Palestine Polytechnic University

College of Engineering & Technology
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Graduation Project

Cell Phone-Based Controller for a Toy Car

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Abstract (English)

Different methods and techniques have been used for both remote controlling and remote monitoring. With the advent and popularity of cellular phones, these phones can provide cheap, dependable and feasible technology to control a remote object and to monitor far away environmental parameters. In this system, it is proposed to use cellular phones as a new technological controlling technique to remotely navigate a toy car, and to request the measurement of some parameters from the car. The system needs a regular cellular phone to be attached to an internal microcontroller board of the toy car to accept commands, execute commands, and send measured parameters to the other phone. In order to achieve all these activities and services, a set of pre-programmed commands and data are stored in the microcontroller memory and considered the interface method between the cellular phone of the toy car and the user's cellular phone. After the toy's car control circuit accepts the commands, process execution will begin. The user should use only the pre-programmed commands, and follow the correct procedures to achieve both navigation and monitoring operations.

The system design proposes three ways of interface between the toy car and the user. The first one, the toy car waits a command from the user to begin its motion; these commands include INITIALIZE, GO, REVERSE, LEFT and RIGHT. The second waits a command from the user to send data; these commands include TEMPERATURE and DARKNESS. The last is decided by the microcontroller on the toy car itself automatically, this data command is BORDER which is sent if any border is in front of the car while moving.

Abstract (Arabic)

العديد من الأساليب والتقنيات التي تستخدم للتحكم في الأجسام الكهربائية عن بعد. إحدى هذه التقنيات الحديثة هو التحكم عن طريق الموبايل, حيث تستخدم هذه الطريقة في التحكم لأنها ذات تكلفة قليلة إذا ما قورنت بتقنيات أخرى, كما أنها متوفرة ويمكن استخدامها للتحكم من على مسافات بعيدة. في هذا النظام سوف نستخدم الموبايل ذو الشريحة كأسلوب جديد في التحكم عن بعد في سيارة كهربائية صغيرة الحجم, وكذلك نقوم بطلب بعض المعلومات من المكان الذي توجد فيه هذه السيارة من خلال الأوامر المتفق عليها داخل النظام. النظام هنا يحتاج إلى شريحة موبايل ليتم توصيلها باللوحة المتحكمة الداخلية للسيارة والتي تعتبر الوسيلة التي يتم من خلالها تبادل المعلومات و تنفيذ الأوامر وإرسال البيانات إلى الطرف المشارك في عملية الاتصال وهو المستخدم. ولكي يتم إنجاح عملية التحكم والحصول على الخدمات المطلوبة هناك مجموعة من الأوامر يتم برمجتها و تخزينها مسبقاً في الذاكرة الداخلية للوحة التحكم والتي تعتبر وسيلة التفاهم بين الشريحتين الموجودة أحداهما داخل السيارة والأخرى مع المستخدم . تبدأ عملية المحاكاة بين الطرفين بعد أن يتم التعرف على الأوامر المرسلة من قبل لوحة التحكم الداخلية للسيارة. مستخدم هذا النظام يجب عليه التقيد بمجموعة الأوامر المتعارف عليها داخل النظام لإتمام عملية التحكم وإجراء العمليات المطلوبة.

تصميم النظام يتضمن ثلاثة أساليب للتفاهم بين المستخدم والسيارة. أول هذه الأساليب أن السيارة تنتظر أمر من المستخدم لبدء عملية الحركة دون إرجاع بيانات له. والأسلوب الثاني أن السيارة تنتظر أمر من المستخدم يطلب فيه إرجاع بيانات فيقوم الجهاز المتحكم على السيارة بتحليل الأمر و من ثم إرسال البيانات المطلوبة. وأما الأسلوب الثالث أن السيارة تبعث إشارة مباشرة عبر الجهاز المتحكم حين تعرضها لحاجز, حيث تخبر المستخدم بوجود عقبة في طريقها وتنتظر الأوامر من المستخدم.

Acknowledgement

Here while finishing our hardware project; we would like thank warmly every body who has helped us complete this work. Especially Dr. Kareem Tahboub, Mr. Hamid Al-Qwasmi, Mr. Rasmi Sayyed Ahmad and Eng. Abed Albaset Al-Jabari for all their efforts.

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Glossary

ADC: Analog –to- Digital Converter. Which convert the analog signal to digital signal.

ALE: Address Latch Enable.

CPU: Central Processing Unit.

DAC: Digital –to- Analog Converter.

DAQ: Data Acquisition.

DC: Direct Current.

EEPROM: Electrical Erasable Programmable Read Only Memory.

IC: Integrated Circuit.

LDR: Light Dependent Resistor.

LSB: Least Significant Bit.

MIC: refers to microphone which found on the cell phone.

PCs: Personal Computers.

PPI: Programmable Peripheral Interface.

PSEN: Program select Enable.

RAM: Random Access Memory.

ROM: Read Only Memorry

SIM: Subscriber Identity Module. Which is a smartcard securely storing the key identifying a mobile subscriber.

1

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Chapter One

Introduction

1.1 Overview

Remote control technology was born to interface the people applications and present many services for them. It helps the users to do their work more accurately than human hands. On the other hand, these robotics maintain human life when sent into a dangerous area to bring something from that place away from human being. User also needs to ask this machine to do something and to receive data from that area.

1.2 Problem Statement

The need for a small robot (object) is necessary in many cases especially when human life is expected to be in a dangerous state when reaches there by him self. This robot will replace humans by doing the task instead of them. The object is to send the robot to bring what is needed. The user needs to ask this machine to do something and to receive data from that area.

In this system, the team designs a main control circuit to navigate a toy car as an application by human voice for controlling the car remotely and monitoring and sensing data using voice commands. This is done through two cell phones. One of them is with the client, and it is any valid cell phone. The other one is built inside the toy car and connected to the control circuit that contains the whole chips that the system needs. The cell phone is converted to silent communication by passing its speakers, microphone, ring, and keypad. This system uses cheap and available technology that enables users to achieve the proposed goals.

1.3 Project Objectives:

This project should:

- Navigate a toy car using a cell phone.
- Send pre-determined set of commands.
- Request data from the car (also pre-determined commands).
- Interpret the received commands.
- Sending back data per request or pre-determined situations.

1.4 Project Benefits

There are several benefits for the project as follows:

- A natural way for sending commands to a toy car.
- A natural way for receiving data from the toy car.
- No transmission infrastructure is needed.
- This project can be used in several applications, such as hospital services, companies and military fields.
- Can be used to maintain the human life from dangerous events when occur.
- Can be used to facilitate bringing some measurements or telling the situation in some certain areas.

1.5 Literature review

There are some research people who have tried to use cell phones to control some remote objects. In South Korea they are planning to launch a home security robot that can be controlled by a mobile phone [1]. The Home Network Service is an upgraded service that lets customers receive, via their cellular phones, text messages or pictures regarding any home emergency situation such as a fire or gas leak. This notification is transmitted by a camera and sensor-equipped robot at home.

Other researchers have tried to design a small toy car and control it by putting special numbers on the cell phone board using software built by the Japanese designer [2]. The car-system can be navigated after downloading the required software on the designer mobile. This project uses only the numbers that determined previously by the programmer and there is no use for the voice and it is a one way communication i.e. only from the client to the toy car. These systems use the cell phone to navigate an object in different applications.

We have to use the cell phone in a different application, especially by using the human voice as means of transfering the determined commands to a toy car. Add to that repeating other data tells the surrounded situation of the car area. The navigation happens under pre-determined commands; each command gives its own service. Some of these commands are GO, RIGHT, LEFT, BACK. These commands will be translated into analog signal, on the keypad of the control circuit and then will be converted into digital signal by ADC to deal with.

1.6 The Proposed System in Brief

The proposed system needs a toy car, two cell phones, a microcontroller, and a control circuit. The microcontroller, the control circuit and one of the cell phones will be attached to the toy car. The second cell phone will be used to navigate and communicate with the toy car.

1.7 Estimated Development Cost

The following table shows the main and necessary chips that are needed for the system. The prices are in US Dollars.

Table 1.1 Estimated Development Cost

IC	Units	Price(US $)
Microcontroller 8051 Chip	1	123
Temperature sensor (LM35)	1	6
Phototransistor Sensor	1	2
LDR Sensor	1	1
Barrier sensor	1	6
Wires and Cables	-	30
Cell phone	2	200
Toy Car	1	150
Amplifier(TL081)	4	5
Relay(+5V)	6	15
Optocoupler (4N25)	12	10
ADC chip(AD0804)	1	6
DAC chip(DAC0814)	1	3
Inverter(74LS14)	1	4
Resistors	100	10
Transistor(2N2219 A)	4	5
Jawwal cards	30	150
Printing	-	100
Total		**826**

1.8 Time Planning

The project plan follows the following time schedule, which includes the related tasks of study and system analysis.

Time planning includes two time estimation schedules; the first one shows what is done in the first semester and the second shows time scheduling of the second semester.

1.8.1 The First Time Planning

Task/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Data gathering & analysis	■	■	■	■	■											
System requirement specifications				■	■											
Study Cell phone kit					■	■	■	■								
Study 8051 kit and interfacing devices							■	■	■	■						
Project Design									■	■	■	■	■			
Documentation	■	■	■	■	■	■	■	■	■	■	■	■	■	■		

Figure 1.1: The First Time Planning

1.8.2 The Second Time Planning

Task/Week	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Implementation	■	■	■	■	■	■	■	■	■	■						
Unit Testing			■	■	■	■	■	■	■	■	■					
System Testing												■	■	■		
Documentation	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	

Figure 1.2: The Second Time Planning

1.9 Report Contents

This report is divided into five chapters; the first chapter is the introduction, which describes the general review of the system, project requirements (hardware and software), system cost, scheduling time, and report contents.

The second chapter talks about the theoretical background that shows the theoretical subjects related to the main ideas of the project information about the cell phone and other special components that are built to distinguish the professional system.
Chapter three talks about the design concepts; the main objectives and a general block diagram that shows how the system works.

Chapter four discusses the Hardware System Design that describes the detailed design of all parts used here.

Chapter five discusses the Software System Design that describes the general algorithms and flowcharts and sub-programs of the system.

Chapter six talks about system testing and implementation. It explains every thing has achieved and worked well.

Chapter seven shows the team's recommendation and the improvements that can be done in future work.

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Chapter Two

Theoretical Background

2.1 Introduction

This chapter discusses the main theoretical subjects which are needed to explain the main ideas of this system. It explains in more detailed way the special components which are needed for design completion of this system.

The main idea of this system is to use the cell phone, which is cheap and available technology, to send commands to the toy car for controlling its navigation, and to receive data from this toy car by using the sensors. To obtain complete design we need to study the cell phone, microcontroller, sensors, toy cars, and any component the system needs in deep manner to understand how to make the interface and in which manner can achieve the interface between these different components.

2.2 System Outline

This system intends to control a toy car by human voice recognition using cellular phone. According to this idea the system has mainly three parts:

- Phone unit.
- Sensing unit.
- Control unit.

This block diagram shows those units and how they are related to each other.

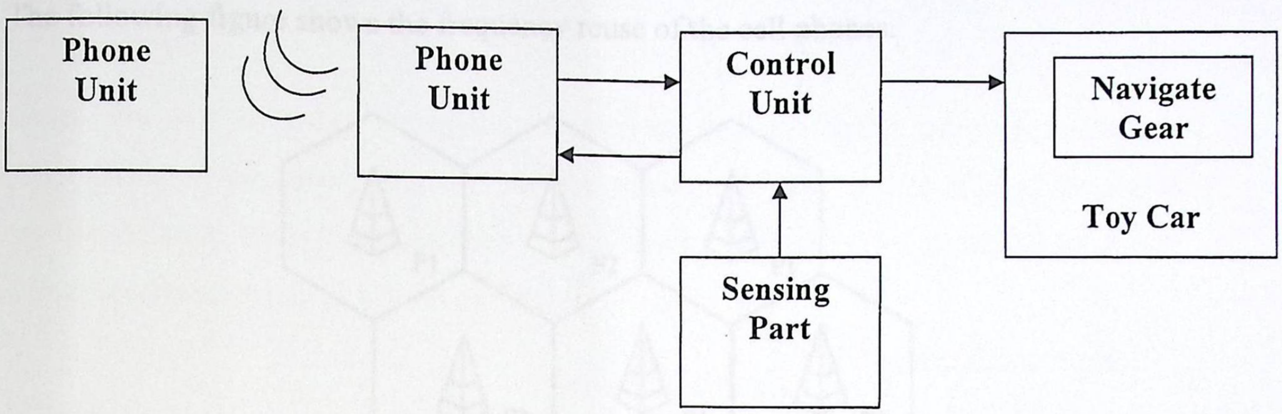

Figure 2.1 General Description of the system

2.2.1 The Cell Phone Unit

Cellular phone technology works on a system of geographically separated zones called "cells." Each cell has its own "base station" that both receives and emits radio waves. When a call is placed from a cellular phone, a signal is sent from the cell phone antenna to that cell's base station antenna. The base station responds to the cellular phone signal by assigning the phone an available channel. When the channel is assigned, radio signals are simultaneously received and transmitted, allowing voice information to be carried between the cell phone and the base. The base station transfers the call to a switching center, where the call can be transferred to a local telephone carrier or another cell phone.

As the name implies, cell phone systems are made up of many small "cells." Each cell, in a cell phone system, represents the area served by one cell phone tower. The concept of cells is the key behind the success of cell phones because by spacing many cells fairly close to each other, the cell phones may broadcast at very low power levels. Since the cell phones may broadcast at low power levels, they use small transmitters and small batteries. In other words, if the network is cellular network type then it has frequency reuse and this icreases the capacity of this network. This is shown below in the figure which explains the reuse of the frequency.

The following figure shows the frequency reuse of the cell phones.

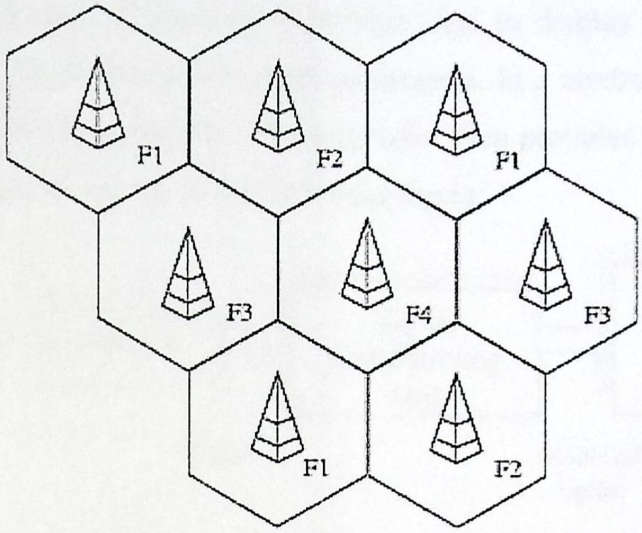

Figure 2.2: Frequency Reuse

When the user receives a call on his wireless telephone, the message travels through the telephone network until it reaches a base station which is close to his wireless phone. Then the base station sends out radio waves that are detected by a receiver in telephone, where the signals are changed back into the sound of a voice as shown in figure 2.3.

