

# 參賽隊伍人員及機器人簡介

## Team Member and Robot Introduction

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### 貳、機器人簡介

## II. Introduction of robot

### 1、構想與策略分析

車體機構的重量一定要儘量減輕，車子在前進、轉彎、煞車時才能動作迅速，馬達以直流馬達 24V 來驅動左右輪，利用 PWM 方式來控制轉速，以達到加減速與轉彎控制。機構製作以簡單有效為主，控制電路則儘量簡單不要太複雜，這樣產生誤動作的機會也比較小。根據這次的題目，我們構思機器人整體的架構和一些重點，包括第一點機器人在行進中動作的方式，是要循線(走還是不要循線走，第二點馬達的傳動方式，是要 4 輪傳動還是 2 輪傳動，第三點感測器使用的種類，是要使用紅外線感測器或是超音波感測器，第四點取娃娃的方式，要全部一起取回還是單獨取回，第五點除去落石的方式，是要用推物品的方式還是要用搬物品的方式。

### 1. Concept and strategy

The weight of the bodywork must be as light as possible, in order to make itself move fast when it goes forward, turns, and stops. 24 V DC motor is used to drive the left wheel and the right one, using PWM to control the speed in order to speed up, slow down, and make a turn. The devices are made based on simple and effectiveness. Control circuit is not so complex but as simple as possible, so as to decrease the risk of wrong movements. According to this topic, we conceive of

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the whole structure and some key point of the robot as followed. First, the way how the robot moves during going forward---through the line or not. Second, the way how the motor drives---four-wheel drive or two-wheel drive. Third, which kind of sensors to choose from---the infrared one or the ultrasonic one. Fourth, the way of doll-picking---one at a time or all at a time. Fifth, the way of removing the falling rocks---by pushing or by moving.

### 2、機構設計

為了拯救麒麟娃娃，機器人必須通過三個不同的障礙區以及排除障礙，在落石區路線有一塊落石需要清除，所以在車體的前方我們仿照堆高機抬重物的方法製作了能夠抬重物的機構，如圖 1 所示。

#### 2. The design of the device

To pick the doll, the robot must go through and overcome three different barriers. In the route of rock-falling area, there are some falling rocks to be removed. Thus, we create a device that can lift heavy things, which we derive from the stacker, shown as figure 1.



圖 1 搬石頭機構



圖 2 爬階梯之升降機構

在淹水區部分需要爬上一個 40 公分的高台，所以我們在車體中間製作像電梯上升下降的機構，能讓車體來自動上升與下降，如圖 2 所示。最後在拯救麒麟娃娃的機構，我們在車體後方製作像夾子一樣的形狀，一次夾取三個娃娃，如圖 3 所示。

In the dropsy area, there is a 40 cm terrace for the robot to climb. Thus, we make a device for the bodywork go up and down automatically just like how the elevator works, shown as figure 2. Finally, we make a clip shape at the back of the bodywork as the device to catch the dolls three at a time, shown as figure 3.

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圖 3 夾娃娃機構

### 3、輪子驅動設計

馬達的控制由於考慮到電源為 24V 單相直流電源，所以採用可以控制馬達正逆轉的 H 型驅動電路，如圖 4 所示，當 Q1 和 Q4 兩個電晶體導通時，電流從馬達左方流到右方，馬達產生正向轉矩，反之，當 Q2 和 Q3 兩個電晶體導通時，電流從馬達右方流到左方，馬達產生逆向轉矩；以 PWM 方式控制時，只要改變控制脈波的工作週期就可以改變馬達轉速和轉向，Q1、Q4 與 Q2、Q3 的導通時間必須錯開，以 Q1 和 Q4 兩個電晶體而言，當工作週期  $D=50\%$  時馬達停止不動， $D>50\%$  時馬達正轉，工作週期越大轉速越快， $D<50\%$  時馬達逆轉，工作週期越小轉速越快。值得注意的是，Q1 和 Q3 不能同時導通，Q2 和 Q4 也不能同時導通，否則將造成短路現象。

### 3. The design of wheel-driving

Because of the 24V single-phase DC power supply, we choose the reversible H-drive circuit, shown as figure 4. When the two transistors Q1 and Q4 are conducted, the electric current go from the left to the right of the motor, and the motor produces forward torque. On the contrary, when the tow transistors Q2 and Q3 are conducted, the electric current go from the right to the left of the motor, and the motor produces reverse torque. When we control in the PWM way, changing the working period of the control pulse only can lead to the speed and steering change of the motor. The period of conduction of Q1 and Q4 or that of Q2 and Q3 must be separated. To the two transistors Q1 and Q4, the motor stops when the working period  $D=50\%$  and forwards when  $D>50\%$ . The longer the working period is, the faster the speed is. When  $D<50\%$ , the motor reverses. The shorter the working period is, the faster the speed is. What's worth noticing is that, Q1 and Q3 cannot be conducted simultaneously, and neither can Q2 and Q4. Otherwise, short circuit would be led to.

