Content

Chapter 1 Introduction

Chapter 2 Spiral Movement robot

Chapter 3 Improvement

Chapter 4 Conclusion

Microcomputer programming

Chapter 1 Introduction

1.1 Research background

Surveillance cameras are video cameras used for the purpose of observing an area. They are often connected to a recording device or IP network, and may be watched by a security guard or law enforcement officer. Cameras and recording equipments used to be relatively expensive and required human personnel to monitor camera footage, but analysis of footage has been made easier by automated software that organizes digital video footage into a searchable database, and by video analysis software. The amount of footage is also drastically reduced by motion sensors which only record when motion is detected. With cheaper production techniques, surveillance cameras are simple and inexpensive enough to be used in home security systems, and for everyday surveillance, and that's why now there are a lot of people installed security camera to protect their family and properties.

Now security cameras technology has been greatly improved, even for a small security camera, it is able to record the footage clearly.But there were many cases where the security camera is not being installed properly at the right place (blind spot existed), crime can't be solved because of lack of footage. To make sure there is no blind spot we have to use mobile security camera as additional to security system. And my research is about mobile security camera using fence.

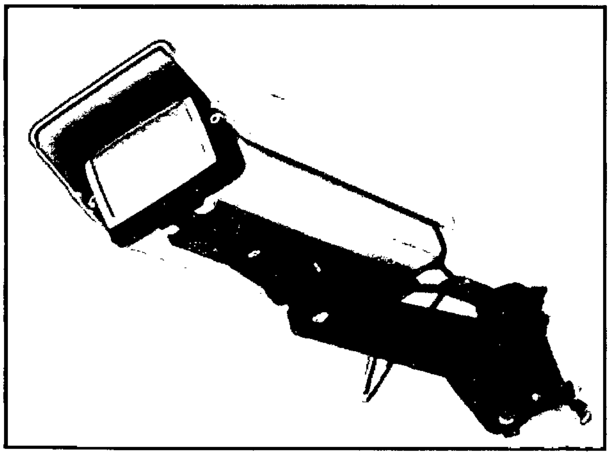


Fig 1.Closed circuit television

1.2 Research Purpose

Improving the movement between the fence and upward downward spiral movement on the fence.

Chapter 2 Spiral Movement robot

2.1 Operating Environment

As shown in Fig 3,fence's diameter is 16mm, distance between the center fence is 85.5mm, its isheight 80cm and the material is stainless steel.Fig 4 is the fence used in this research which is a slippery stainless steel with a round shape and moving spirally on it.

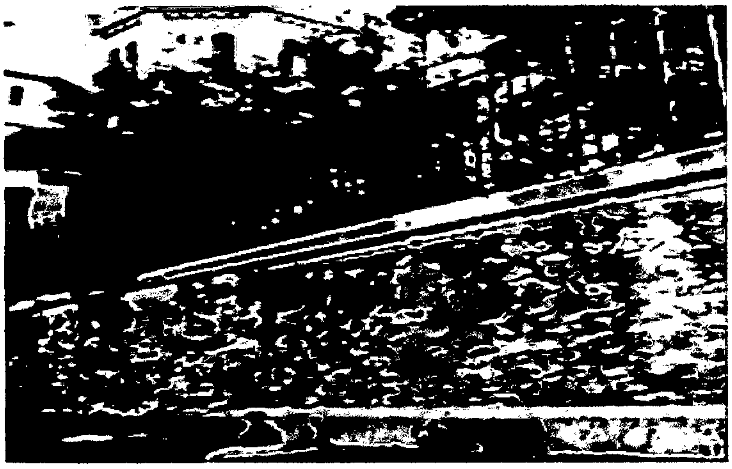


Fig 2. Fence on the wall

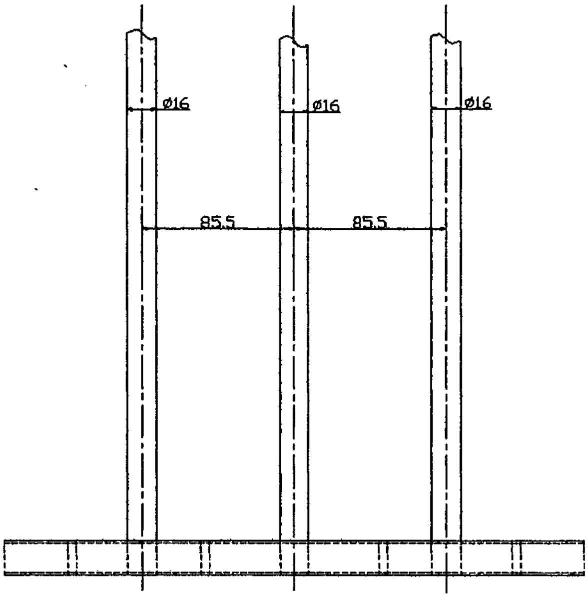


Fig 3.fence

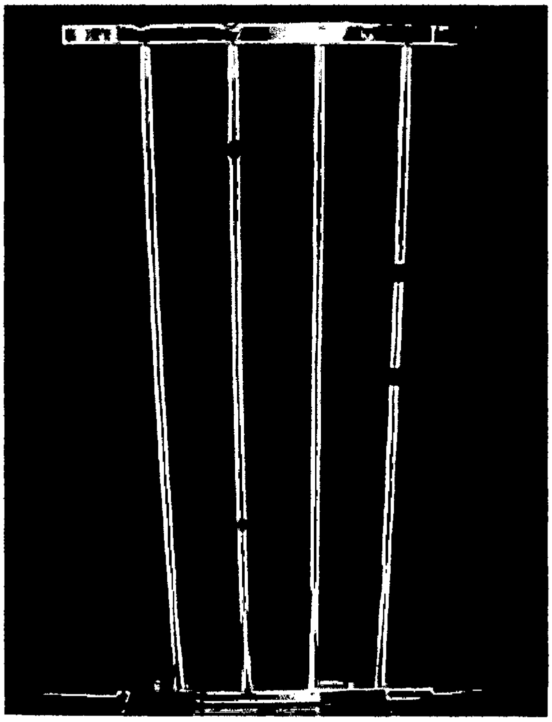


Fig 4.fence

2.2 Robot mechanism

8 spiral movement robot acrylic parts is connected by the hinge as shown in Fig 5. The robot can be divided into three parts, lower arm, upper arm and the circuit. Each arm is mounted with 2 climbing motors and 1 link controlling motor. Link controlling motor is used to open and closeboth arms.