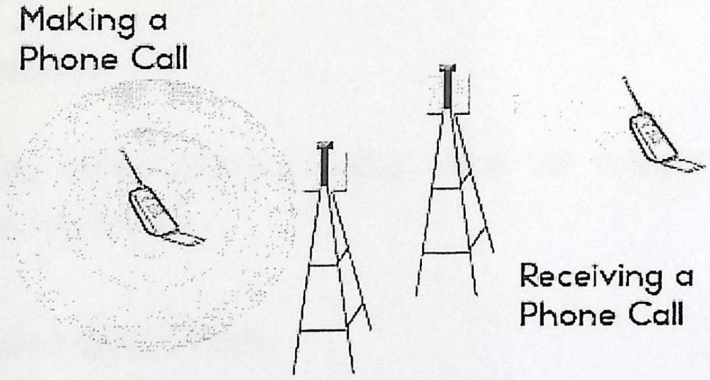

Figure 2.3: General form of mobile station.

The cellular phone is used in this system to navigate and communicate the toy car via 8051 microcontroller to send commands and receive data.

2.2.2 Sensing unit

Sensors are used to gather information to provide data to display purpose to give an understanding of the current status of system parameters. In a control system, the signal from the sensor is input to a controller. The controller then provides an output to govern the measured parameters as shown in the following figure:

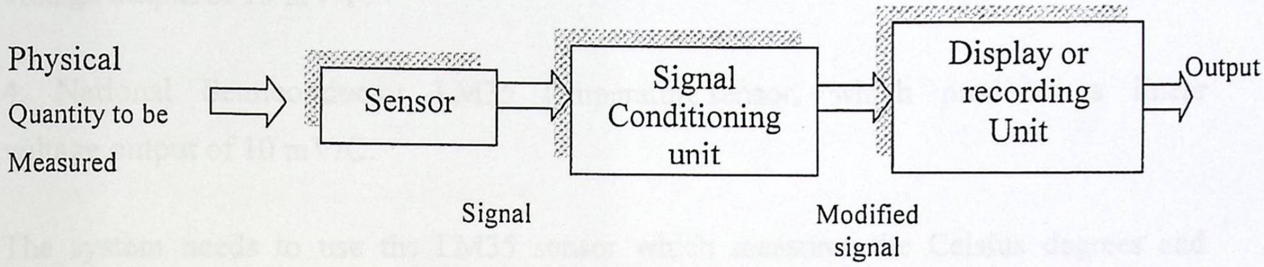

Figure 2.4: Functional elements of measurement

In this system there's a need for sensors to sense different variables or things and then return information or data to the user. This part explains some types of sensors and how they work to complete their functions. These sensors interface the system dependent on their output signal. These outputs signal either an analog one such as the temperature sensor or digital signal that interfaces the system directly such as LDR sensor.

2. **Analog Sensors**

The following sensor produces analog values of voltages which represents the environmental temperature.

- **Temperature Sensor (LM35).**

Temperature sensors provide change in physical parameter such as resistance or output voltage that corresponds to a temperature change. They can be used for measuring temperatures in the environmental and biological range of -50C to +150C.

There are four basic types of IC temperature sensors. According to the produced output signal in response to sensed temperature, as follows:

1. Analog Devices AD590/592 series temperature sensor, which produces a linear current output of 1 μA/K.

2. National Semiconductor LM335 temperature sensor, which produces a linear voltage output of 10 mV/K.

3. National Semiconductor LM34 temperature sensor, which produces a linear voltage output of 10 mV/F.

4. National Semiconductor LM35 temperature sensor, which produces a linear voltage output of 10 mV/C.

The system needs to use the LM35 sensor which measures the Celsius degrees and produces 10mV to each one degree.

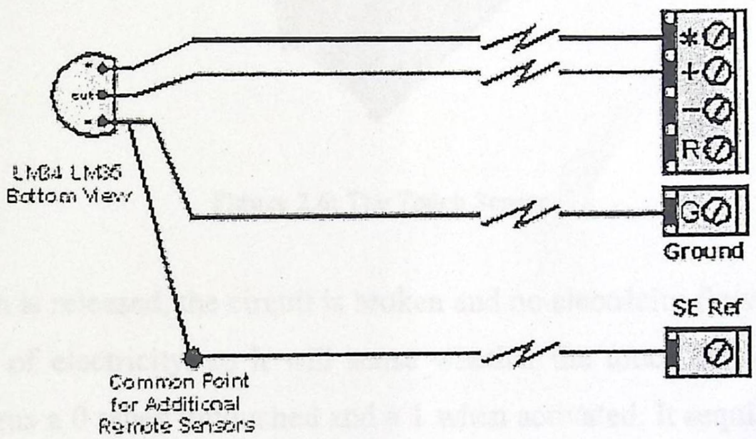

Figure 2.5: The Temperature Sensor

Because of the small output voltage, amplification is usually needed unless the thermocouple is used for temperature measurement along with a sensitive millivoltmeter. If the output of the thermocouple is required to drive anything more than a meter movement, then DC amplification will be needed by using an operational amplifier.

The system uses this sensor to achieve one of its main targets by sending and receiving data which is telling the temperature value around the toy car.

2. Digital sensors

The following sensors have the digital output values. They are connected directly with the 8051 input ports to read the voltage values.

A) Touch Sensor

The touch sensor is a sensor that detects any contact with objects in the robot's environment. When the button is pressed, an electrical circuit is closed inside the sensor. This process lets electricity flow.

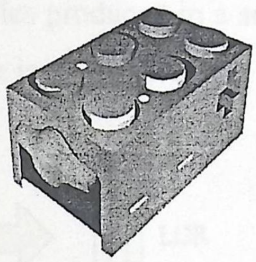

Figure 2.6: The Touch Sensor

When the button is released, the circuit is broken and no electricity flows. The RCX can sense this flow of electricity, so it will sense whether the touch sensor is pressed or released. It returns a 0 when untouched and a 1 when activated. It requires only a slight force to activate them.

b) LDR Sensor

LDR (Light Dependent Resistor) sensor is a very useful sensor especially in light/dark circuit to implement if the surrounded area of the toy car is daylight or darkness. Though it is easy to use and available. Normally, the resistance of the LDR is very high, sometimes as high as 1,000,000 ohms, but when they are illuminated (lighted) with, light resistance drops dramatically.

LDR sensor is a semiconductor device which resistance decreases when light intensity increases.

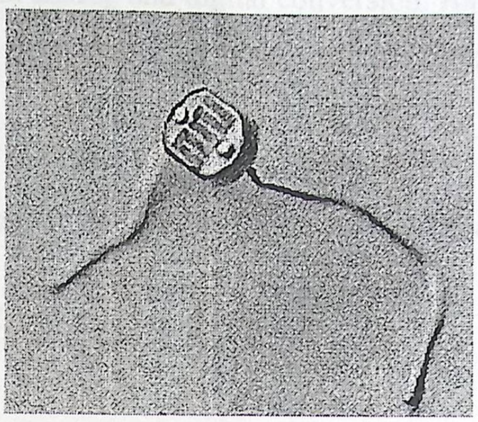

Figure2.7: shape of The LDR Sensor.

This is due to the electrons and holes produced in a semiconductor by the photoelectric effect, and the response in therefore is quite linear.

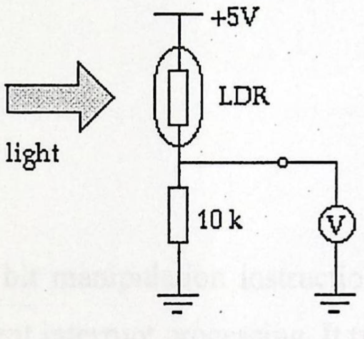

Figure 2.8: potential divider circuit.

2.2.3 The Control Unit

The control unit consists mainly of a microcontroller and interfacing circuits. The microcontroller represents the main brain of the control unit to interface the integrated circuit.

The 8051 Microcontroller

The 8051 development board provides an easy-to-use and low-cost method to control several processes of the toy car. The built-in ports on the board work are an integrity system to execute tasks.

The system needs a special microcontroller that should have the capability of storage, extension memory and both analog and digital conversion. As a result of researches, the team has found the 8051 microcontroller board that has all or most needed parts of a controller.

The microcontroller has an included package of features. These main features are:

- Intel 8051/52/552 CPU
- 32K RAM
- 32K EPROM
- 8 Channel A/D
- 1 Channel D/A
- 2 x 16LCD Display
- 4 Digital Inputs
- 4 Digital Outputs
- Serial Port

A typical microcontroller has bit manipulation instructions, easy direct access to I/O (input/output), quick and efficient interrupt processing. It typically includes:

- CPU (central processing unit)
- RAM (Random Access Memory)
- EPROM (Erasable Programmable Read Only Memory)
- I/O (input/output)
- Interrupt controller.
- PPI (Programmable Peripheral Interface)

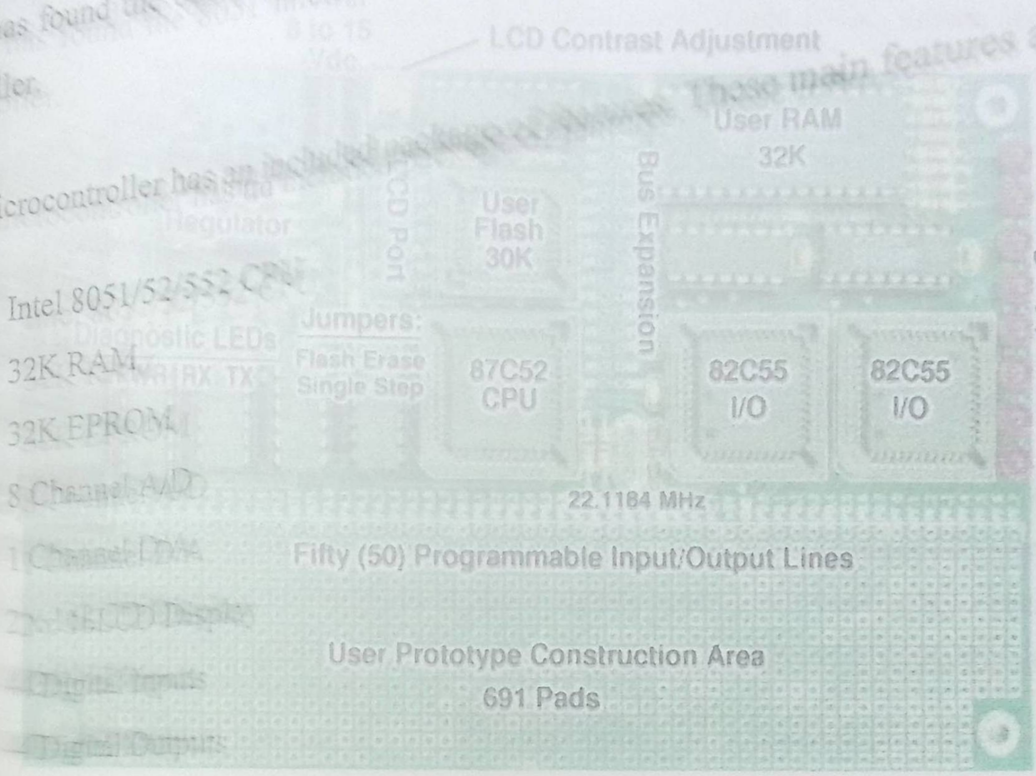

Figure 2.9: The 8051 Microcontroller

The chip-sockets of microcontroller

There is a set of chips on the 8051 microcontroller that are necessary to operate the system. These chips are:

1. CPU(87C52)

The Philips 87C52 is a high-performance technology which operates from 2.7 V to 5.5 V. In addition, the device is a low power static design which offers a wide range of operating frequencies down to zero.

Figure 2.10: The 87C52 chip

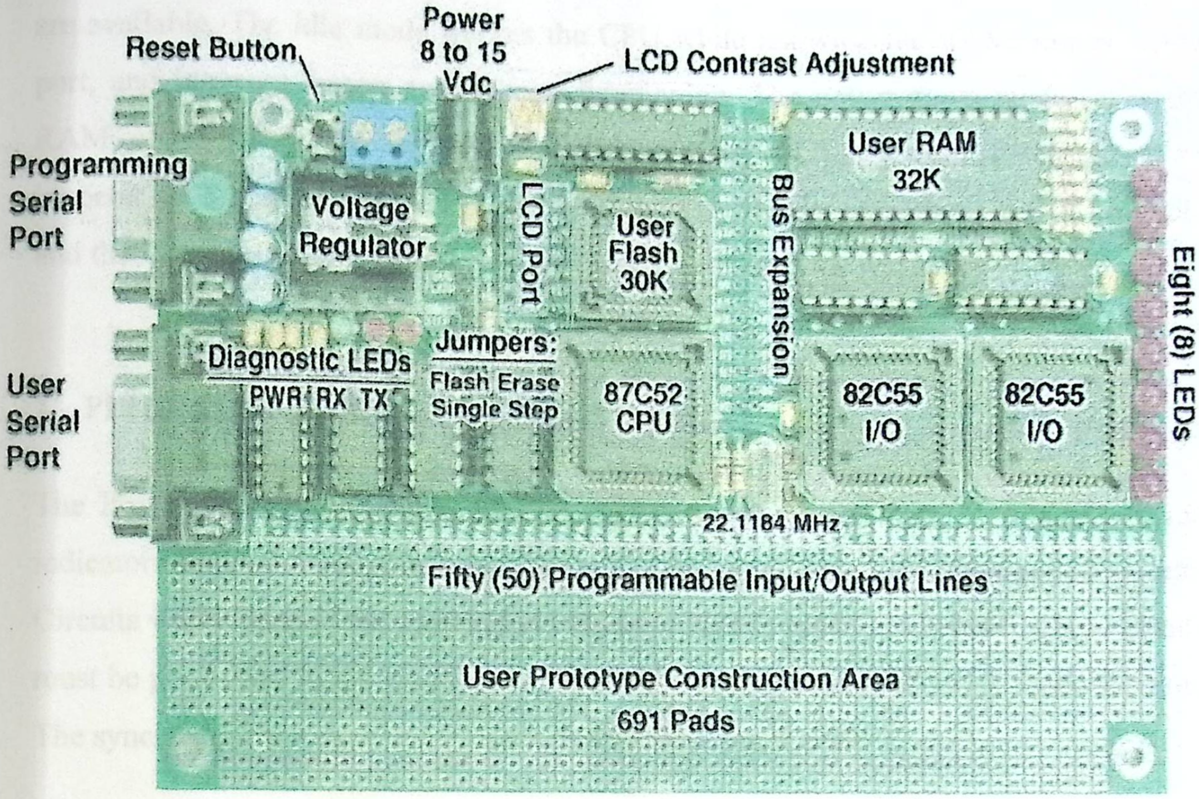

Figure 2.9: The 8051 Microcontroller

The chip-sockets of microcontroller

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Figure 2.10: The 87C52 chip

Two software selectable modes of power reduction—idle mode and power-down mode are available. The idle mode freezes the CPU while allowing the RAM, timers, serial port, and interrupt system to continue functioning. The power-down mode saves the RAM contents but freezes the oscillator, causing all other chip functions to be inoperative. Since the design is static, the clock can be stopped without loss of user data and then the execution is resumed at the point when the clock was stopped.

