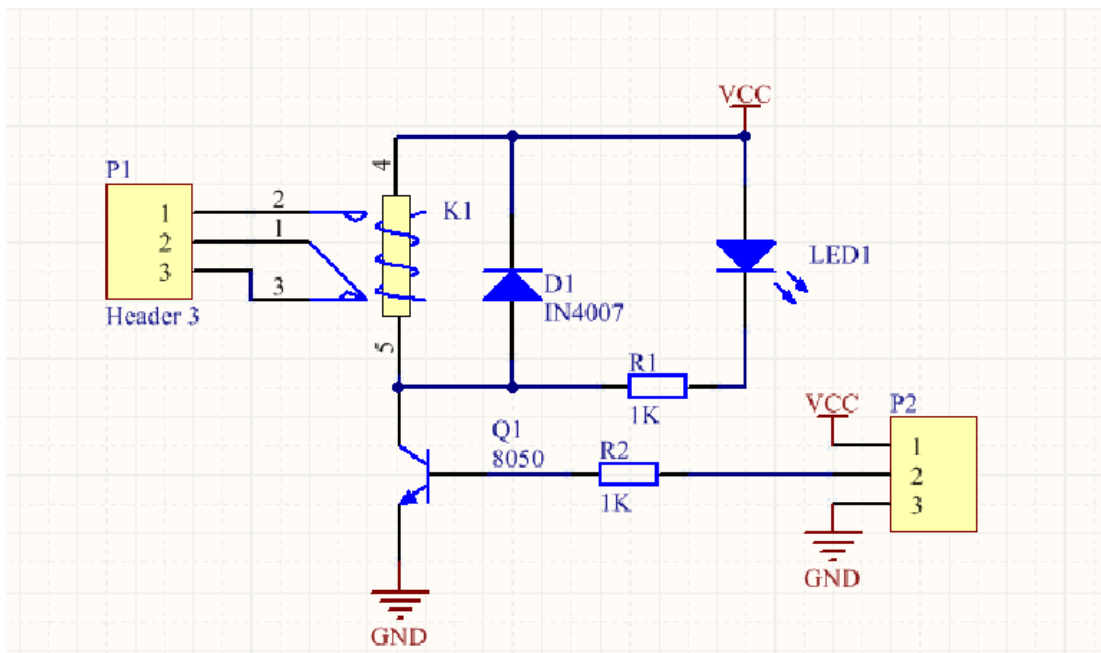


Figure 4. Relay module schematic

## 4. Wireless Connection Technology

For the purpose of convenience and management, the target controller and Android mobile terminal in this paper communicate by wireless connection. Here, the Bluetooth and DTU wireless communication technologies involved in this paper are introduced.

### 4.1 Bluetooth

Bluetooth is a wireless technology specification that supports voice communication and data wireless transmission between devices within a certain distance. Through Bluetooth technology, data transmission can be efficiently carried out, and communication between mobile communication terminal devices and between devices and the Internet can be effectively simplified. Bluetooth technology features include: frequency hopping technology, strong anti-signal attenuation ability; using the frequency band near 2.4 GHz, without applying for radio license; supporting data, audio and video signals at the same time; using FM modulation mode, reducing the complexity of equipment and so on[4]. At present, Bluetooth technology has been widely used. Most of the mobile phones have Bluetooth functions, which are mostly used in voice communication. With the rapid development of the Internet of Things, Bluetooth still has a lot of room for development.

The standard specification for Bluetooth is proposed by the Bluetooth Technology Alliance. In 2005, the Bluetooth Communication Alliance released the Bluetooth communication standard version 2.0 and EDR. This specification increases the transmission rate to a maximum of 10Mb/s and a transmission distance of up to 100 meters. Currently the most widely used standard. The Bluetooth Technology Alliance has since introduced the Bluetooth 3.0 and Bluetooth 4.0 specification standards.

The maximum transmitting power of Bluetooth devices can be divided into three levels: 100mW (20dBm) and 2.5mW (4dBm) 1mW (0dBm). When the distance of the signal source changes and the received signal intensity of Bluetooth devices changes, Bluetooth devices will automatically adjust the transmitting power. The range of Bluetooth devices depends on power and type, but the effective range of Bluetooth devices will be affected by field conditions in practical applications. The figure shows the schematic diagram of the Bluetooth module:





E103-W02-DTU supports standard IEEE802.11b/g/n protocol and complete TCP/IP protocol stack. It supports STA/AP mode, SmartConfig, serial port and boot-through functions. After simple configuration, it can easily realize network access function, and minimize developers'work and project development time. The figure shows the DTU communication pin diagram:

## 5. Experimental results and conclusions

In the training ground, open the Bluetooth mobile phone of the Android system and operate the target machine through the client software. After the target machine is powered on, connect the target machine through the application software, set the target time, hidden target time and other settings, and test the control operation of the target machine according to the flow. The results show that although the control of the target machine operation can be performed normally, there is a time delay and further optimization is required.

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