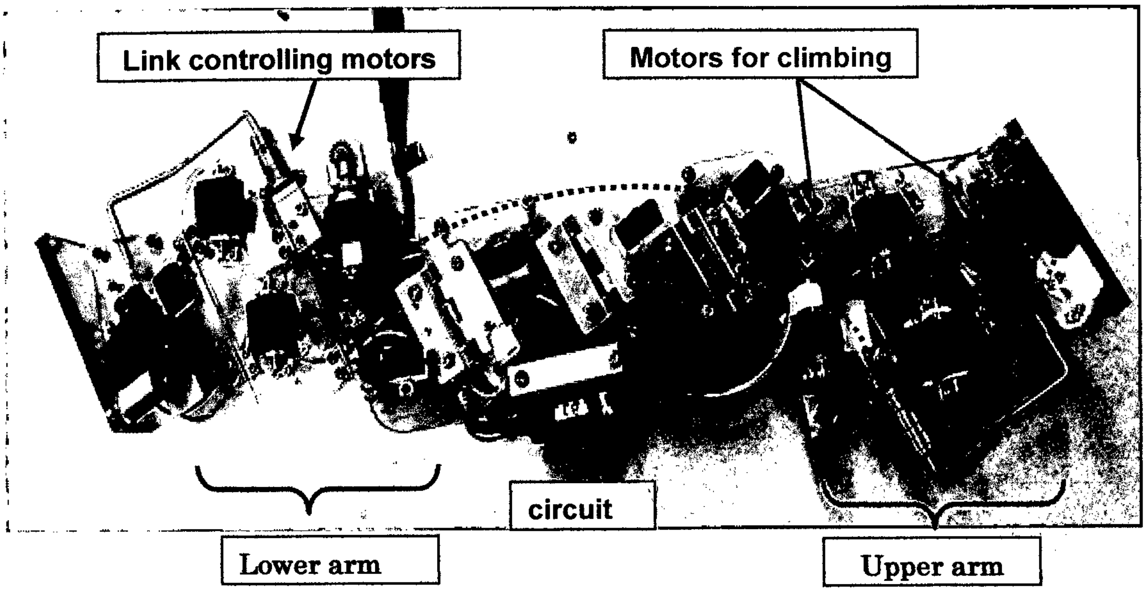


Fig 5. Spiral movement robot

2.3 Fence grabbing mechanism

Robot arm has U-shaped link and four tires. U-shaped link (see Fig 6) is connected to the motor, rotating direction controlling the opening and closing arm . All 4 tires are usedto grab the fence. (Refer to Fig 7), support blocks are attached to stabilize the robot posture.

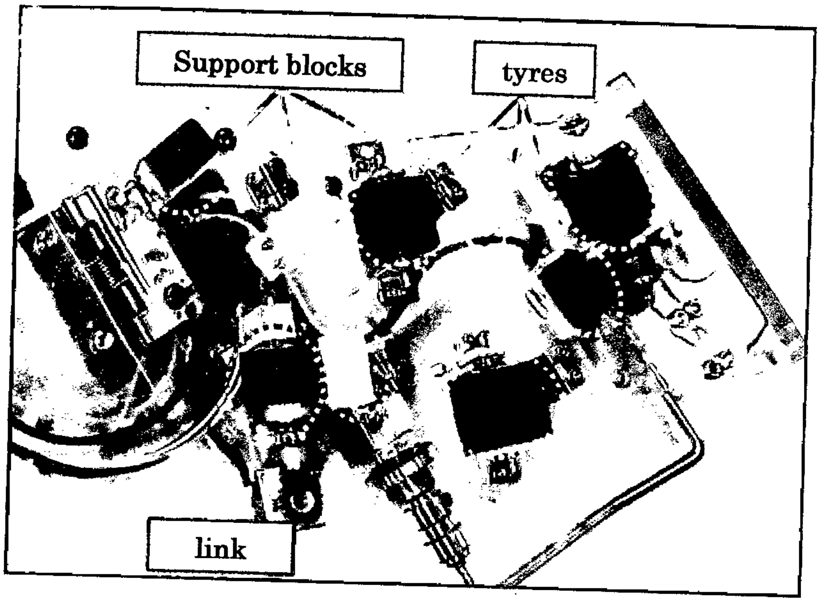


Fig 6. arm's mechanism

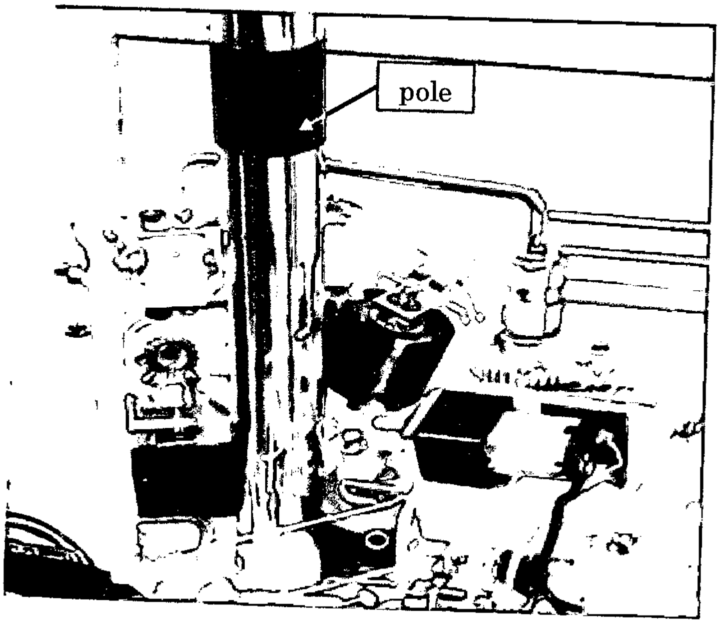


Fig 7.The arm grabbing pole picture

2.4 Circuit

Circuit is mounted on the robot as shown in Fig 8. Mounted circuit divided into three parts - power-receiving and amplifying circuit, lower arm control circuit and upper arm control circuit. Using a lithium polymer battery (7.4V) as the power source, the receiver receiving signal sent by remote controller and amplifying the output by the amplifier circuit for microcomputer.

After receiving the amplified output, microcomputer processes it into command signal and send it to motor driver in Pulse-width modulation (PWM) . Based on the PWM signal, motor driver start rotating the DC motor