2. PPI (8255 Programmable Peripheral Interface)

The Programmable Peripheral Interface illustrates the major units of a plan position indicator. Synchronization of events is particularly important in the presentation system. Circuits which control the presentation on the indicator must be activated. These events must be performed to a high degree of accuracy to ensure range accuracy determination. The synchronization of these events is provided by gate circuit.

Most of the I/O lines on the 8051 development board are provided by two 82C55 programmable peripheral I/O chips

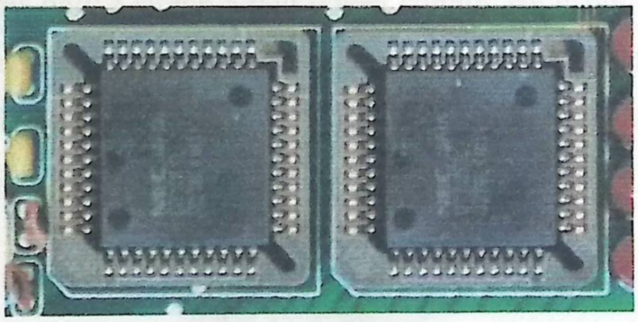


Figure2.11: Two 82C55 Chips Provide 40 I/O Lines and 8 LEDs

• Memory Mapped Peripheral Access

Both 82C55 chips are external memory mapped peripherals. This means that the access to them requires certain usage of memory locations (the MOVX instruction). Each chip has byte-wide registers for access. The MOVX instruction always uses DPTR to specify the memory location, and data is always transferred to/from the accumulator.

When programming in C, the compiler takes care of handling the registers, so what we need to do is reading the 82C55 registers as if they were ordinary global variables.

- **Reset Signal**

The 87C52 uses an "active high" reset signal. This means that the 87C52 does not execute code when the reset signal is high. It begins code running when this signal goes from high to low.

The reset signal can be verified by measuring the voltage on the RST pin of the 87C52. When the reset button is pressed, the RST pin should measure 5 volts DC. When the button is released, it should go back to zero. The voltage makes transition from 5 to 0 volts with time constant of 0.1 seconds.

3. Flash ROM Chip (39F512)

The 39F512 requires only a single 5 volt power supply. By using this Flash ROM chip, we can add permanent storage to download programs. It is also possible to use the chip for data logging. This chip supports erasure of the entire chip at once, or in 4k blocks.

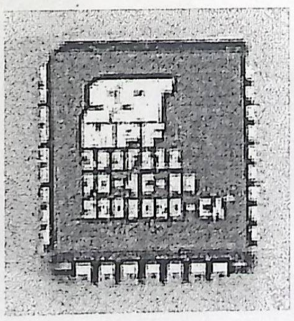


Figure2.12: 39F512 Flash ROM Chip

This Flash ROM chip is pre-programmed with suitable software. This chip includes several_commands for cursor positioning, scrolling, etc.... It is also intended to hobbits that do not have the EPROM programmer required to program their own chip.

4. Voltage Regulator (7805)

The Voltage Regulator (regulator), usually having three legs, converts variable input voltage and produces a constant regulated output voltage. They are available in a variety of outputs.

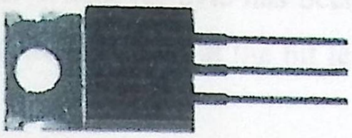


Figure2.13: DC Voltage Regulator

The most common part numbers start with the numbers 78 or 79 and finish with two digits indicating the output voltage. The number 78 represents positive voltage and 79 negative one. The 78XX series of voltage regulators are designed for positive input. And the 79XX series is designed for negative input.

The system needs a positive regulator in order to convert the input voltage from the 9.6V battery of car to +5V. The system needs two regulators to divide the voltage of two used batteries into +5V, -5V, and COM (GND), also the full battery voltage to operate the 8051 Microcontroller is needed.

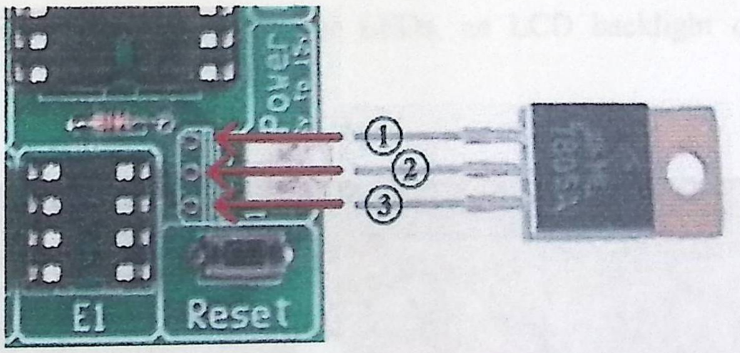


Figure2.14: The 8051 Voltage Regulator

The 8051 voltage regulator indicates the three legs and their positions. These pins are:

- Pin 1: Unregulated power input.
- Pin 2: Ground.
- Pin 3: Regulated +5 Volt output.

4. Serial Port

The fact that the 8051 has an integrated serial port means that it may easily read and write values to the serial port. . The 8051 will automatically tell when it has finished by sending the character we wrote. Whenever byte has been received we can process it. We do not have to worry about transmission at the bit level--which saves quite a bit of coding and processing time.

Figure2.15: The 8051 Voltage Regulator

6. Power Supply Check

The 8051 development board requires DC voltage between 8 to 15 volts to operate properly. The power source should be rated for 100 mA or higher. Higher input voltages, between 15 to 30 volts may also be used, but the heat sink which may become hot if an additional power is used for LEDs, an LCD backlight or other add-on peripherals.

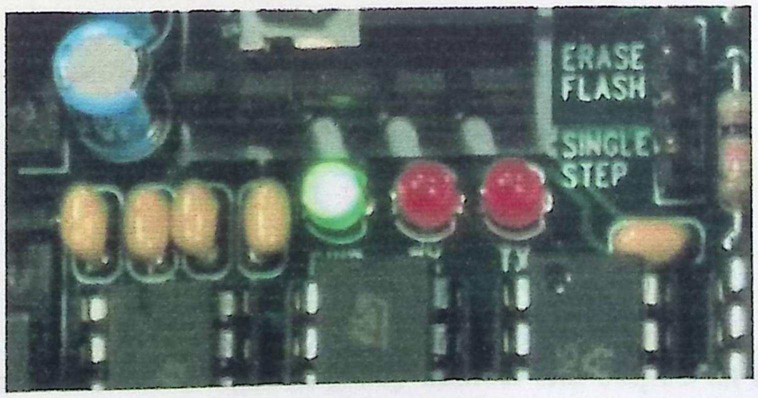


Figure 2.12: Green LED Indicates Power

The first, quick check is the green LED that indicates the board is receiving power. If this LED is not illuminated, the power may not be connected, or may not be turned on.

The power input may also be connected backwards. The 1N5819 diode protects the board from damage due to reversed polarity power. But the board can not run without the power applied correctly. If the green is LED, an additional check is to measure the DC voltage output from the 7805 voltage regulator.

External Chips

The system needs the following chips to interface the 8051 microcontroller with the circuits to navigate correctly the toy car.

1. DAC (Digital to Analog Conversion)

Digital systems have inputs and outputs that are represented by discrete values of logic 1's and logic 0's, high and low. The logic 1's and 0's are simply representations of voltage in an electrical system. The reference voltages are used to determine whether a signal should be considered a logical 1 or a logical 0.

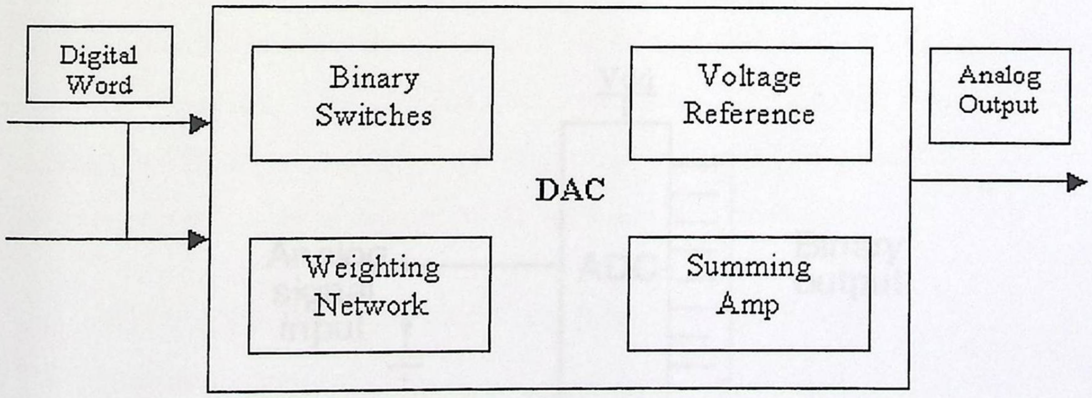


Figure2.16: DAC Block Diagram

A DAC, on the other hand, inputs a binary number and outputs an analog voltage or current signal. In block diagram shape, it looks like this:

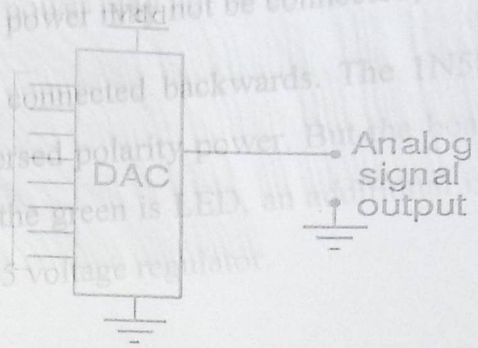


Figure2.17: DAC Function Block Diagram

There are sort of digital to analog converter needed. A digital to analog converter, a DAC, is an essential circuit to interface from the digital world to the analog signal processing area. DACs produce a continuous output voltage signal that represents a sequence of digital numbers at the input. The DAC takes a binary input and through the appropriate "technique" determines a continuous analog output. So we need DAC conversion in order to convert the digital input data to analog signal.

2. ADC (Analog to Digital Conversion)

The input of ADC is an analog electrical signal such as voltage or current which appears as a binary number. In block diagram form, it can be represented as follow:

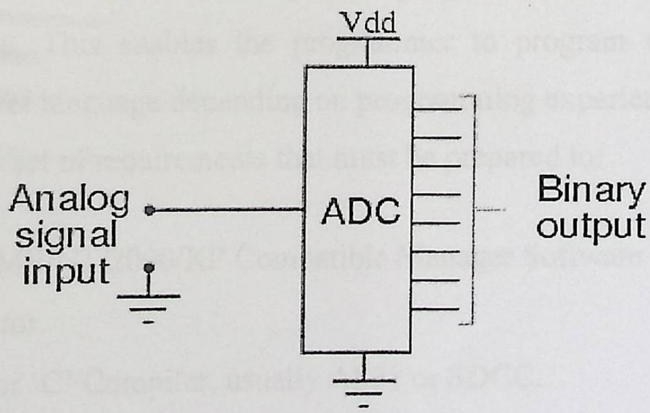
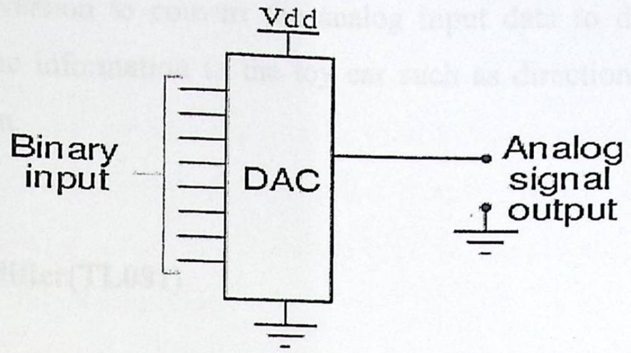


Figure2.18: ADC Block diagram



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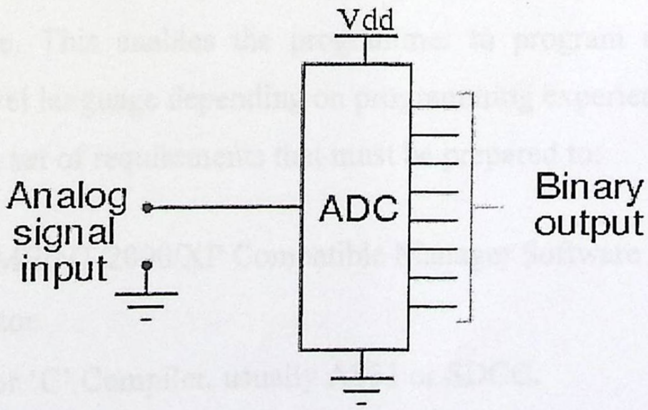

Figure2.18: ADC Block diagram

We need ADC conversion to convert the analog input data to digital signal that is capable to send some information to the toy car such as direction-commands, TEMP and other information.

3. Operational Amplifier(TL081)

Operational amplifiers are used to amplify the input signal for several times as needed. This signal will be readable and sensed to deal with, so the electric circuits can sense this value of voltage to do its valid work.

The TL081 is used in the system to duplicate the output signal of temperature-sensor value (0V – 1V) nearly five times to be readable by the ADC circuit. The duplication happens by using the following formula:

$$Av = Vo/Vi \text{ ; where } Vo = (Rf/Ri)*Vi + 1 \text{ for non-inverting amplifiers.}$$

The Microcontroller Software

The 8051 microcontroller has the ability to be programed either using C-language or assembler language. This enables the programmer to program either in high level language or low level language depending on programming experience.
The system needs a set of requirements that must be prepared to:

- Win 95/98/ME/NT/2000/XP Compatible Manager Software
- Built-in Editor
- Assembler or 'C' Compiler, usually AS31 or SDCC.
- Expansion Connector for External Hardware
- Terminal Emulation Program, such HyperTerminal (windows), Minicom (linux)
- Text Editor Program, like Notepad.
- Standard 9 pin serial cable.
- DC Voltage, 8 to 15 volts (regulated).