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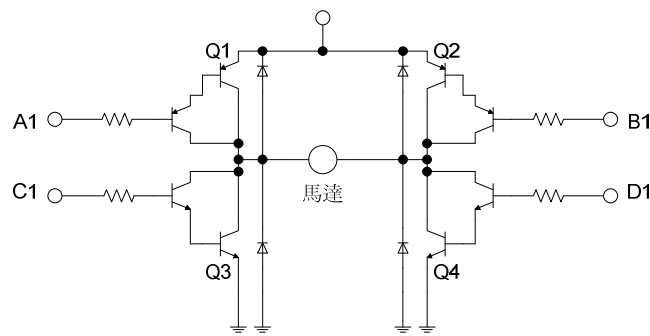


圖 4 H 型馬達驅動電路

### 4、電路設計

控制電路採用 AT89C51 單晶片做為控制核心，以 8 個反射型紅外線感測器作為認路之用，安裝在車底的前面中間，如此一來在行走的時候，都能準確的修正行進方向。控制電路分成二塊板子，第一塊電路板主要是連接 8 個認路感測器，以及控制 4 個行走路線時所用到的馬達，如圖 5 所示。第二塊電路板主要目的在於控制清除落石的機構、升降車體的機構及拯救娃娃的機構，如圖 6 所示。

### 4. The design of the circuit

AT89C51 single chip is used as the controlling core of the control circuit. 8 reflective infrared sensors, which are used to recognize the routes, are installed in the middle of the front bottom of the bodywork. Thus, they can correct the routes precisely while the bodywork is moving. Control circuit is divided into two boards. The first board is mainly used to connect the 8 road-recognizing sensors and to control 4 motors that would be used when moving, shown as figure 5. The second board shown as figure 6 is aimed to control the device of clearing the falling rocks, the device of raising and descending the bodywork, and device of picking the dolls.

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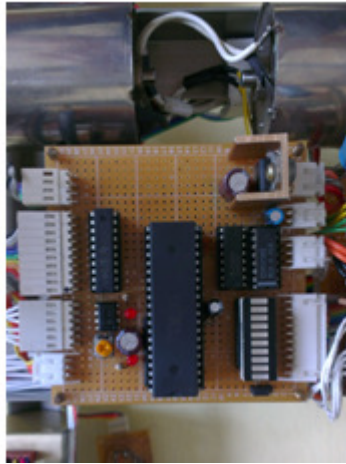


圖 5 第一塊電路板

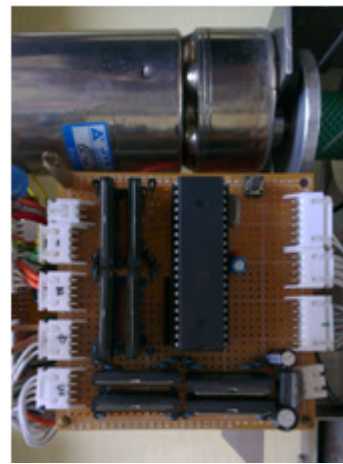


圖 6 第二塊電路板

### 5、感測器設計

自走車最重要的感測元件就是認路，我們在車頭的底部中央位置安裝 8 個紅外線感測器，如圖 7(a)所示，圖 7(b)所示為感測器與黑色軌跡位置示意圖，當感測器經過黑色軌跡時輸出信號為 High，當感測器離開黑色軌跡時輸出信號為 Low，根據 8 個感測器的信號變化，經過單晶片的程式運算執行之後，就能分別控制左右馬達的轉速，以達到修正路線和轉彎動作。

### 5. The design of the sensor

The most important sensing element of the automobile bodywork is to recognize routes. We install 8 infrared sensors in the middle of the bottom of the front bodywork, shown as figure 7(a). Figure 7(b) shows the positions of the sensors and the black orbits. When the sensors pass through the black orbits, they deliver the signal High. When the sensors stray from the black orbits, they deliver the signal Low. After the changes of the signals of these 8 sensors are operated by the program, they are able to control the speed of the left and right motors in order to correct the routes and make a turn.