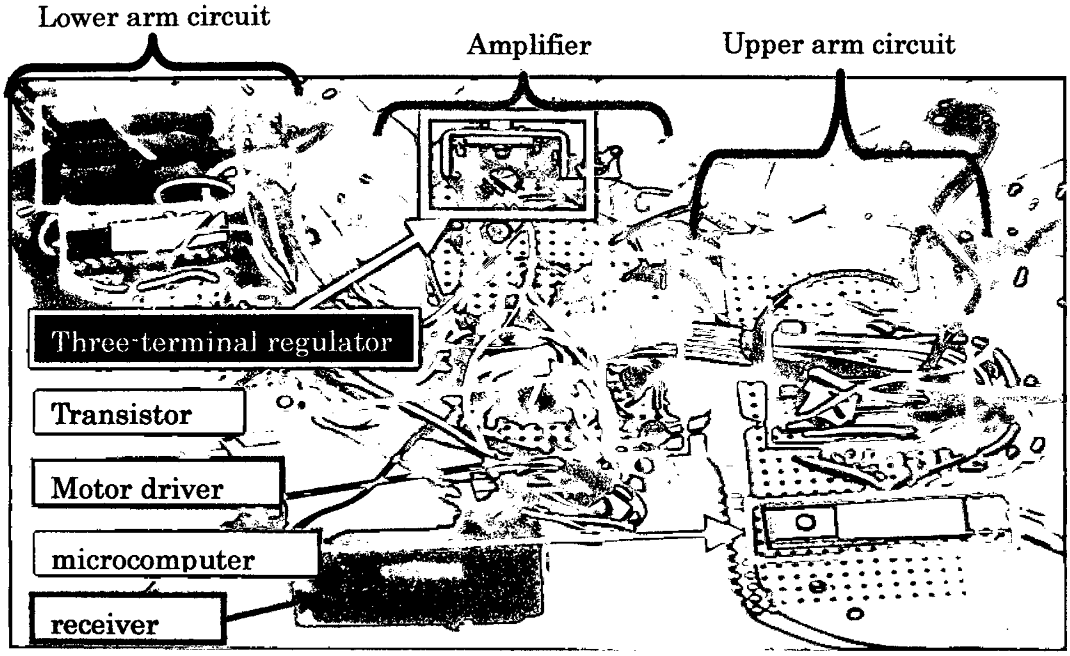


Fig 8.Problem circuit

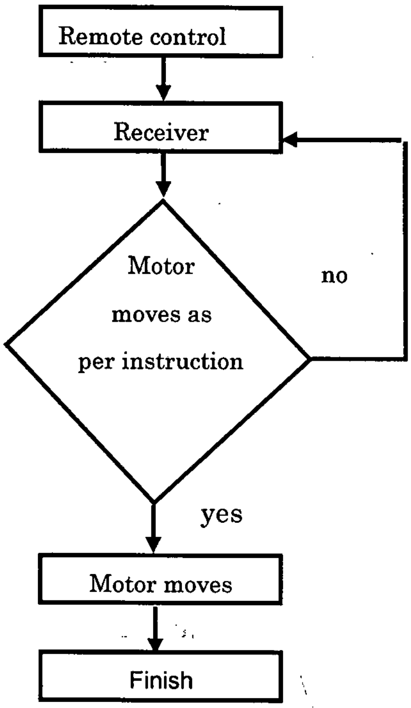


Fig 9. Flow chart

2.5 Spiral Movement

2.5.1 Upward and downward backward movement

Upward and downward movement can be performed with both arms grabbing the fence and all climbing motors rotating in the same direction as shown in Fig 10. Fig 11 shows sequence of movement for the motor, climbing up and down the pole.

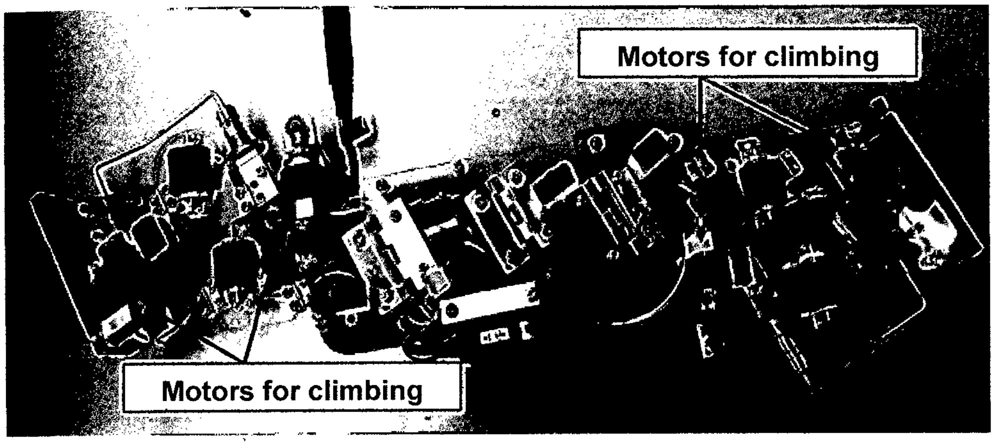


Fig 10. Motors for climbing

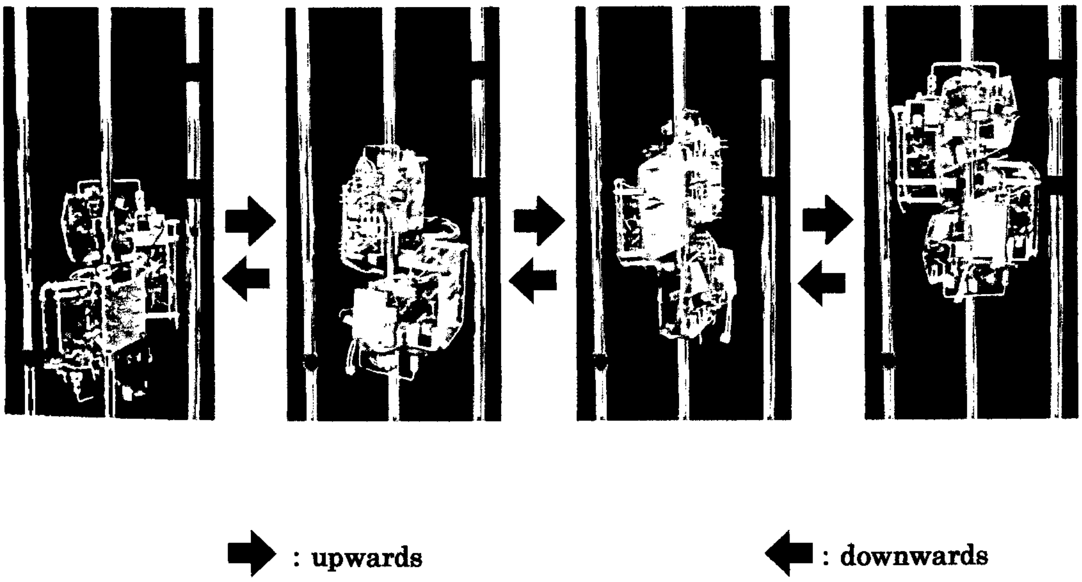


Fig 11. Climbing movement

2.5.2 Fencetransfer movement

As shown in Fig 13,fence transfer movement can be achieved by upper arm releases the hold to the pole while lower arm moves slowly upward. This will enable the upper arm to grab to the adjacent fence. At the end of this step, both arms will be almost parallel with each other thus upper arm,at this point,will moves upward in order to provide area needed for lower arm to move to the adjacent fence.