2.2.4 The Toy Car

There are several types of toy cars that can be used in many applications. This system needs only one type of toy cars which is a remote control and advances the objective of this design. The following toy car is the chosen type for the project since it has the most popular features that the system needs.

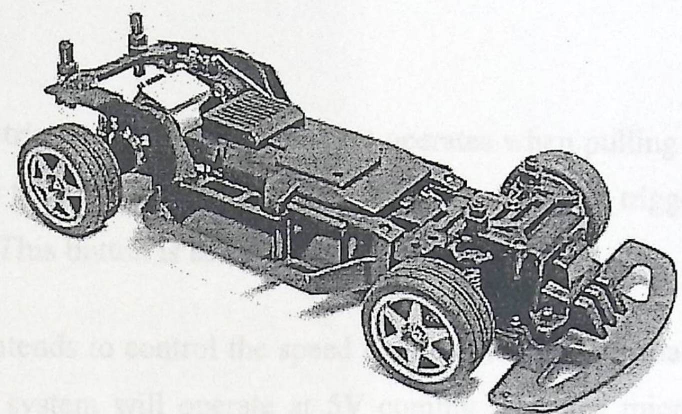

Figure2.19: a Toy Car Form

1. **Car Features**

The Toy Car has several features represented as follows:

1) 1:10 scale super-speed R/C car

2) Full function: back, right, left, forward.

3) Charger and battery: 12v rechargeable Ni-Cd battery.

4) Frequency: 27mhz, 49mhz or 35mhz

5) 2-step speed lever can select "high" or "low" speeds

6) ABC switch allows simultaneous operation of three QD (Quick Drive) cars.

2. Car Motors

The Toy Car has the ability of moving in four directions controlled by transceiver circuits of a remote control. It consists of two main DC motors of maximum 12V. These motors used to obtain the required voltage of each execution command. The first motor is used to control both Forward and Backward directions, while the second is used to navigate both Right and Left directions.

3. Car Speed

The speed control trigger of the toy car in fact operates when pulling or pushing with a finger. Pulling the trigger runs the model forward. Pushing the trigger runs the model reverse direction. This button is in the forward-backward motor.

The team design intends to control the speed by the voltage value that is sent to motors with its task. The system will operate at 5V coming from the microcontroller. If we need to increase the speed we need to maximize the output voltage of microcontroller.

The right-angle and left-angle are fixed from the manufactured company and they equal 45. So every command to the right-left, motor will rotate the car 45 degree from its state.

4. Toy Car Size and Weight

The toy car has a medium size that consists of the motors, battery, and the whole body. This indicates that the size is suitable to be an experimental surface for team application.

The car is nearly 3.5Kg weight. It is tested to load up to 4Kg, while keeping the speed as it is. These data comfort to build our own circuits that may not weighted more than the maximum weight.

The dimensions of the toy car relative with its size. The tall of the car is 55cm while the width is 25cm.

5. **Toy Car Battery**

The toy car has a 9.6V DC battery that is needed to operate the motors. The remote control consists also of a 9.6V DC battery to be able to send control waves toward the toy car. The remote control navigates the toy car under limited area of 30m.

The toy-car system needs two 9.6V DC batteries that must be connected to operate the microcontroller and the car motors adding to the control circuits.

2.3 Summary

- The chapter contains the whole peripherals and parts that will be used in the system.
- A Cell Phone is the main idea of controlling the system by receiving commands and sending data during an internal design.
- The system needs two cell phones; one of them will be with the client and used to send the pre commands and receives data from controlling port.
- The other cell phone will be put on the board and the whole system depends directly on it.
- A cell phone contains a set of main parts that the interface needs; they are: Keypad, MIC, Speakers, and The Ring.
- Sensors are mostly needed to do the control tasks
- Necessary sensors needed in the system are: Infrared, Sunshine\dark, and Temperature.
- The 8051 microcontroller is the main brain of the system; it consists of all chips that are necessary for interfacing.
- The memory is used to store the commands and data that will be used to control the object.
- EPROM is used to store the software of the project.
- RAM is used to store the commands and data of the project.
- DAC and ADC are used to convert the signal in order to be understood for the system.
- The interface between these components will be done in the forth chapter.

3

Chapter Three
Design Concepts

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Chapter Three

Design Concepts

3.1 Introduction:

In this project there is a need to select a suitable remote controlled toy car with a middle size for controlling its navigation. The team has to setup the required sensors that determine the needed data such as surrounded temperature and darkness or daylight conditions, movement, and any kind of interruption, using a cell phone of the toy car.

This media is used to navigate the car remotely through the main control circuits to take commands to the cell phone. This control is designed on the user site to make it easier to control the car, and at the present time there is no need for designing a camera to feedback the site.

The system uses some important commands which are designed to control the car by sending this command via human voice through the cell phone. These commands are:

- Initialize car
- Go
- Right
- Left
- Back.

The client also needs some important information about the surrounding such as:

- Temperature
- Daylight / Darkness state.
- Predetermined situation such as road closed, car on fire.
- If there is any movement object around the toy car.

The angles of RIGHT and LEFT directions are fixed by the manufacturer company of the toy car. And it is 45 C˚.

The car's speed is controlled during the input voltage of the motors. The speed is increased by increasing the voltage.

3.2 Project Objectives

This project supports many ideas and objectives that can be summarized as follows :

- Navigate a toy car using a cellular phone.
- Send predetermined set of commands, such as GO, RIGHT, LEFT, BACK to move the car forward, right, left, and backward directions respectively.
- Request data from the car (also predetermined commands) such TEMP to receive the temperature from the toy car, DARK to receive if the surrounding area if it daylight or darkness.
- Receive data from the toy car directly if there is any interruption, obstacle or any form of danger such as fire.
- Interpret the received commands.
- Sending back data per request or predetermined situations.

3.3 General Block Diagram:

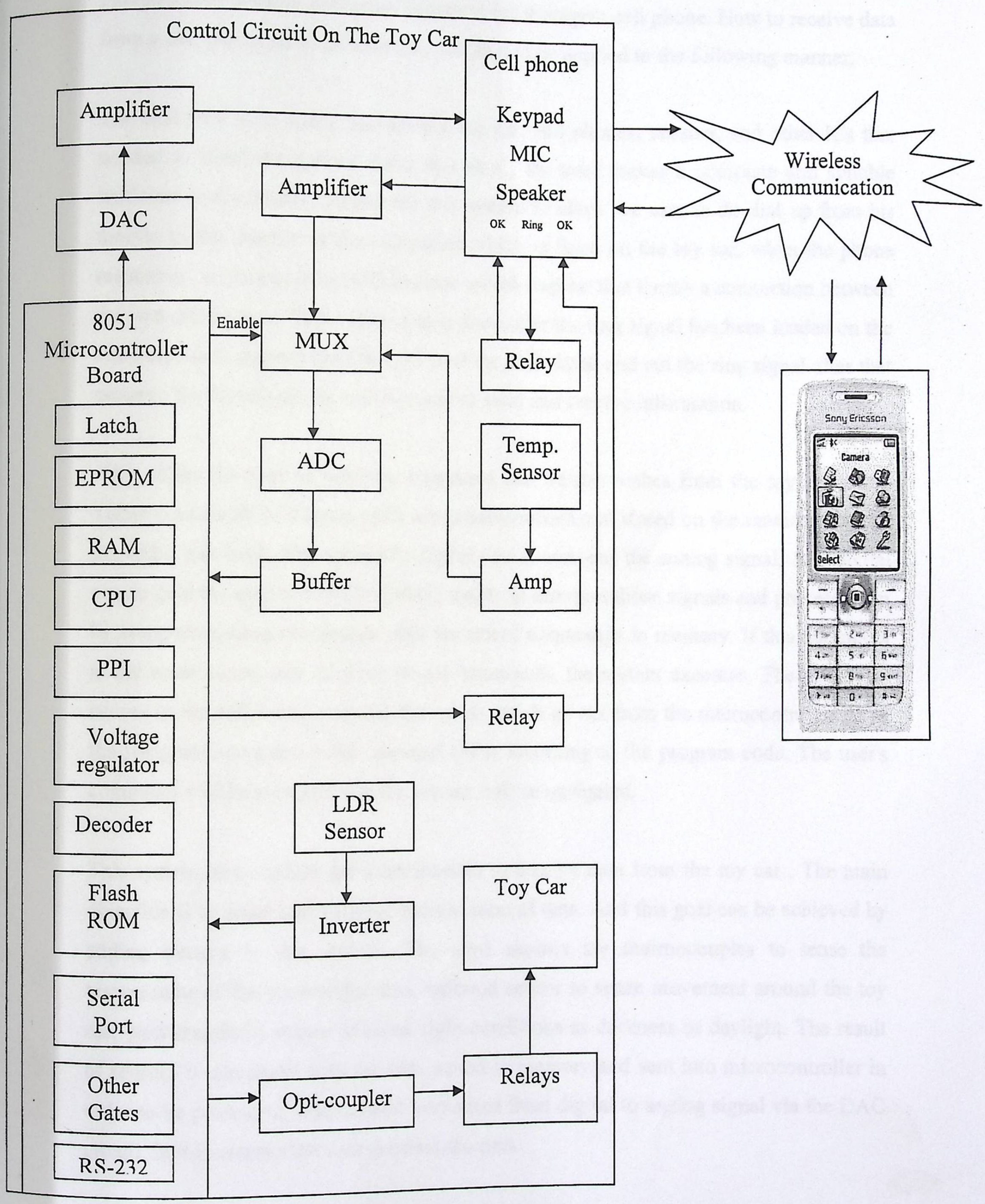

Figure 3.1: General Block Diagram

3.3 How Does System Work?

The main idea of this project is how to use remote control technology to control a car movement by sending a wireless human voice through a cell phone. How to receive data from a cell phone fixed on a toy car. So this can be applied in the following manner.

The first step is to select the suitable toy car, cell phones, sensors, and other ICs that needed to build the system. After this step , the team makes a complete and suitable hardware and software designs for this system to allow the user to do dial up from his mobile to the number of the cell phone which is fixed on the toy car, when the phone responses , a closed circuit will be done which implies that there's a connection between the two cell phones. This connection is done after the ring signal has been loaded on the relay-circuit to operate the OK-button of the cell phone and cut the ring signal after that process. So the cell phone will be ready to send and receive information.

This offers the user to send the command that he/she wishes from the toy car to do. Those commands of human voice are predetermined and stored on the memory such as go, right, left, back. The analog-to-digital circuit converts the analog signals into digital one to give the microcontroller (8051) ability to interpret those signals and process them by comparing these commands with the stored commands in memory. If this command is the same as any one of those stored commands, the system executes. The execution occurs in the following scenario, the result which go out from the microcontroller go to the peripheral programmable interrupt (PPI) according to the program code. The user's command will be executed and the toy car will be navigated.

This system also enables the administrator to receive data from the toy car . The main objective is to make bidirectional transmission of data. And this goal can be achieved by adding sensors to this system. The used sensors are thermocouples to sense the temperature of the surrounded area, infrared sensor to sense movement around the toy car, phototransistor sensor to sense sight conditions as darkness or daylight. The result of sensors is compared with the data stored in memory and sent into microcontroller in order to be processed. The result is converted from digital to analog signal via the DAC circuit. In this manner the user receives the data.

Some of sensors can be used to give the client data directly without any request. These sensors are used to tell the surrounding state of the toy car especially dangerous regions, or any interruption in the toy car route. When the toy car is found in dangerous regions, for example, the control circuit sends a command to the car-cell phone to dial up the number of the administrator-mobile, which is stored in its memory automatically and tells about this danger condition.

So the system can be summarized in three basic scenarios:

- The system receives commands only such as go, right, left, and back.
- The system receives commands and process to send data from it.
- The system sends data only about its surrounded state.

In this manner the system will complete the idea which is built for. Anyone may insert improvements on this system to do many things such as sending and bringing objects from the place the toy car is in, especially when that place has some kind of danger to human life. Also there are many ideas to make this system more effective since the cell phone technology is available and the data which is sent is reaching for long distances, the system uses natural way of communication so it is simple to use.

4

Chapter Four
Hardware System Design

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4.3 The System Design 49

Chapter Four

Hardware System Design

4.1 Introduction

After explaining the theoretical background, the general block diagram of the system, and how the system works, there is a need to view what is the design of this system in more specific, powerful and more formal terms. So this chapter describes the final system design with all its features which are necessary to make the system works well and achieves the object of the system. This chapter shows the interface between the equipments of the theoretical background, and the more suitable chips that advanced the design.

4.2 The Unit Design

The system has mainly four parts; these parts must interface with each others to achieve the project goals. The team has to deal with each one as a separate unit, study its features and prepare it to operate successfully with other units. These units are:

- Phone unit.
- Sensing unit.
- Control unit.
- Application unit.

4.2.1 Phone unit

The system needs two valid cell phones, one of them carried with the administrator used as a transceiver control. The other cell phone is put on the toy car and used as a transceiver control too. The system will take care with the cellular phone of the toy car. The cellular phone must have a set of necessary features to do a complete communication with its administrator. These features are:

- Work with JAWWAL SIM card.
- Easy to charge.
- Receive and Send correctly.
- Valid ring, speakers, and MIC.

There are two parts of communications have to be done by the cellular phone. Once, the cellular phone is used as a receiver unit. So there is a need to cut-off the internal ring lines to connect them externally with a RELAY circuit. This circuit consists mainly of a relay, capacitor, and resistor. This circuit opens the connection directly between the cell phones after the first tone. This tone represents a 2.7V DC that operates the relay to send this voltage to the OK button of the cellular phone. The values of the capacitor and the resistor depend on the results of the ring frequency. The frequency of the ring is nearly 200Hz. This value determines the charge time of the tune according the following formula:

$$T = 1/F$$

Where F: Frequency (Hertz).

T: Time (second).

By using the oscilloscope found the frequency of the ring of the cell phone equal 200Hz and from T=1/F found the Time equal 5 ms. The 5ms determines the required values of the capacitor and resistor according the next formula.

$$T = R * C$$

Where T: Time Constant (second).

R : resistor (Ohm).

C : Capacitor (Farad).

So the system needs a capacitor and a resistance where their multiplication equals 5ms, the most suitable values are a 500Ω resistor and 10μF capacitor.

The second part makes the cellular phone as a Transmitter unit. Here, another RELAY circuit has done in order to dial up the administrator cell phone. The input voltage depends on the border signal. The input relay voltage loads the microcontroller signal to the cellular phone. This will open a connection with the admin-cell phone directly telling him that an object founded in its path.

Figure 4.1 explains the two way communications.