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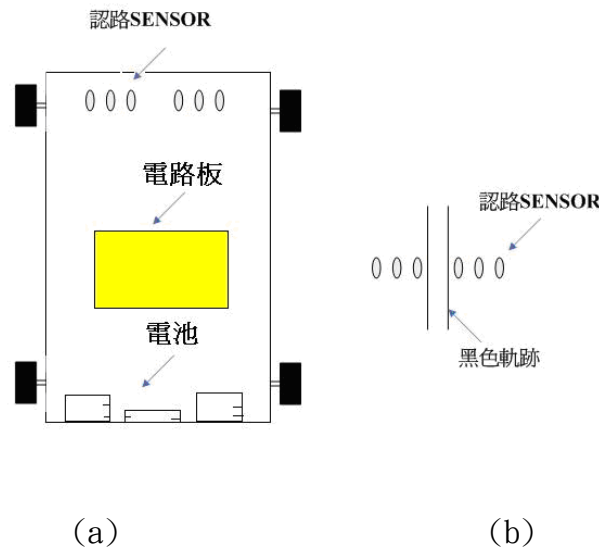


圖 7 (a)自走車體系統配置圖，(b)認路軌跡示意圖

### 6、組裝、測試與修改

為了方便於測試，我們利用了 2 個禮拜多的時間，製作出了 1:1 的練習場地，因為紅綠場地的差異性不大，所以只做了左半邊的場地。我們自製的機器人在測試期間，機構部分頻出問題，經由不斷的修改與測試，總算最後能夠正常的走到定位夾取娃娃。接下來就是思考如何加速機器人的動作，但是由於比賽場地地面非常光滑，所以也必須考慮輪子的抓地力，以穩定度優先考慮，其次才是速度。

### 6. Assembly, test and modification

In order to test our bodywork more easily, we spend more than 2 weeks to make a 1:1 practicing field. Because of the minor difference of the red field and the green one, we only make the left half side of the field. During the test period, problems come out from the device of our self-made robot. After continuing modifications and tests, our robot is able to go to a fixed position to pick the dolls. Next, we have to think of a way to accelerate the robot's movement. However, because the contest field is so smooth that we have to take the grip of the wheels into consideration. We have to prioritize the steadiness and then the speed.

### 7、機器人創意特色說明

我們製作機器人的靈感取自於日常生活中，在許多工廠都能看見的堆高機，很適合用於搬開石頭的项目；其次是升降梯的原理，利用馬達拉動繩索再配合滑桿，就可以使整個機器人升到 40 公分高的階梯上。我們的機器人特色是機構簡單、重量僅僅 16 公斤，可以完成三個障礙區的闖關及抓取娃娃動作。

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### 7. The innovation of the robot

We are inspired to make our robot by two elements. The first one is the stacker, which is usually seen in factories and is suitable to remove the rocks. The second one is the elevator, which uses the motor to pull the ropes and the slider to raise the whole robot to the 40 cm terrace. The feature of our robot is that its devices are simple, that it only weights 16 kg, and that it can go through 3 barriers to pick up the dolls.

### 參、參賽心得

參與這麼大型的機器人競賽難免會有些緊張，加上今年難度提高，我們從上學期就開始構思如何製作本次競賽的車體，和各關卡的機構製作，一而再、再而三的測試與改裝，並設法如何去製作較順利、流暢的機構，以及使用現有的材料製作一個 1:1 的競賽場地來做練習，雖然沒有很完善，但是足以讓我們可以測試以及改善我們的車體。這次競賽是要跟來至各個學校派出的代表競爭，雖然沒有十足把握能夠獲得好成績，但我們還是盡最大的能力去完成這次比賽。

### III. Reflection

To take part in such a big robot contest makes us a little nervous. Besides, the contest this year is more difficult than ever. Therefore, we have started to think how to make the bodywork for this contest and the devices to go through each barriers since last semester. We test and modify our devices continually. Furthermore, we try to make a device that works smoothly. In addition, we use the materials at hand to make a 1:1 contest-mocked field for practice. Though it is not so perfect, it is good enough for us to test and modify our bodywork. In this contest, we compete with representatives that come from other schools. We are not sure if we could get a good grade, but we still do our best in this contest.