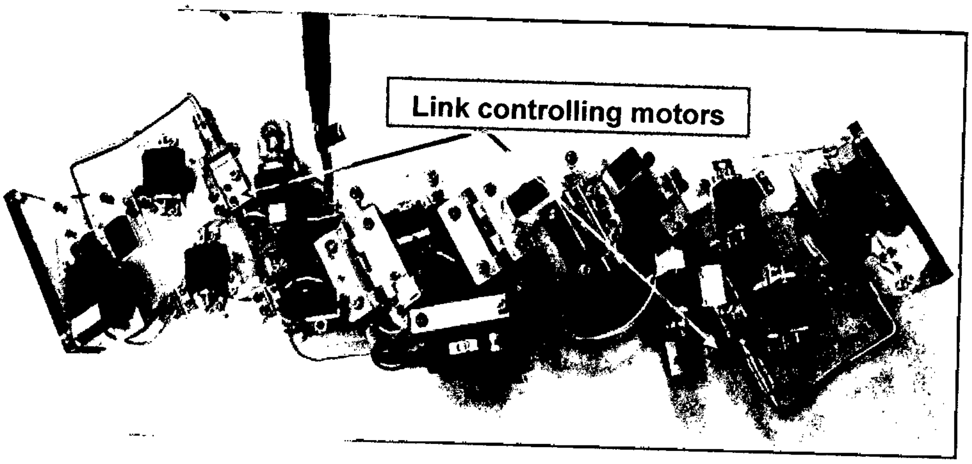


Fig 12. Link controlling motors

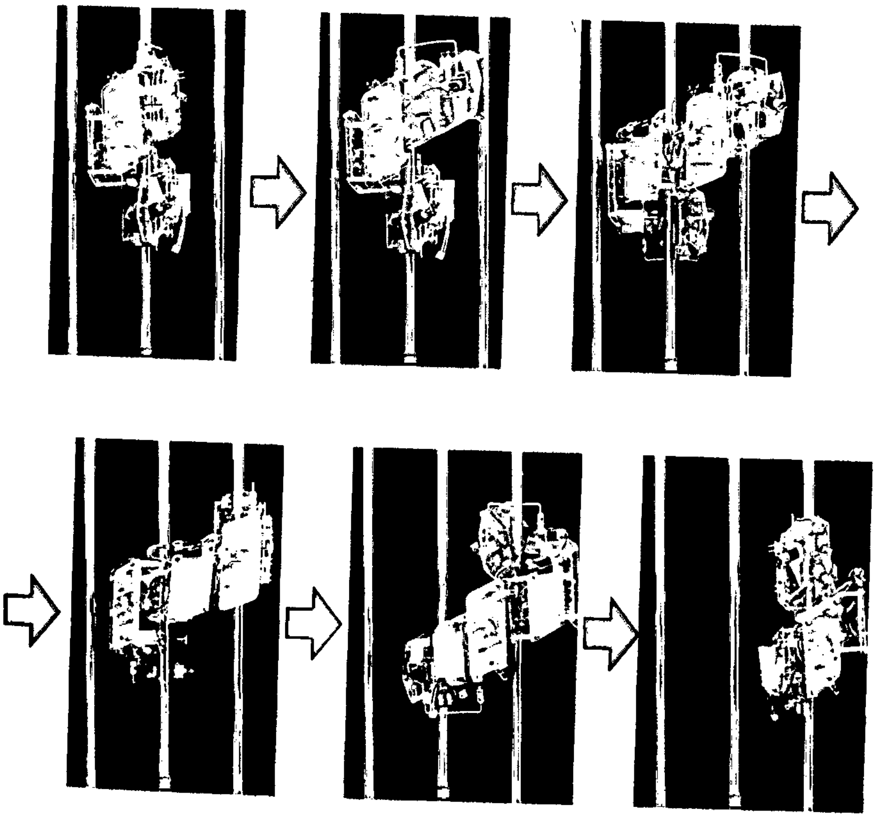


Fig 13. Movement to the other pole

Chapter 3 Improvement

3.1 Robot problems

The spiral movement robot couldn't move perfectly because of circuit failure, bad upper arm posture during fence transfer and friction force between fence and tires are weak. As the result robot will slip during upward and downward movement.

3.1.1 Problem 1

Because of the poor soldering technique,short-circuit happened from time to time and the signal from receiver is not being transmitted smoothly to microcomputer. In addition to this problem, receiver might hit the fence and this can affect the robot posture.

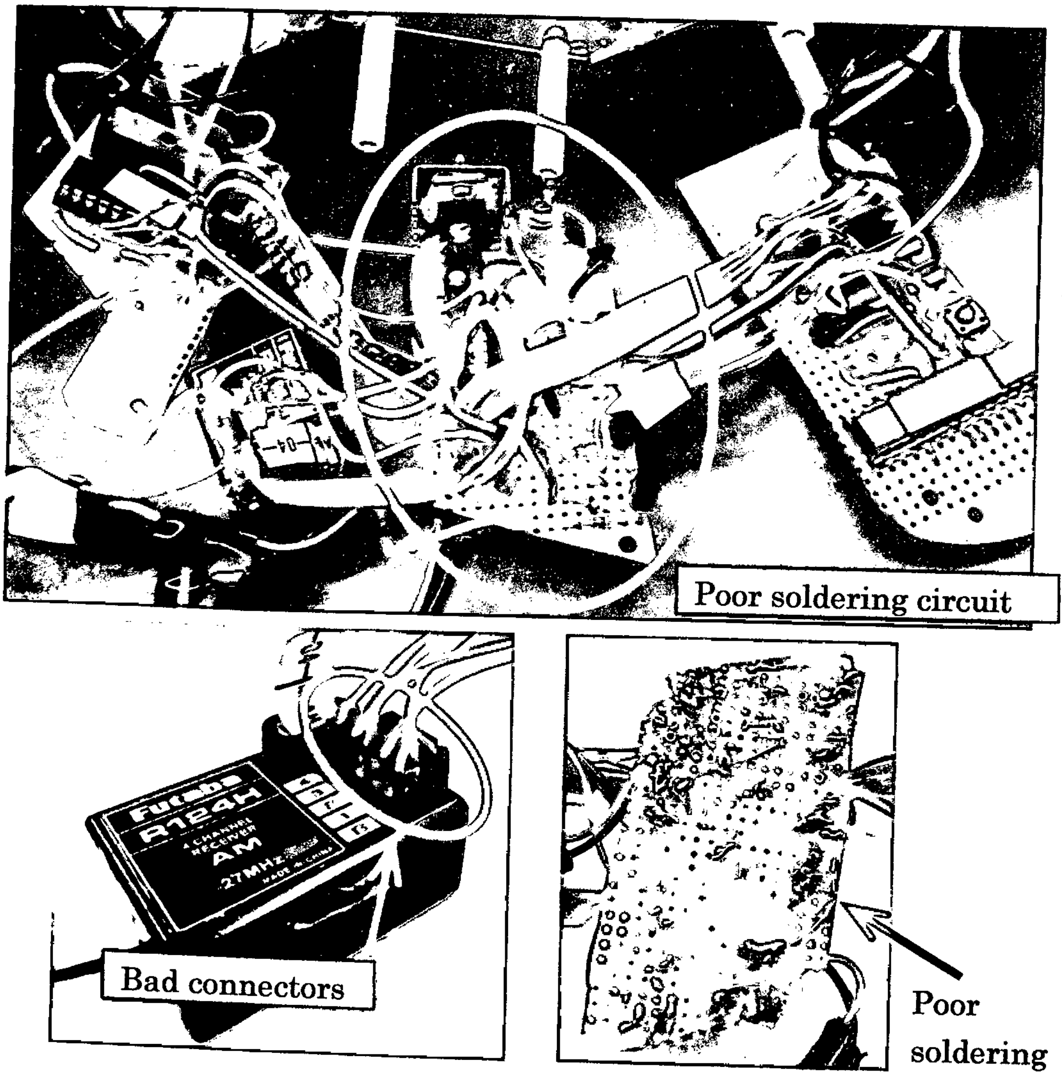


Fig 14. Problem circuit

3.1.2 Problem 2

As shown in Fig 15, the friction force between fence and tires are weak. This causes the upward and downward movement to be less effective. On the other hand, the robot also suffer from a weak link grabbing force. Because of these two factors, fence transfer movement can't be achieved successfully as the entire robot weight couldn't be supported with only one functioning arm.