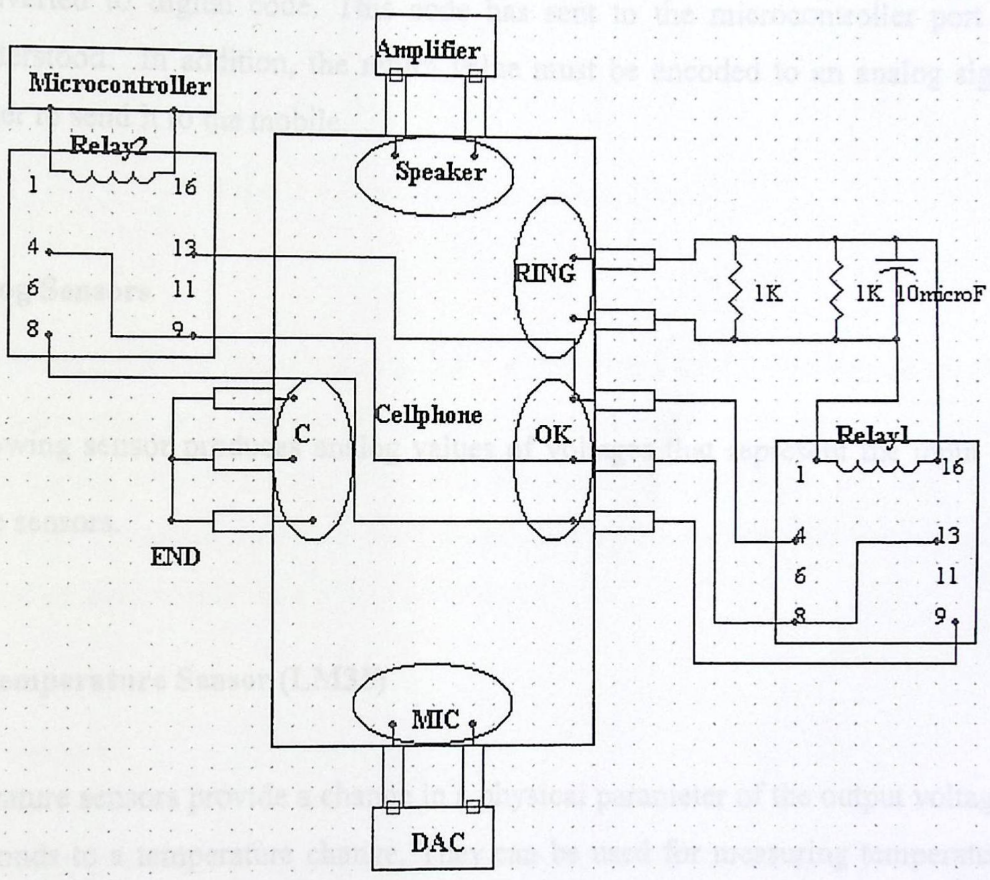

Figure 4.1: The block diagram of the cell phone

4.2.2 Sensing Unit

The sensing unit represents the environmental area of the toy car. They can indicate the situation depending on their input data. The output signal either analog or digital signal. The digital signal is loaded directly to the microcontroller port and its output signal has to be converted to an analog one if it is needed for another task and loaded to the cell phone. On the other hand, the analog signal of the sensor has converted to digital code. This code has sent to the microcontroller port to be understood. In addition, the return value must be encoded to an analog signal in order to send it to the mobile.

1. Analog Sensors

The following sensor produces analog values of voltages that represent the input signal into these sensors.

- **Temperature Sensor (LM35)**

Temperature sensors provide a change in a physical parameter of the output voltage that corresponds to a temperature change. They can be used for measuring temperatures in the environmental and biological range of -50C to +150C.

The system needs to use the LM35 sensor that measures the cellicous degrees and produces 10mV for each one degree. The output voltage of the sensor ranges from 0V to 1V maximum, so amplification has usually needed unless the thermocouple has used for temperature measurement along with a sensitive millivoltmeter. If the output of the thermocouple is required to drive anything more than a meter movement, then DC amplification will be needed, using an operational amplifier as shown in figure 4.2 below.

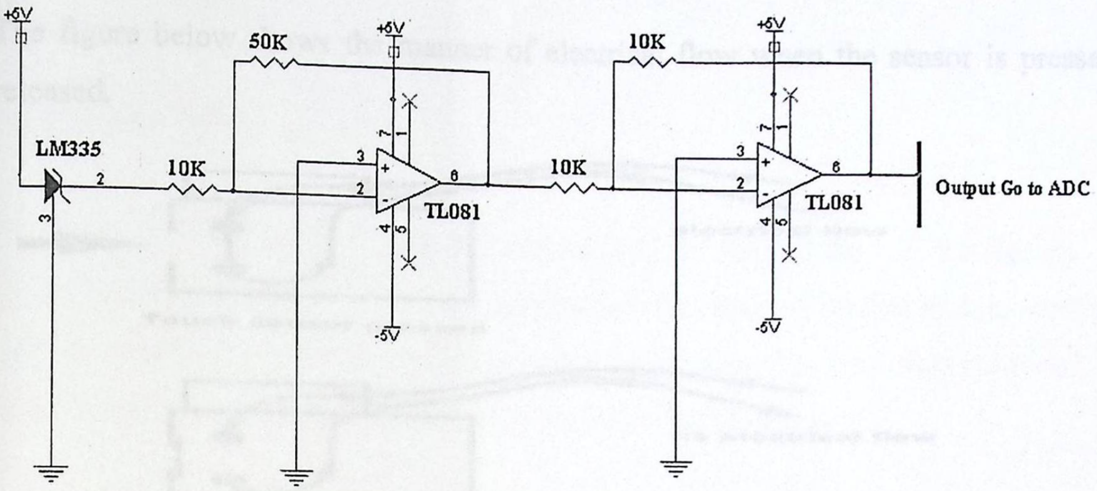

Figure 4.2: temperature sensor circuit.

This figure explains the output signals that are connected to the operational amplifier that is non-inverting one. The signals out from the first amplifier is minus one, and the analog to digital converter don't deal with the minus signal. Since the amplifier is inverting type. Therefore, there's a need to second amplifier to convert this signal and out it to the microcontroller in a positive value.

2. Digital sensors

The second type of sensors is the digital sensors that have the digital output values. They are connected directly with the 8051 input ports to read the voltage values. The cell phone-based system control uses mainly the following types of the digital sensors.

A) Touch Sensor

This sensor detects the objects in the robot's environment. When the button is pressed, an electrical circuit has closed inside the sensor. When the button is released, the circuit is broken and no electricity flows. The RCX can sense this flow of electricity, so it knows if the touch sensor is pressed or released. It returns a 0 when untouched and a 1 when activated. It requires only a slight force to activate them.

The figure below shows the manner of electrical flow when the sensor is pressed or released.

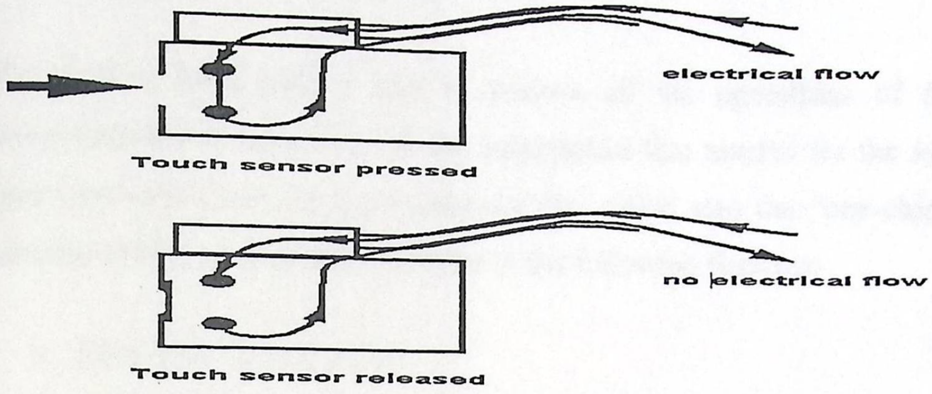

Figure 4.3: The Touch Sensor state.

b) LDR Sensor

LDR (Light Dependent Resistor) sensor is a very simple and useful sensor especially in light/dark circuit to implement if the surrounded area of the toy car is light or dark. Figure 4.4 shows the principle of the LDR and how it works.

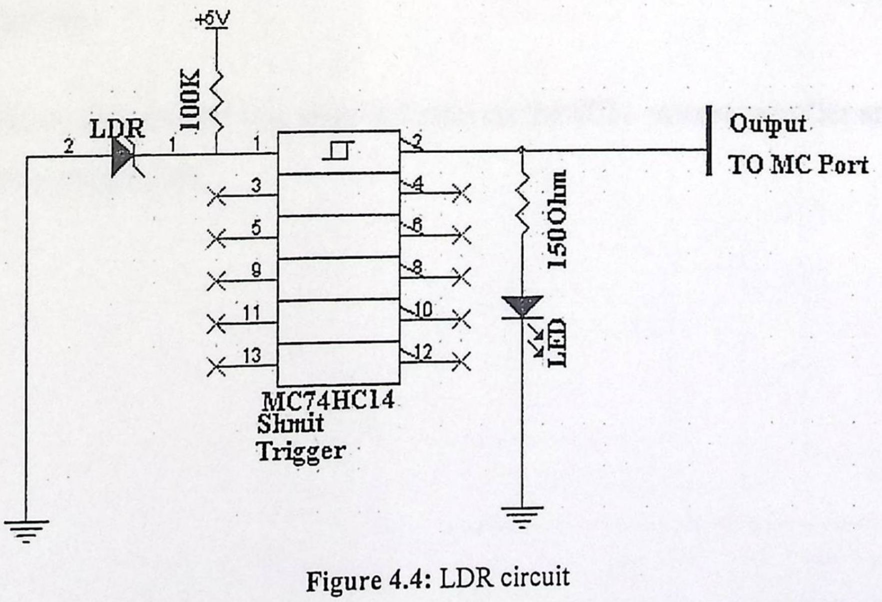

Figure 4.4: LDR circuit

This circuit explains that the LDR resistor decrease as light intensity increases. So to obtain light intensity that the system need it must decrease the resistor because the current pass in low resistor. The output of this sensor connects with an inverter then to the microcontroller ports.

4.2.3 Control Unit

The system need control unit to achieve all the operations of the design. The microcontroller is used since all the components that needed for the system were built right onto one board, so the microcontroller called also the "one-chip solution", The microcontroller used in this system have the following features:

- Intel 8051/52/552 CPU
- 32K RAM
- 32K EPROM
- 8 Channel A/D
- 1 Channel D/A
- 2 x 16LCD Display
- 4 Digital Inputs
- 4 Digital Outputs
- Serial Port.

All previous components has already found on the 8051 microcontroller and shown in the following figure.

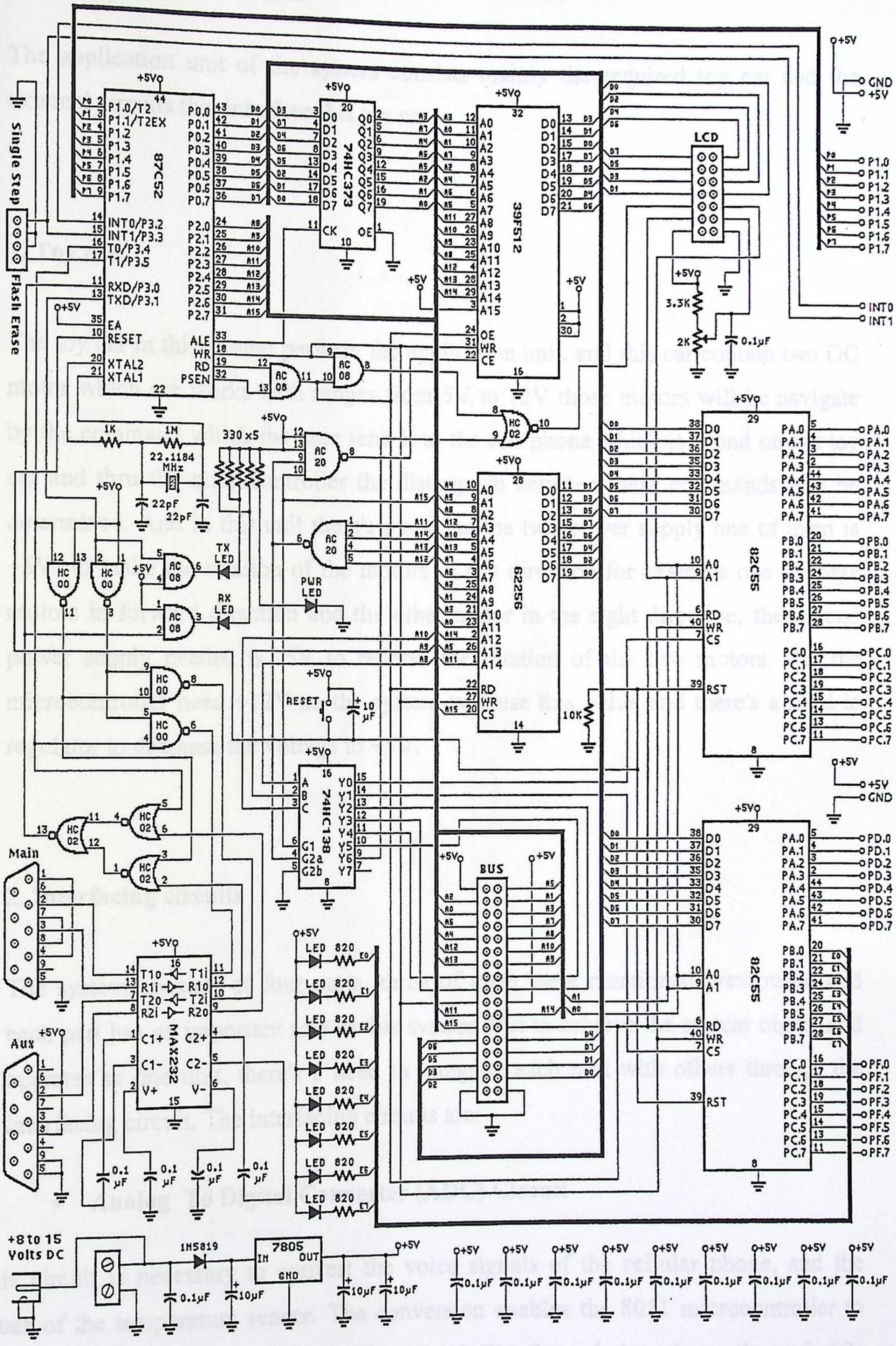

Figure 4.5: The 8051 board.

4.2.4 The Application Unit

The application unit of the system consists mainly the required toy car and the external circuits that interface this toy car.

1. Toy car

The toy car in this system perform the application unit, and this car contain two DC motor which are works with ranges from 5V to 12V those motors will be navigate by the command which the user send it to the cell phone which is found on the toy car and thru the microcontroller the distinguish between these commands will be determined. And in this unit there's a need to the two power supply one of them is +5V to make the rotation of the motors in any direction for example one of these motors in forward direction and the other motor in the right direction, the second power supply needed is -5V to reverse the rotation of the two motors. But the microcontroller need +12V so the system will use this value and there's a need to regulator to decrease the voltage to +5V.