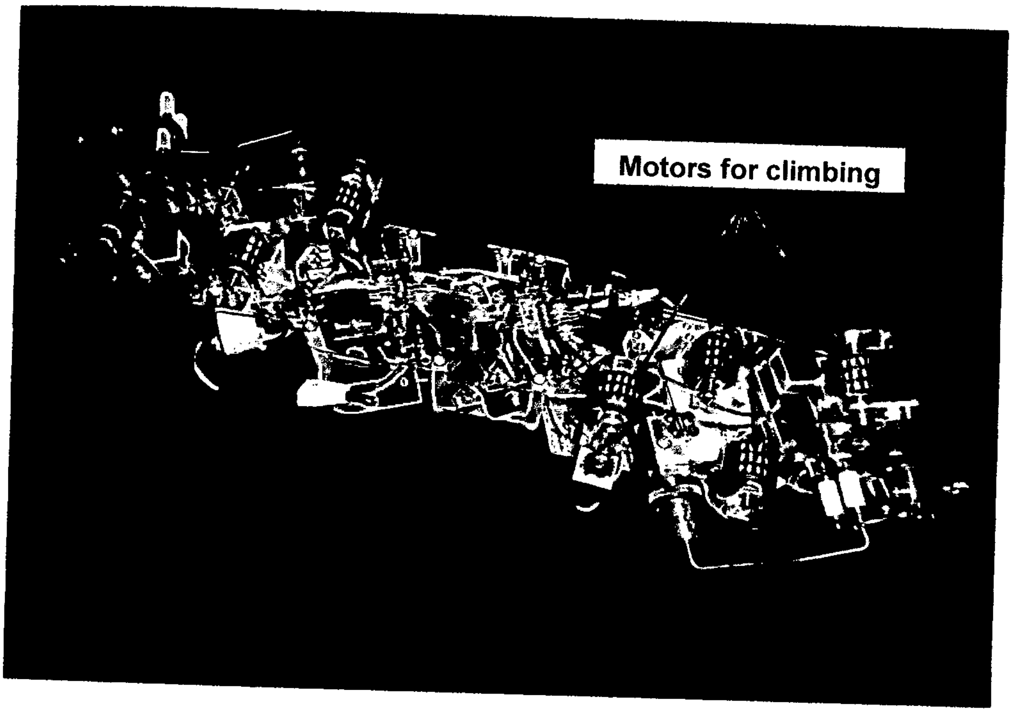


Fig 15. Robot's picture before the improvements

3.1.3 Problem 3

During fence transfer movement, a weak hinges spring causes upper arm to move too much, exciding its desired angles in order to grab to the adjacent pole of fence. This also produced surplus weight momentum at the end of upper arm, leaving the robot posture unstable (see Fig 16).

When moving between fences, owing to the short length of the robot, the amount of force generated is no longer enough. Looking at Fig 17(a), the red line outlines the portion of lower arm that solely grabs the fence while upper arm is doing transfer movement.

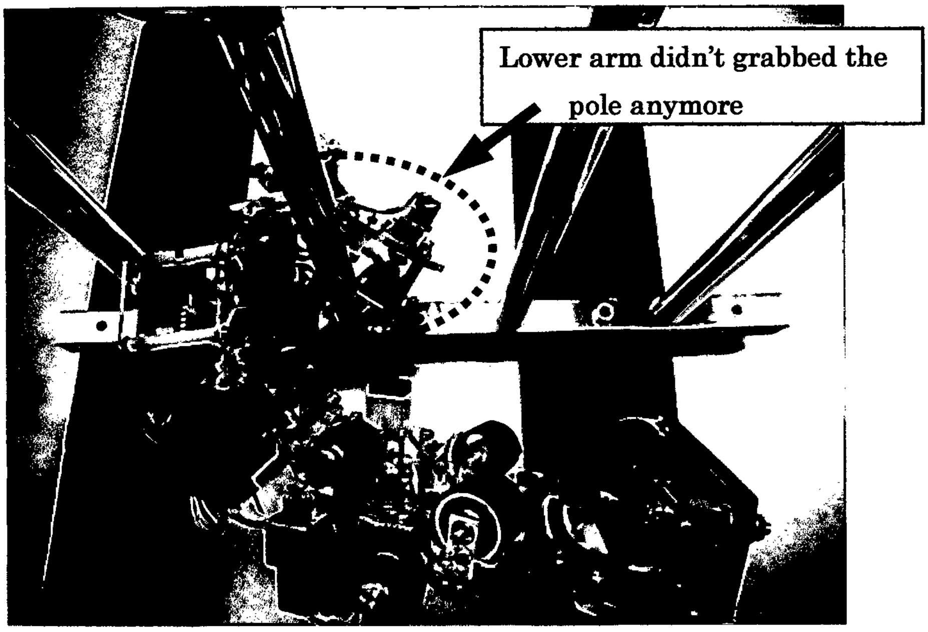


Fig 16.Widely open problem

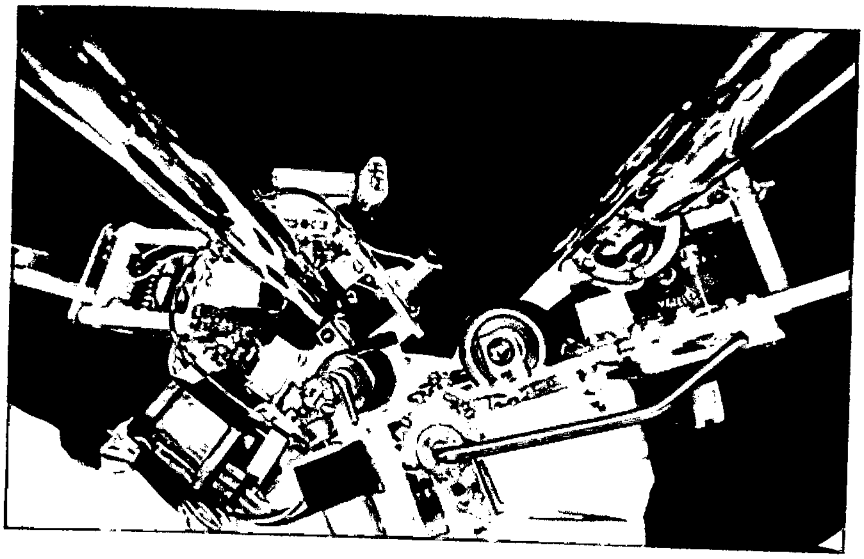
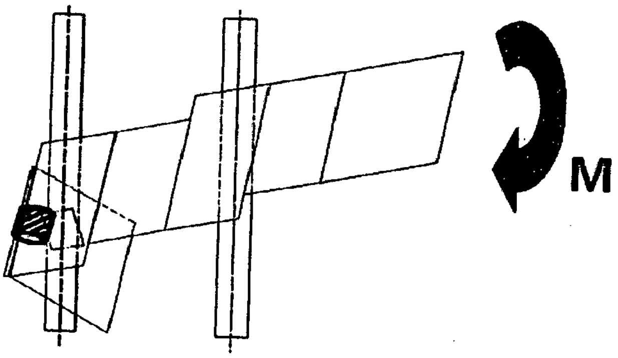


Fig 17 (a).Fence grabbing portion

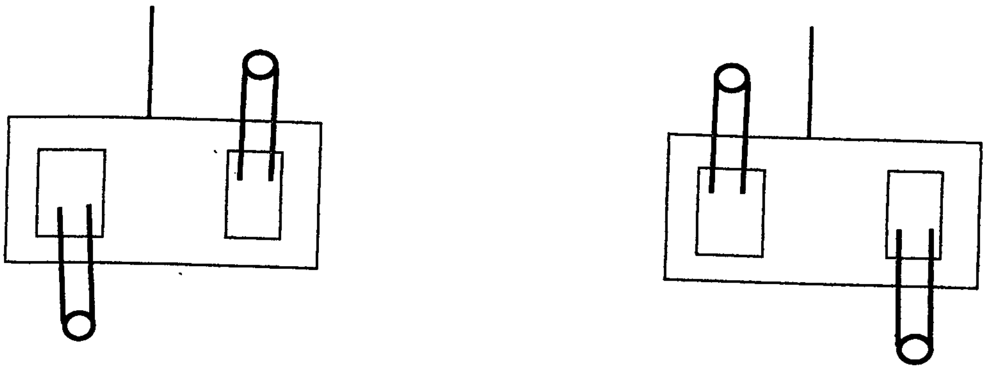


M = weight momentum

Fig 17 (b). Weight Momentum

3.1.4 Problem4 Remote Controller

In order to increase the fence transfer movement success rate, the robot must have an easy controlling system. Take a look at Fig 18(a), for upward movement push forward the left stick and push backward the right stick. If do it oppositely, it's become downward movement as shown in Fig 18(b).



(a). Upward movement

(b)Downward movement

Fig 18.Movement control

3.2 Solving the Problems

3.2.1 Problem 1 solution

After replacing new components and rebuild the circuit (Fig 19), it works perfectly. Some of the transistors replaced to a higher resistance values to protect other components from damage. Plus, smaller receiver used in this circuit to reduce the entire robot weight for a better performance. Receiver's frequency is 40.83MHz. List of electronic components used are shown in Tables 1 and 2.

Before the improvement, 2 lithium polymer batteries (each 7.4V) have to be used as power source but now only one lithium polymer battery (7.4V) is needed.

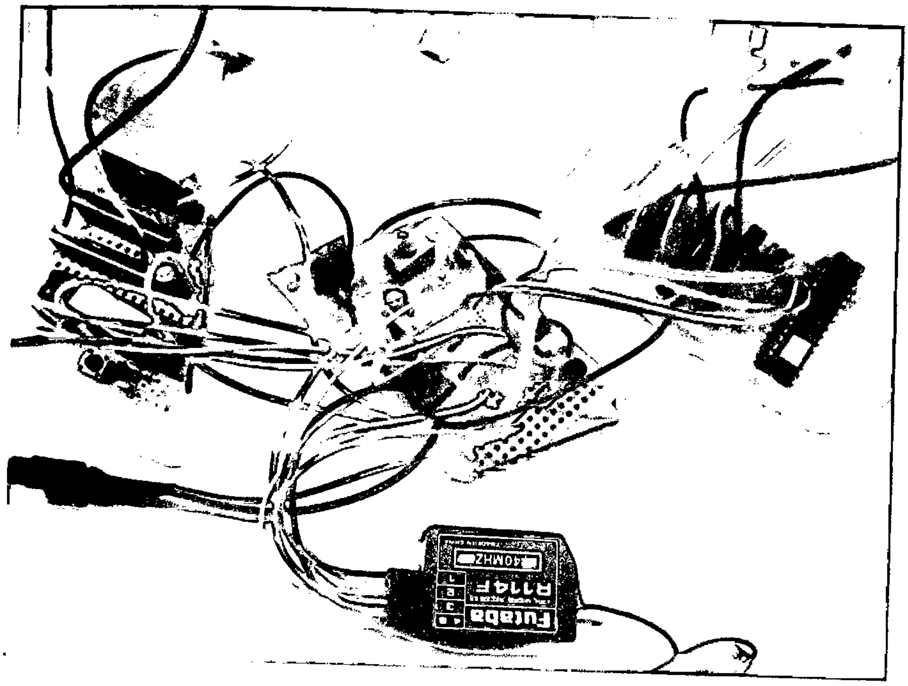


Fig 19. New circuit

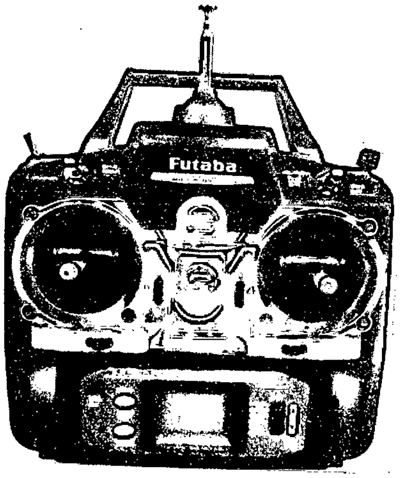


Fig 20. New remote controller

Part	Serial number	Capacity	Number
Three-terminal regulator	LM317T		1
transistor	2sc1815		4
resistor		16Ω 200Ω 300Ω 10kΩ	4 1 2 4
Electrolytic capacitor		10μ 100μ	1 1
receiver	R114F	400MHz	1
Connector			5
switch			1
Lithium battery	Thunder power	7.4V	1
Source power connector	CT3 connector system		1
board	ICB-93SG	72 X 95mm	1

Table 1. Electronic parts (middle circuit)

Table 2. Electronic parts (left and right circuit)

Part	Serial number	Capacity	Number
AVR microcomputer	ATmega 48		2
Socket			2
Motor driver IC	TA7291P		6
Reset switch			2
LED			2
Resistor		200Ω	2
Ceramic capacitor		0.1μ	6
Electrolytic capacitor	ICB-93SG	100μ	2
Board		72 X 95mm	2