2. Interfacing circuits

The system consists of four parts, three of them were mentioned previously, and each part has an important role in this system. But to achieve the system object and operates as one unit, there's a need to integrate each unit with others through the interfacing circuit. The interfacing circuits are:

- **Analog To Digital Converter (ADC) Circuit**

This circuit is necessary to convert the voice signals of the cellular phone, and the values of the temperature sensor. The conversion enables the 8051 microcontroller to understand the digital code of the coming signal. The figure below shows the main ICs of the circuit.

4.2.4 The Application Unit

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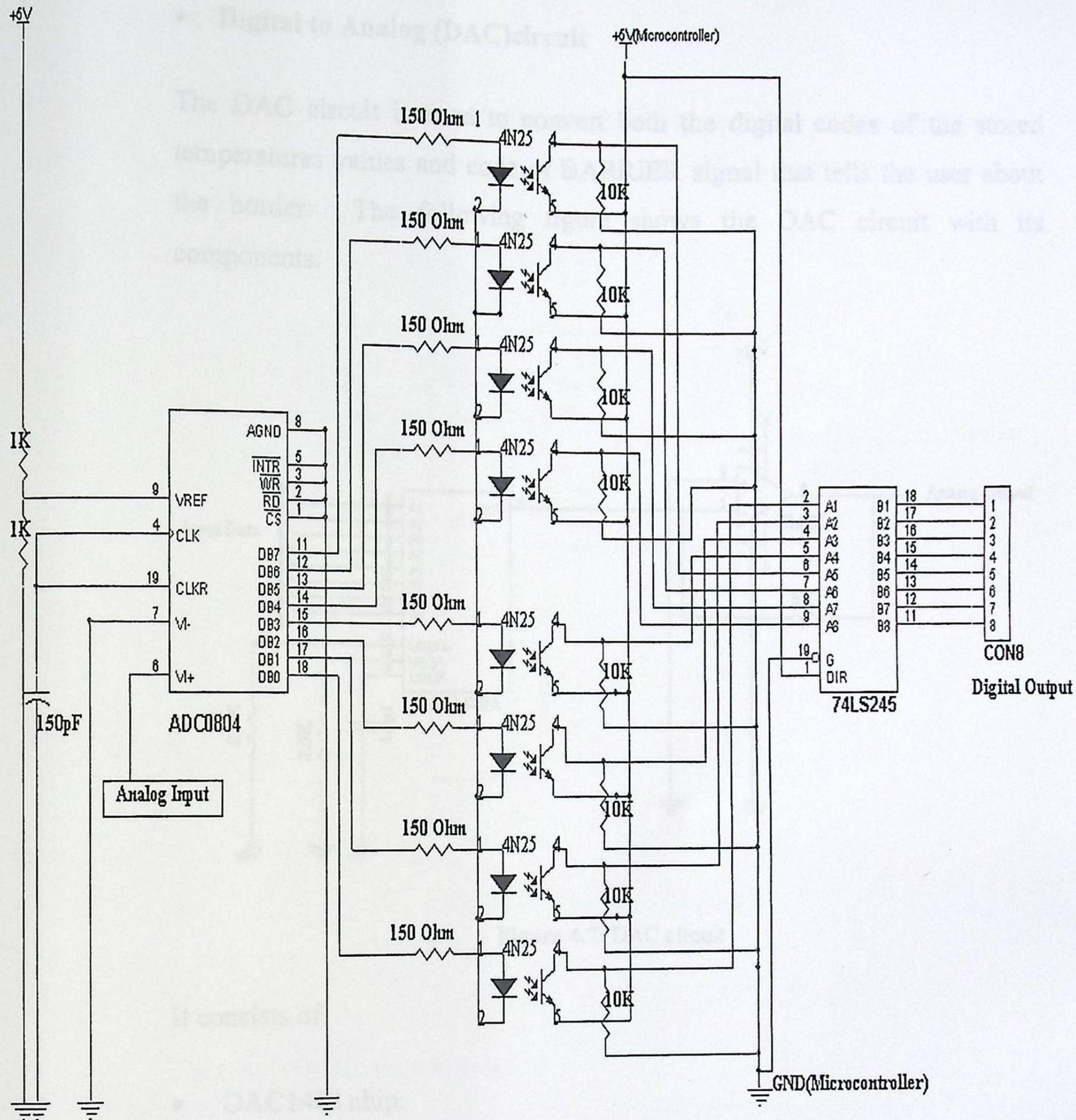

Figure 4.6: The ADC circuit

The ADC consists mainly of:

- 1x 0804ADC
- 8x 4N25 Optocouplers
- 1x 74LS245 Inverter
- 8x 10KΩ Resistors
- 8x 150Ω Resistors
- Voltage supply

- **Digital to Analog (DAC)circuit**

The DAC circuit is used to convert both the digital codes of the stored temperatures values and code of BARRIER signal that tells the user about the border. The following figure shows the DAC circuit with its components.

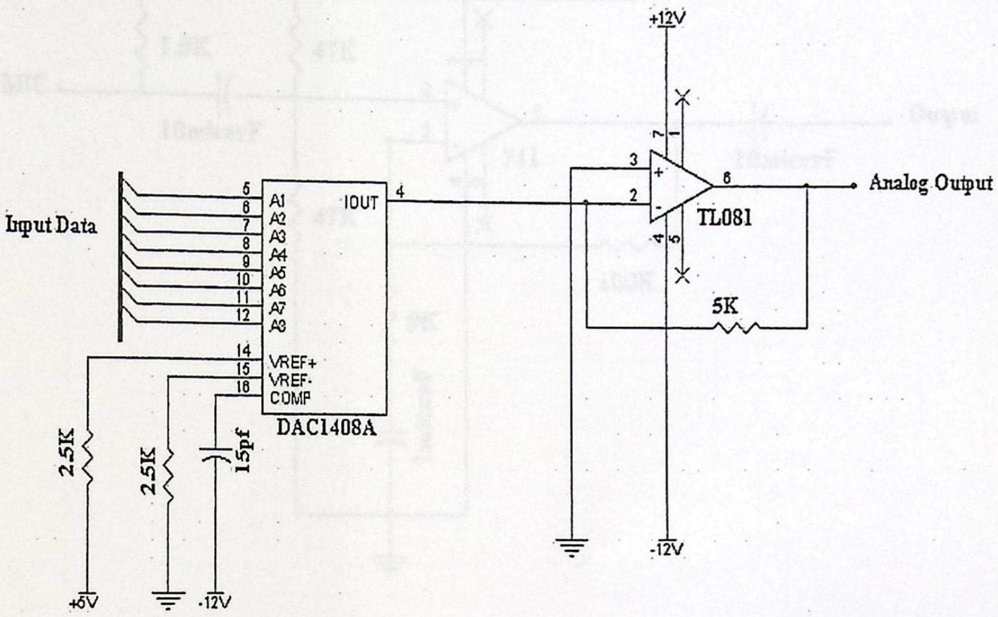

Figure 4.7: DAC circuit

It consists of:

- DAC1408 chip.
- TL081 Amplifier.
- Capacitor
- Resistors
- Voltage supply

The values of the capacitor and resistors are shown in the previous figure.

- **Amplifier circuit**

The system needs this circuit to amplify and enlarges the output signal of the cell phone. This signal in fact represents the voice commands that received from the administrator.

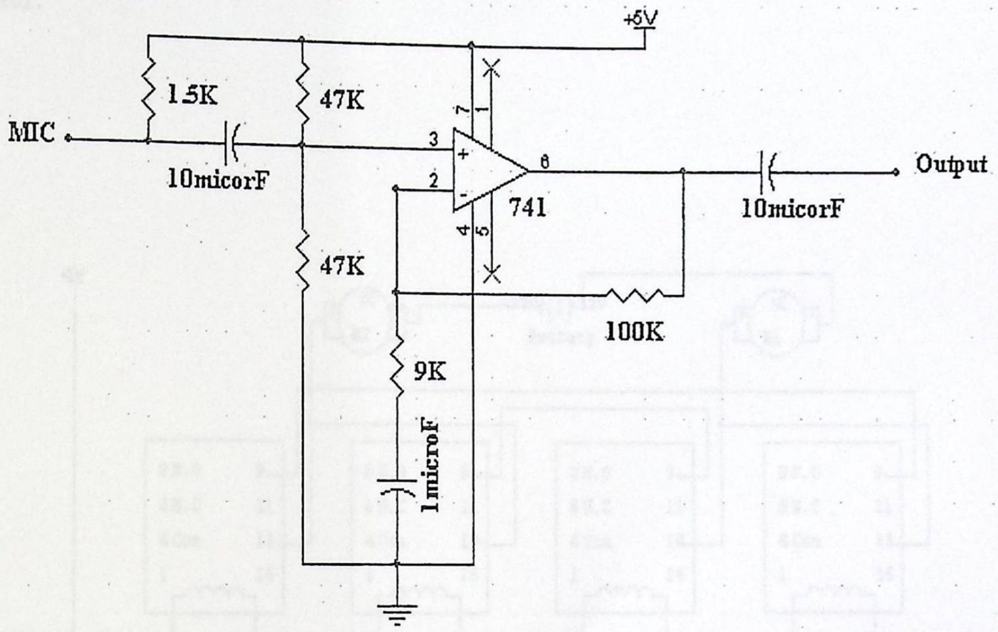

Figure 4.8: The Amplifier circuit.

The amplifier circuit consists of:

- 741 Amplifier
- Capacitors
- Resistors
- Voltage supply

The values of the capacitor and resistors are shown in the previous figure.

- **Relay-Based Directing Circuit**

This circuit interfaces the control unit with the application unit. It switches on the directions according the coming command of the 8051 microcontroller.

The following figure shows the interface operation between the toy car motors and the microcontroller.

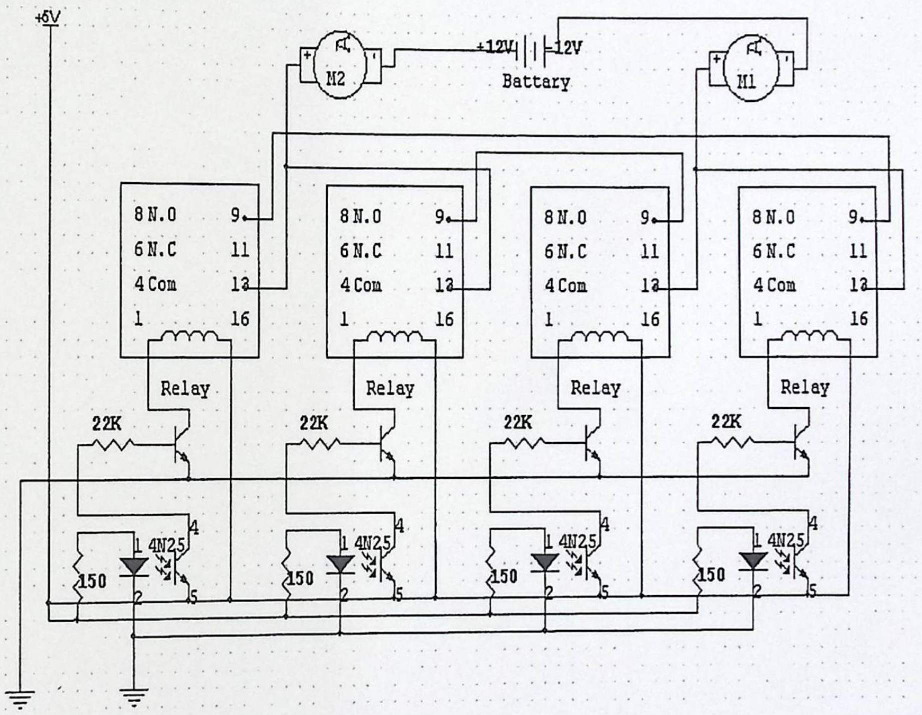

Figure4.9: The Relay-Based Directing Circuit

This circuit consists of:

- 4 Relays (5V)
- 4x 4N25 Optocouplers
- 4x 2N2219 Transistors
- 4x 22KΩ Resistors
- 4x 150Ω Resistors

4.3 The System Design

The system design represents the complete interface between the units-design. Therefore, to control a toy car by the cellular phone the following design has to be built and tested carefully to achieve the needed objects. The complete characteristic of the system is shown below.

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Palestine Polytechnic University
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Acc. 18651 الرقم المتسلسل
Class. رقم التصنيف

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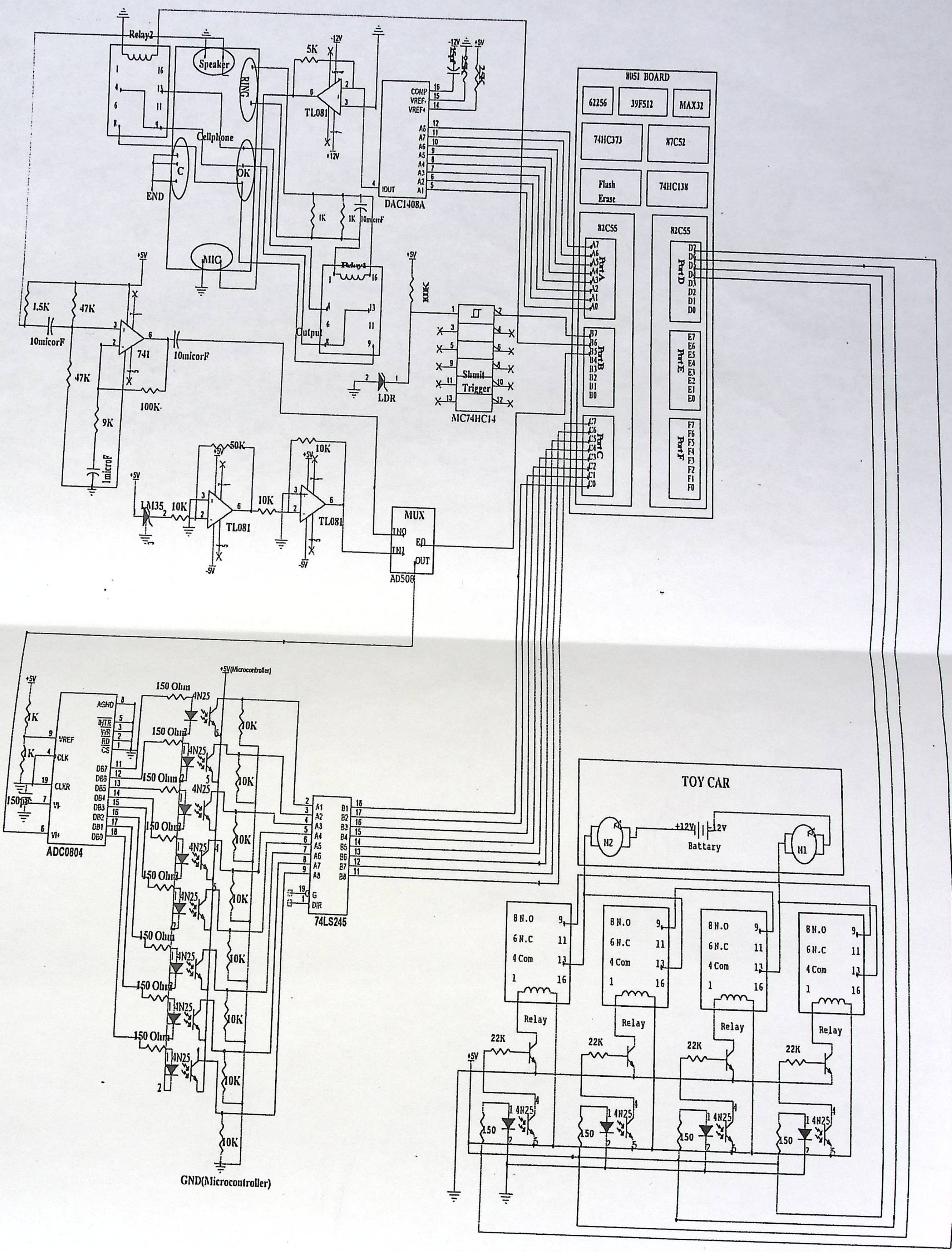

Figure4.10: The System Design Circuit

5

Chapter Five
Software System Design

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Chapter Five

Software System Programming

5.1 Introduction :

In this chapter, the detailed description for the program that will be stored in the EPROM to control the direction of the toy car, sense the surrounded temperature car, and sense the light around the toy car, so all these object can be perform using cell phone.