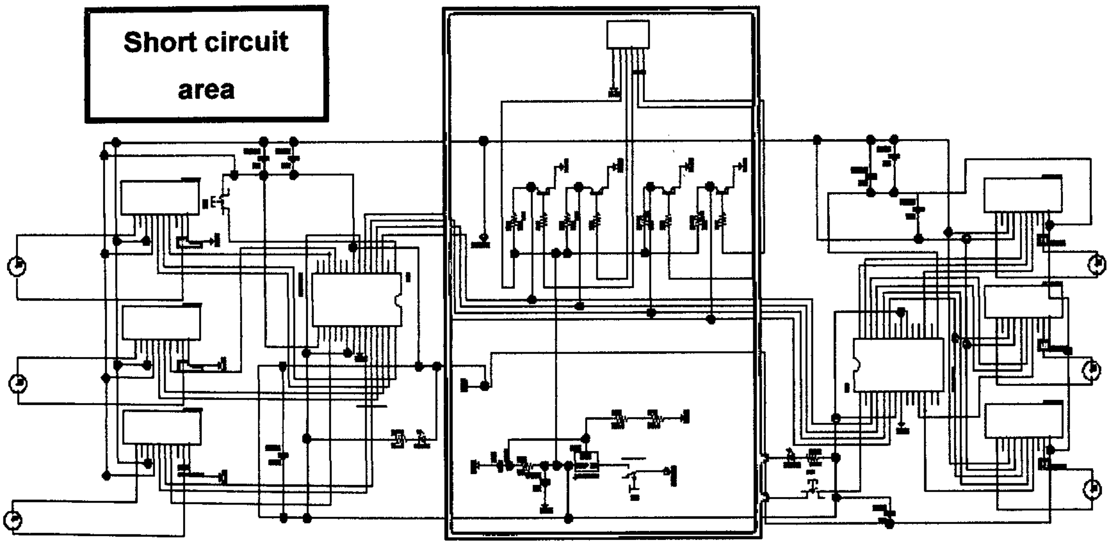


Fig 21.Short circuit area

Left and right circuit

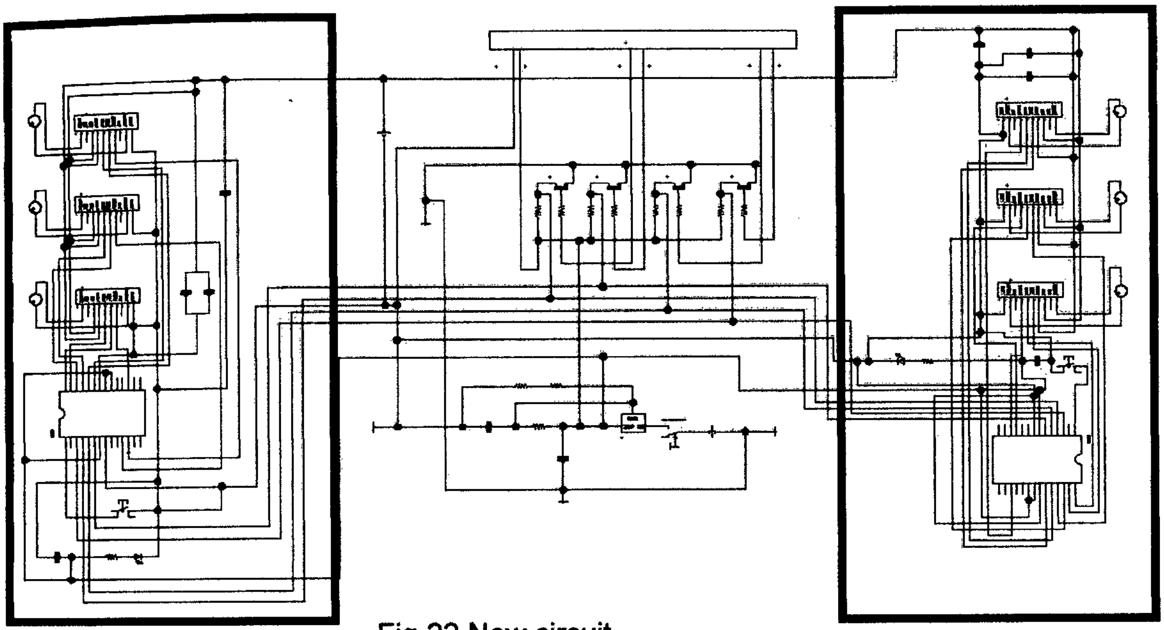


Fig 22.New circuit

3.2.2 Problem 2 solutions

To avoid slippage from fence pole, the material wrapped around tire have to be changed to increase the friction force between fence and tires. However, before selecting the material, minimum friction coefficient needed in order to prevent slippage must be known to select the right material. Then each material had been tested to know the maximum frictional force and calculate the friction coefficient.

Further, created a new program for microcomputer to improve the frictional force of the robot.

3.2.2 Problem 2 solutions

To avoid slippage from fence pole, the material wrapped around tire have to be changed to increase the friction force between fence and tires. However, before selecting the material, minimum friction coefficient needed in order to prevent slippage must be known to select the right material. Then each material had been tested to know the maximum frictional force and calculate the friction coefficient.

Further, created a new program for microcomputer to improve the frictional force of the robot.

3.2.2.1 New programming

```
motor1_move_CW:
PWM4:
sbi     portc,2  ;
cbi     portc,3  ;
mov     r18, r20 ;
subi    r18, 0x80;
brpl    pc+2     ;
neg     r18      ;
ldi     r16, 3   ;
mul     r18, r16 ;
mov     r18, r0  ;
cpi     r18, 0xE4;
brlo    pc+2
ldi     r18, 0xE4
out     OCR0B, r18;
clr     r20
rjmp    judge3
```

(a) Upper arm

```
motor1_move_CCW:
PWM4:
sbi     portc,4  ;
cbi     portc,5  ;
mov     r18, r23 ;
subi    r18, 0x9f;
brpl    pc+2     ;
neg     r18      ;
ldi     r16, 6   ;
mul     r18, r16 ;
mov     r18, r0  ;
cpi     r18, 0xE4 ;
brlo    pc+2
ldi     r18, 0xE4
sts     OCR2A, r18 ;
clr     r23
reti
```

(b) Lower arm

Fig 23. Microcomputer programming

Maximum available current of the motor is 400mA. If more than 400mA of current flows to the motor, there is a possibility that is going to be damaged. Based on calculation, the duty ratio was set to 0xE4. Duty cycle is the percent of time that an entity spends in an active state as a fraction of the total time under consideration. After changed to 0xE4, confirmation of the current flowing to the motor from the motor driver does not exceed 400mA has been made by running some tests.

3.2.2.2 Confirmation method

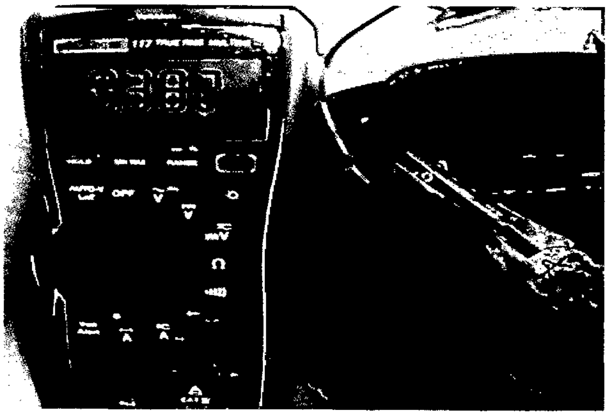


Fig 24. Measuring the maximum current

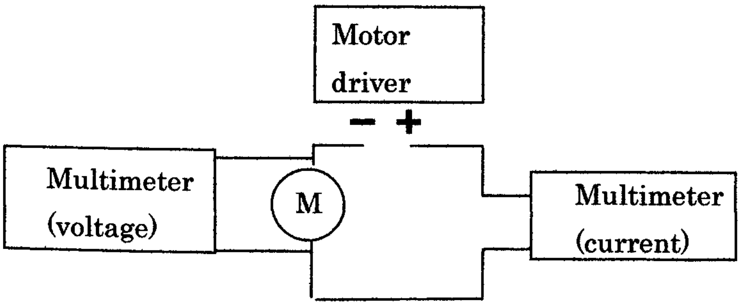


Fig 25. Circuit diagram

Applying some loads to the rotating motor at a constant voltage until it stopped. After motor shaft completely stopped, the flowing current to motor was measured using a multi-meter. The current increases rapidly, and then decreased to a stable range as shown in Fig 26.

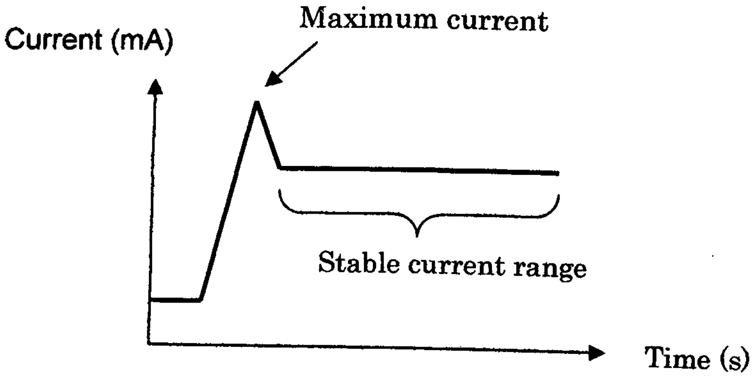


Fig 26. Result graph

Duty ratio	DC voltage (V)	AC voltage (V)	Maximum current (mA)	Stable current range (mA)
0X9D	2.986	1.01 ~ 0.99	324	300 – 280
0XB4	3.170	0.96 ~ 0.94	355	320 – 300
0XC8	3.772	0.76 ~ 0.74	411	360 – 340
0XD4	3.995	0.66 ~ 0.64	424	390 – 370
0XE4	4.264	0.49 ~ 0.47	436	400 – 380

Table 3. Result

Table 1 shows that when the duty ratio is set to 0xE4 (89.4%), the stable current range does not exceed the motor's maximum available current.

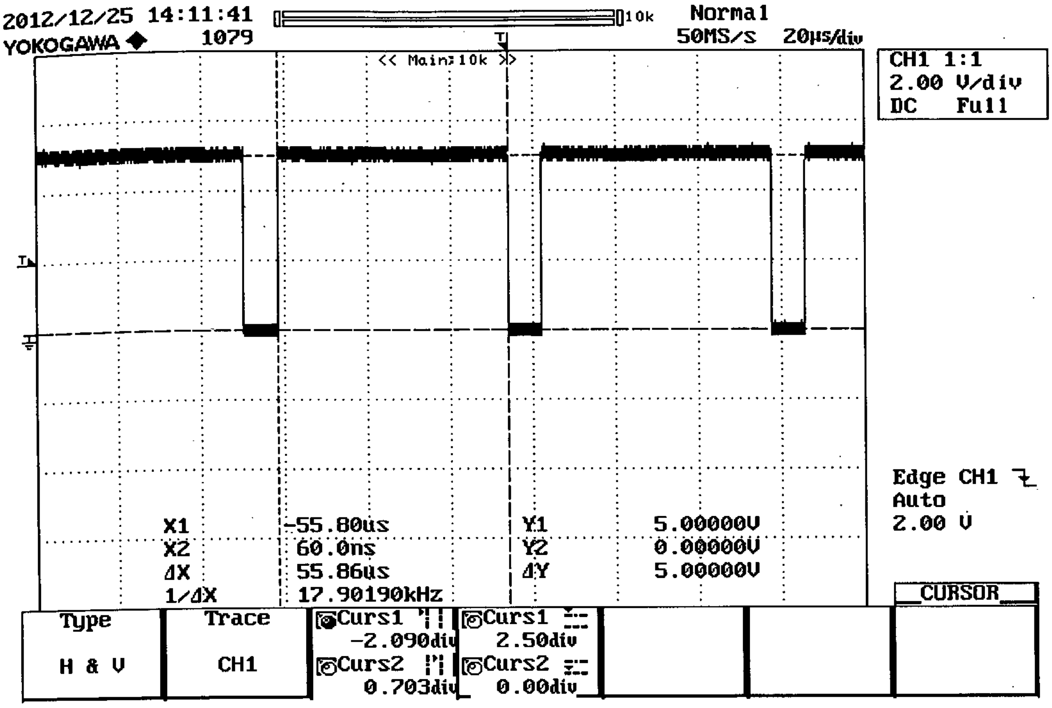


Fig 27(a). PWM signal from upper arm microcomputer to the motor driver

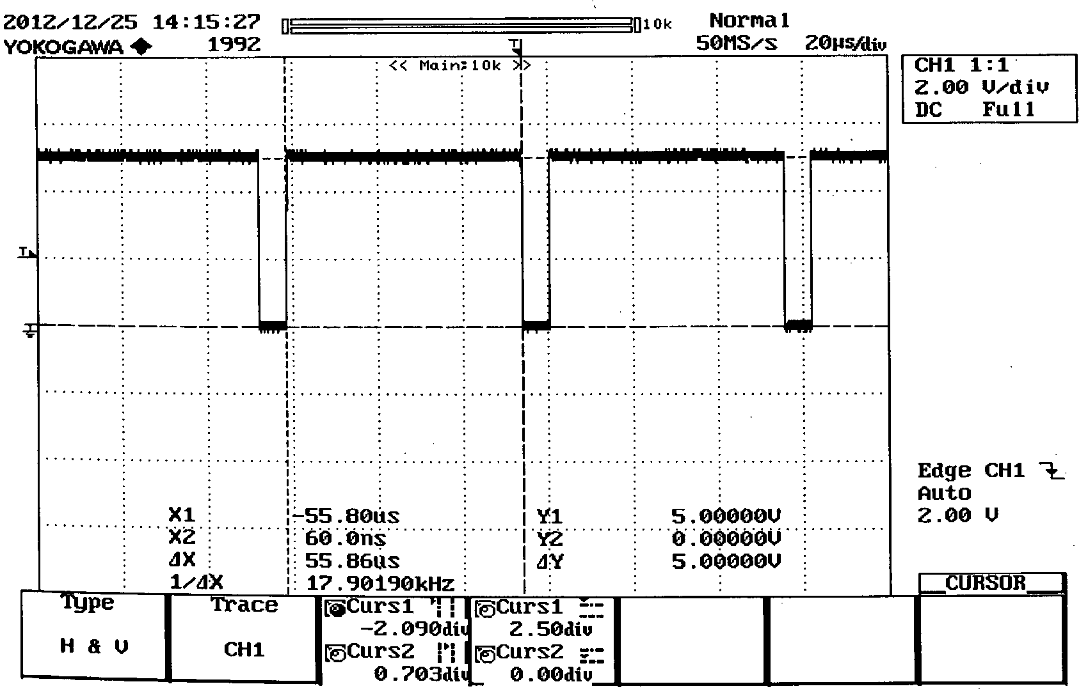


Fig 27(b). PWM signal from lower arm microcomputer to the motor driver