The programs will be written in the assembly language using the Chip-lab device.

This project, has a control circuit which found on the toy car to receive the command from the user to process those commands and execute it, and the interpret with those command occurs in several cases which will be described using flow chart and software program.

In this chapter, the main parts have to be described by using the flowchart and its software program which is describe what is the main function that will be doing to perform each parts, and these parts can be divided into four parts, they are:

- The Initialization part.
- Receiving command from the client cell phone only, such as GO, RIGHT, LEFT, REVERSE.
- Receiving command and sending data such as TEMP, DARK.
- Sending data to the client cell phone such as the sensor which sense if there is any interrupt or danger.

5.2 Software Requirement Specification

After analyzing all software needs and requirements, the following software functions and modules are needed:

- **Win 95/98/ME/NT/2000/XP Compatible Manager Software**

This system needs these types of windows in order to write all assembler codes on an Text Editor Program, e.g. Notepad, also to used HyperTerminal as a program for transfer the assembler code, where these programs are already found on these windows.

- **HyperTerminal**

HyperTerminal, which comes with Windows95, 98, Me, NT, 2K & XP can be used to obtain information from any external device such as microcontroller or modem, or to send any data or information to these external devices; where it can be used to get information from your external device. Also it can be used to Set up, format, memory access and erased memory for any external device.

In this system there is a need for this program to dial up the connection between PC and the 8051 microcontroller, where this program is used to transfer all programs that will be writing in assembler language via serial cable to the 8051 microcontroller, but first we need to understand how to setup this program on your PC according to 8051 microcontroller.

To Setup the connection of the HyperTerminal, the following procedures should be performed:

1. Click on HyperTerminal icon which found in the programs file on your PC then you will see the Connection Description screen as shown in the figure below.

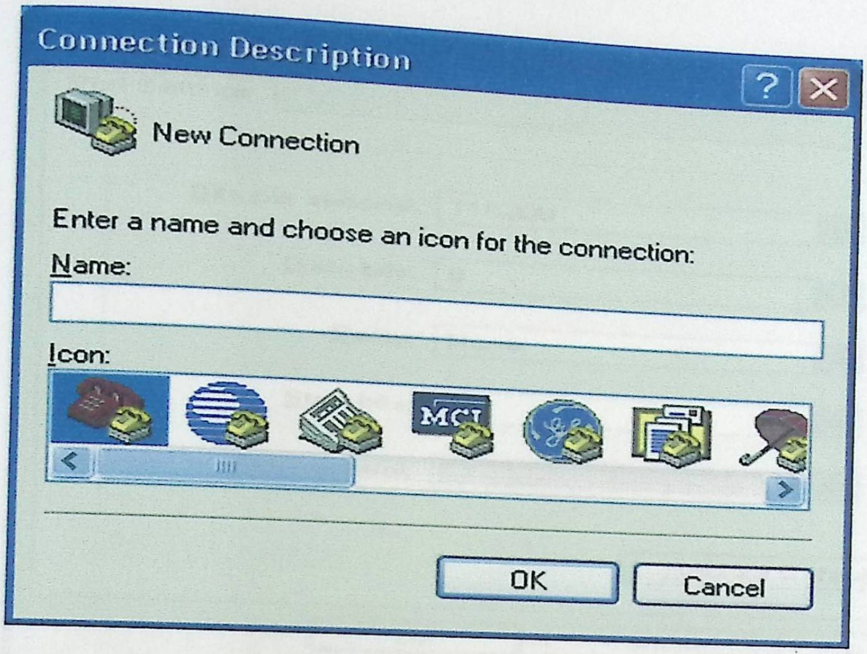

Figure 5.1: Connection Description screen

2. Put the name of the connection and choose COM1 or COM2 dependent where serial cable is connected then you will see the Connect to screen as shown in the figure below.

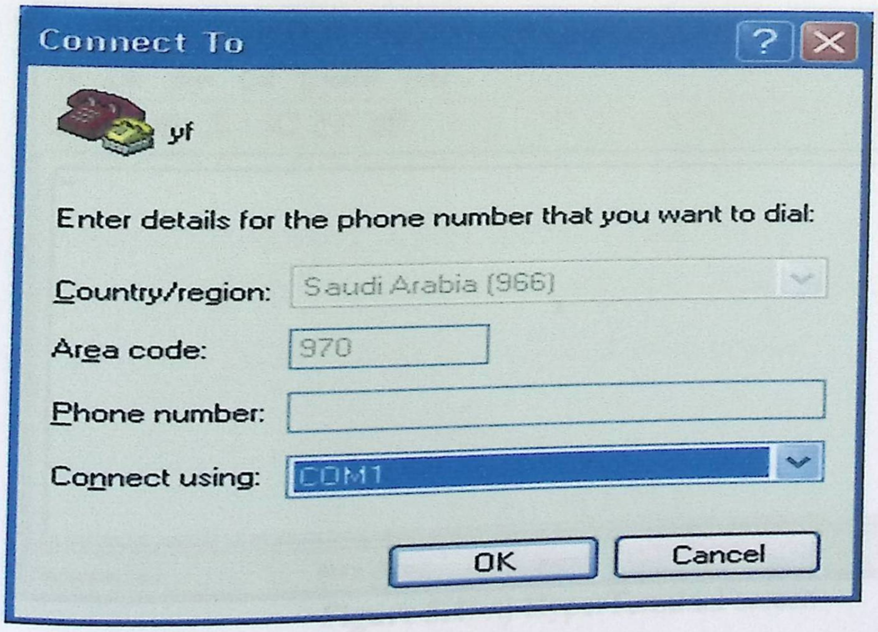

Figure 5.2: Connect To screen

3. Type any country/region, area code, phone number, and connection in the previous screen then you will see the COM1 Properties screen as shown in the figure below.

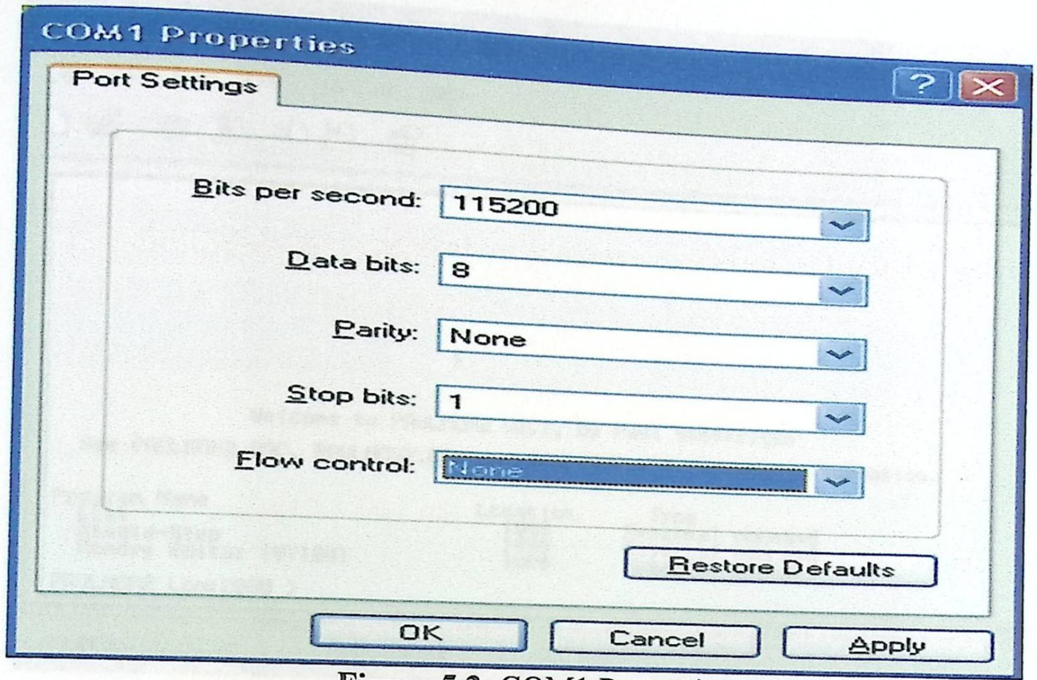

Figure 5.3: COM1 Properties

4. Choose 115200 for bits per second, 8 bits for data bits, 1 bit for stop bits and none for flow control also press on OK icon in the previous screen then you will see the rtj-HyperTerminal screen as shown in the figure below.

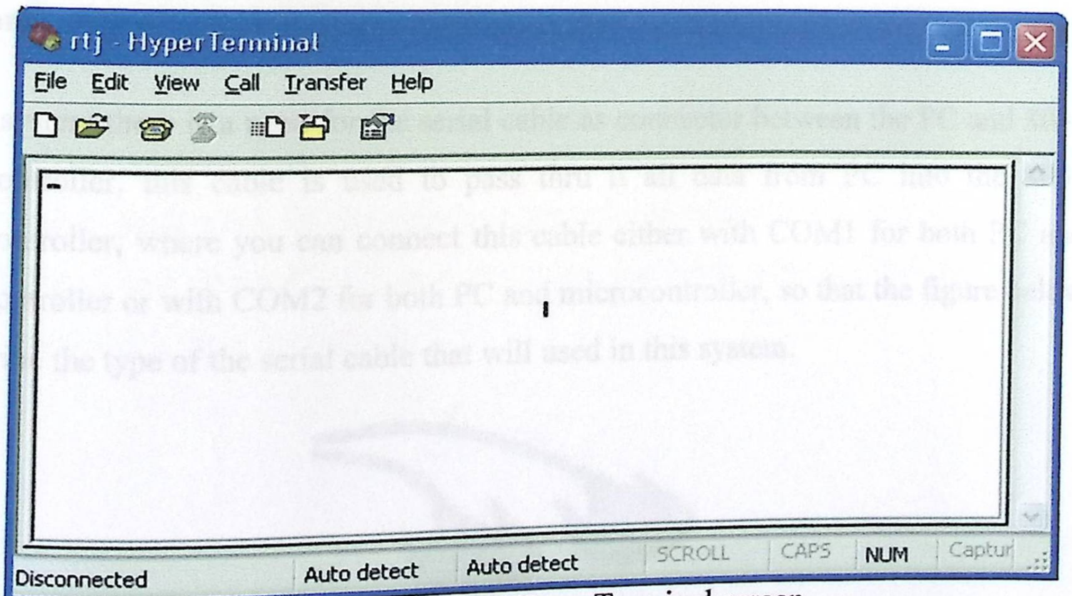

Figure 5.4: rtj-HyperTerminal screen

5. press enter to dial up the connection between the HyperTerminal program and the 8051 microcontroller then you will see the following screen:

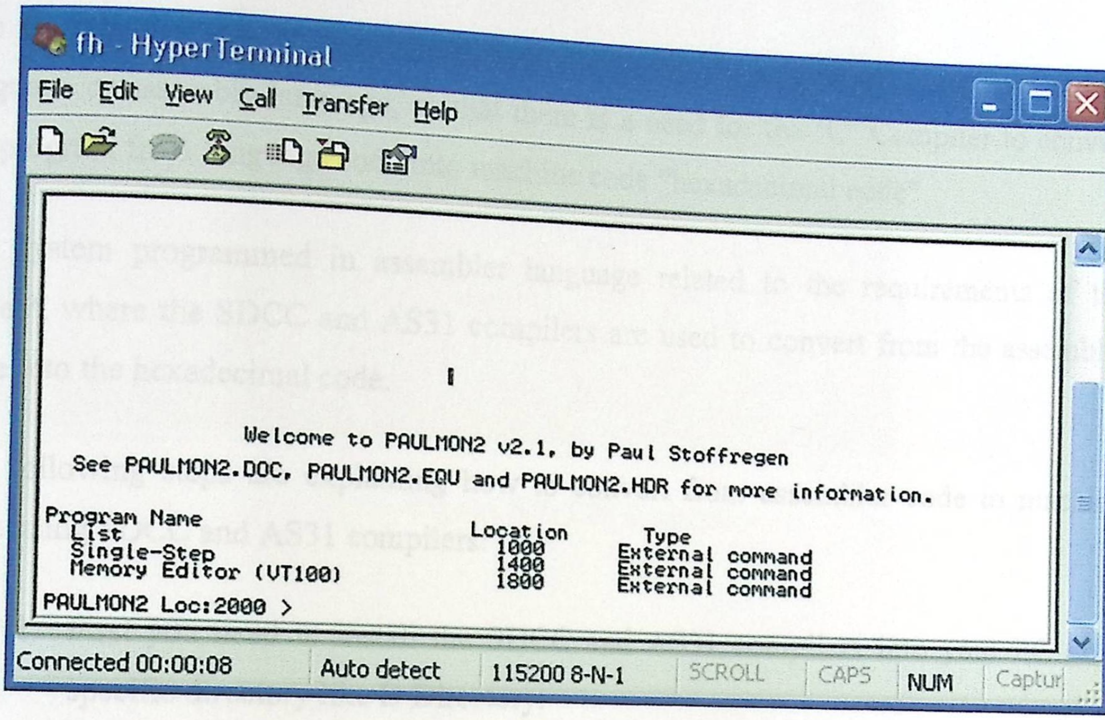

Figure 5.5 Dial up screen

After performed all the previous stages the connection will dial up between the PC and the 8051 microcontroller.

- **Standard 9 pin serial cable (straight through)**

In this system there is a need for the serial cable as connector between the PC and 8051 microcontroller, this cable is used to pass thru it all data from PC into the 8051 microcontroller, where you can connect this cable either with COM1 for both PC and microcontroller or with COM2 for both PC and microcontroller, so that the figure below is describe the type of the serial cable that will used in this system.

Figure 5.6 serial cable

- **Assembler or 'C' Compiler, usually AS31 or SDCC.**

The 8051 microcontroller programming is deal with the hexadecimal code of the C-language or assembly language, so that there is a need for the 'C' Compiler to convert the program from language code into machine code "hexadecimal code".

The system programmed in assembler language related to the requirements of the project, where the SDCC and AS31 compilers are used to convert from the assembler code into the hexadecimal code.

The following steps are explaining how to convert from assembler code to machine code using SDCC and AS31 compilers:

1. First you need to install the SDCC and AS31 compilers into your PC on a specific directory like D Directory.
2. Install the autostart program into your PC on the same specific directory like D Directory.
3. Go to CMD screen "black screen" then go to the specific directory which found the SDCC compiler.
4. Type cd sdcc then press enter.
5. Type cd bin then press enter.
6. Type as31 d:\name of the assemble program.ASM then press enter.

After performed all the previous procedures successfully you will see (Begin Pass1 and Begin Pass2) as a result on the black screen. The figure below is describing these procedures.

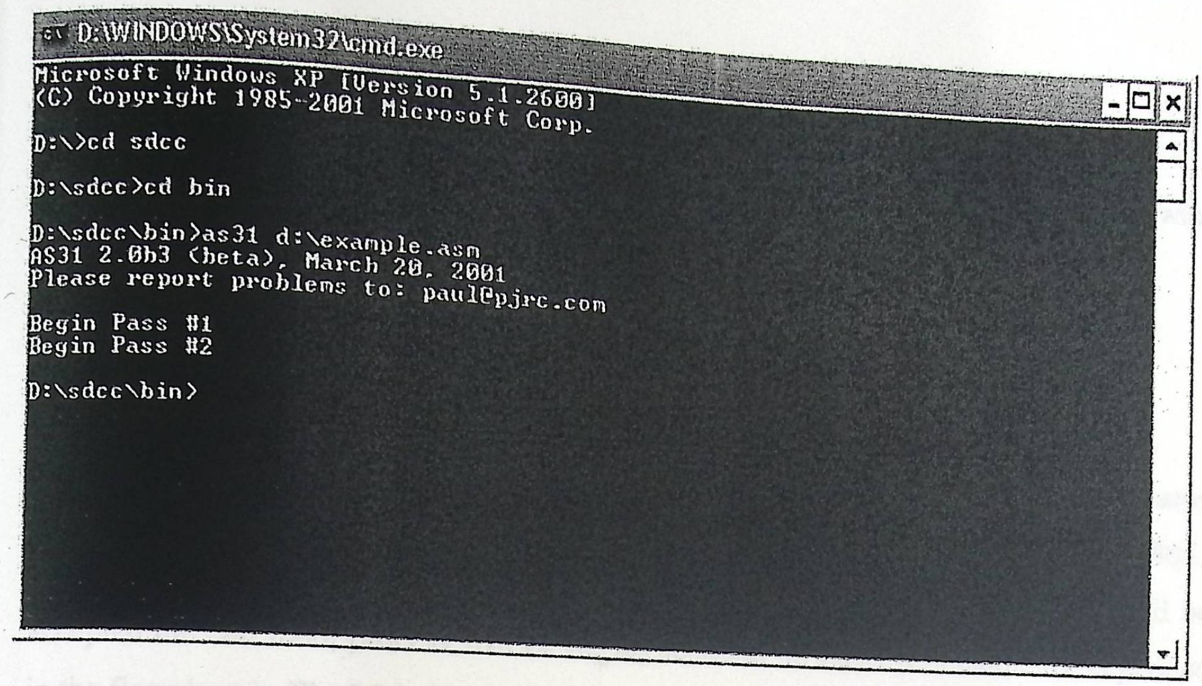

Figure 5.7: CMD screen

- **Text Editor Program, e.g. Notepad**

There is a need for an Editor Program like Notepad in order to write all assembler programs on the notepad program, where you shall save any assemble program with extension .ASM on a specific directory and after compile this program a new hexadecimal program will save on the same specific directory, where the hexadecimal code will send to the microcontroller via serial cable.

- **DC Voltage, 8 to 15 volts (regulated)**

The 8051 microcontroller is work with 12 DC voltages, so that the DC Voltage, 8 to 15 volts (regulated into 12 volts) is need as a power supply.

5.3 Receiving User Commands

After creating the communication channel between the two cell phones, the following commands can be issued:

5.3.1 GO Command

The system needs to move the toy car forward direction, in order to perform this matter we will send a command from a portable cell phone to the toy car under 8051 microcontroller controlling, then another cell phone which is built on toy car will be accepted the call then, process will be begin, however all these procedure are explained in the flowchart in **Fig.5.2** below and its software programming.

- **Algorithm of moving the toy car forward:**

```
Begin call
    If (Length (command code) = = Length (GO code))
                Begin
                    Response the command
                    Send code signal to output port
                    Execute the code
                End
    Else
        Call other function
    End if
End process.
```

- **Code Sub-Program**

```
mov a,#0x02
subb a,r1
jnc test ;if the length of the code is greater than 2 hex then continue
mov a,#0x12
subb a,r1
jc test ; if the length of the code is less than12 hex then jump to move car forward
```

- **Flowchart:**

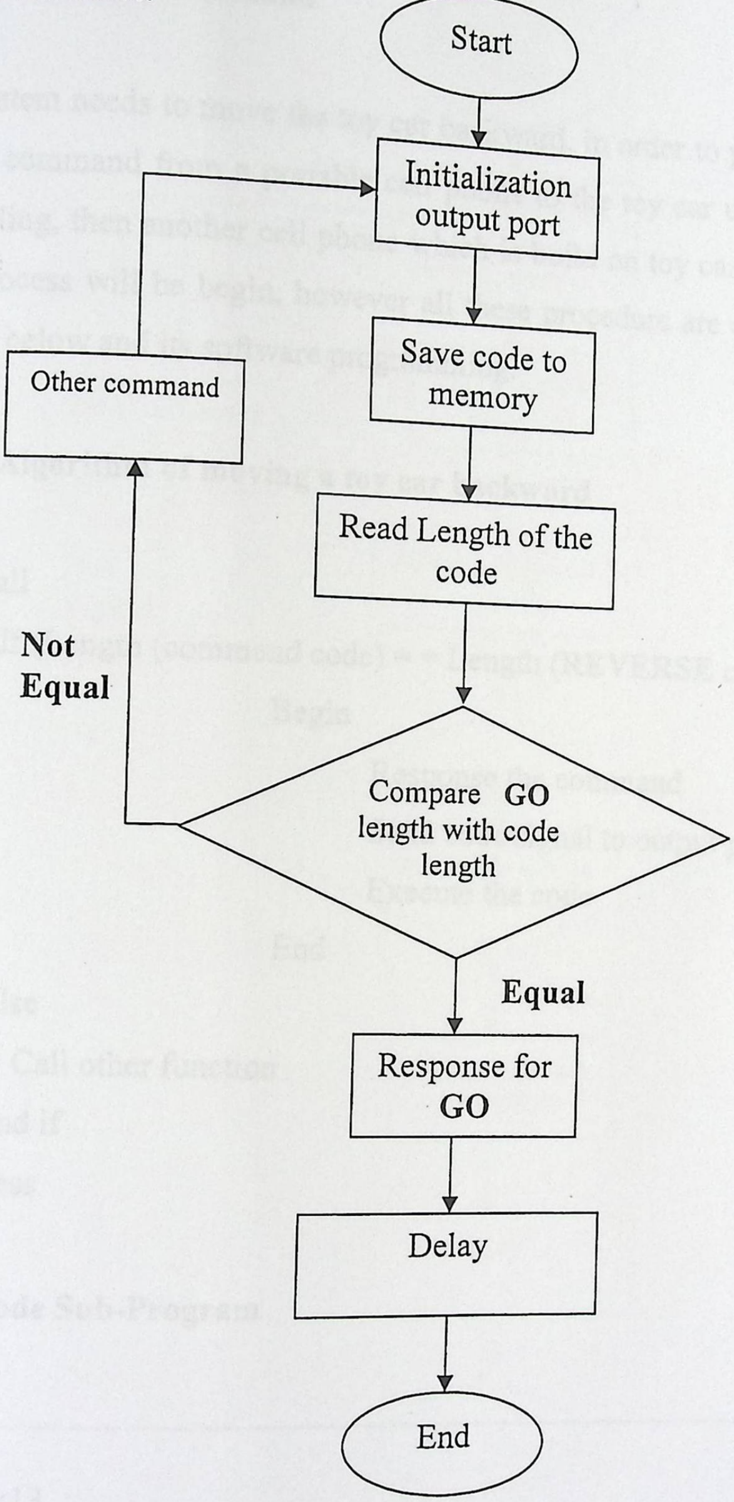

Figure5.8: Flowchart of GO command

5.3.2 REVERSE Command

The system needs to move the toy car backward, in order to perform this matter we will send a command from a portable cell phone to the toy car under 8051 microcontroller controlling, then another cell phone which is build on toy car will be accepting the call, then process will be begin, however all these procedure are explain in the flowchart in **Fig.5.3** below and its software programming.

- **Algorithm of moving a toy car backward**

Begin call
    If (Length (command code) = = Length (**REVERSE** code))
        Begin
            Response the command
            Send code signal to output port
            Execute the code
        End
    Else
        Call other function
    End if
End process

- **Code Sub-Program**

```
mov a,#0x13
subb a,r1
jnc test ;if the length of the code is greater than 13 hex then continue
mov a,#0x25
subb a,r1
jc test ; if the length of the code is less than 25 hex then jump to move car reverse
```

- **Flowchart**

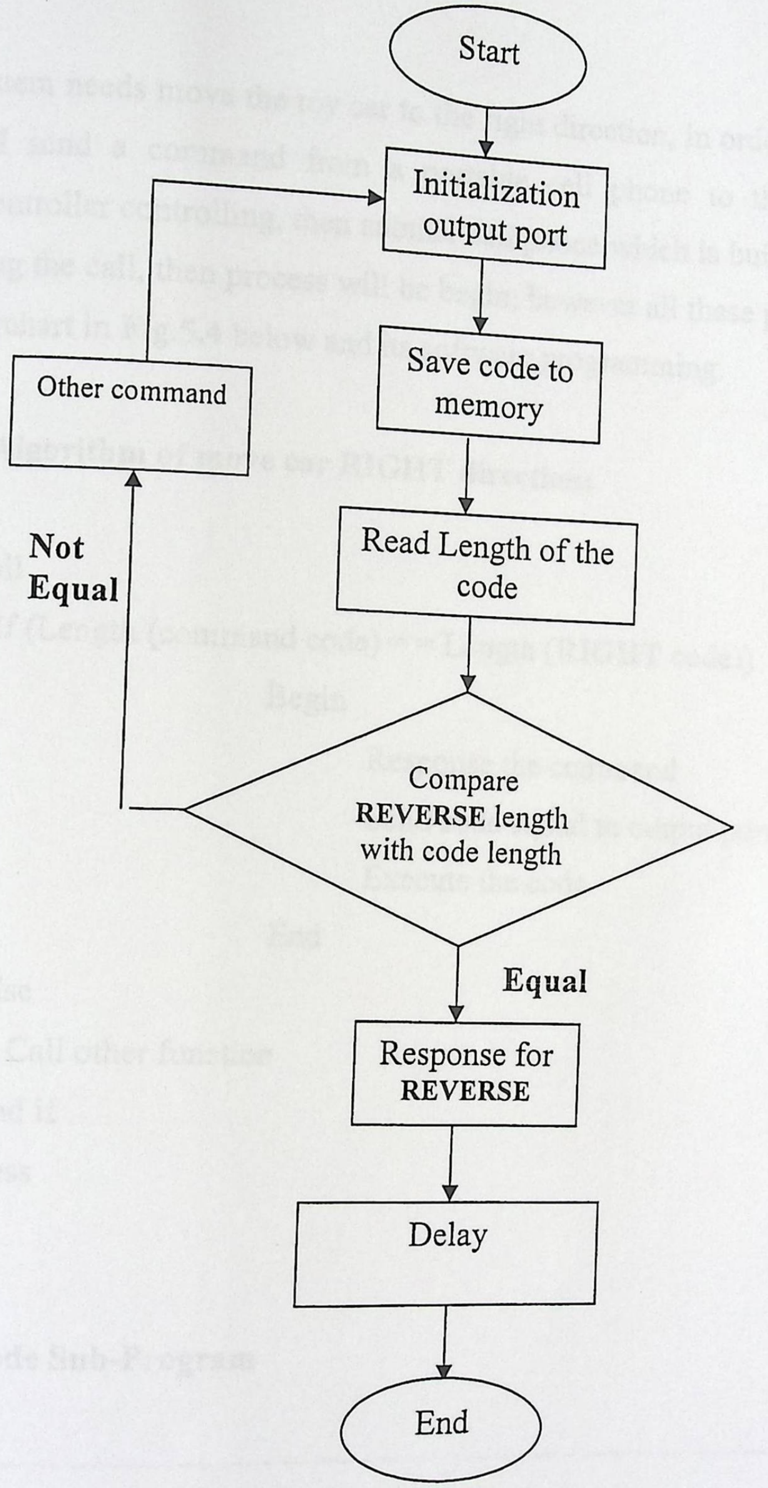

Figure5.9: Flowchart of **REVERSE** command

5.3.3 RIGHT Command:

The system needs move the toy car to the right direction, in order to perform this matter we will send a command from a portable cell phone to the toy car under 8051 microcontroller controlling, then another cell phone which is build on the toy car will be accepting the call, then process will be begin, however all these procedure are explain in the flowchart in **Fig.5.4** below and its software programming.

- **Algorithm of move car RIGHT direction:**

```
Begin call
        If (Length (command code) = = Length (RIGHT code))
                        Begin
                                Response the command
                                Send code signal to output port
                                Execute the code
                        End
        Else
            Call other function
        End if
End process
```

- **Code Sub-Program**

```
mov a,#0x26
subb a,r1
jnc test ;if the length of the code is greater than 26 hex then continue
mov a,#0x40
subb a,r1
jc test ; if the length of the code is less than 40 hex then jump to move car right
```

- **Flowchart:**

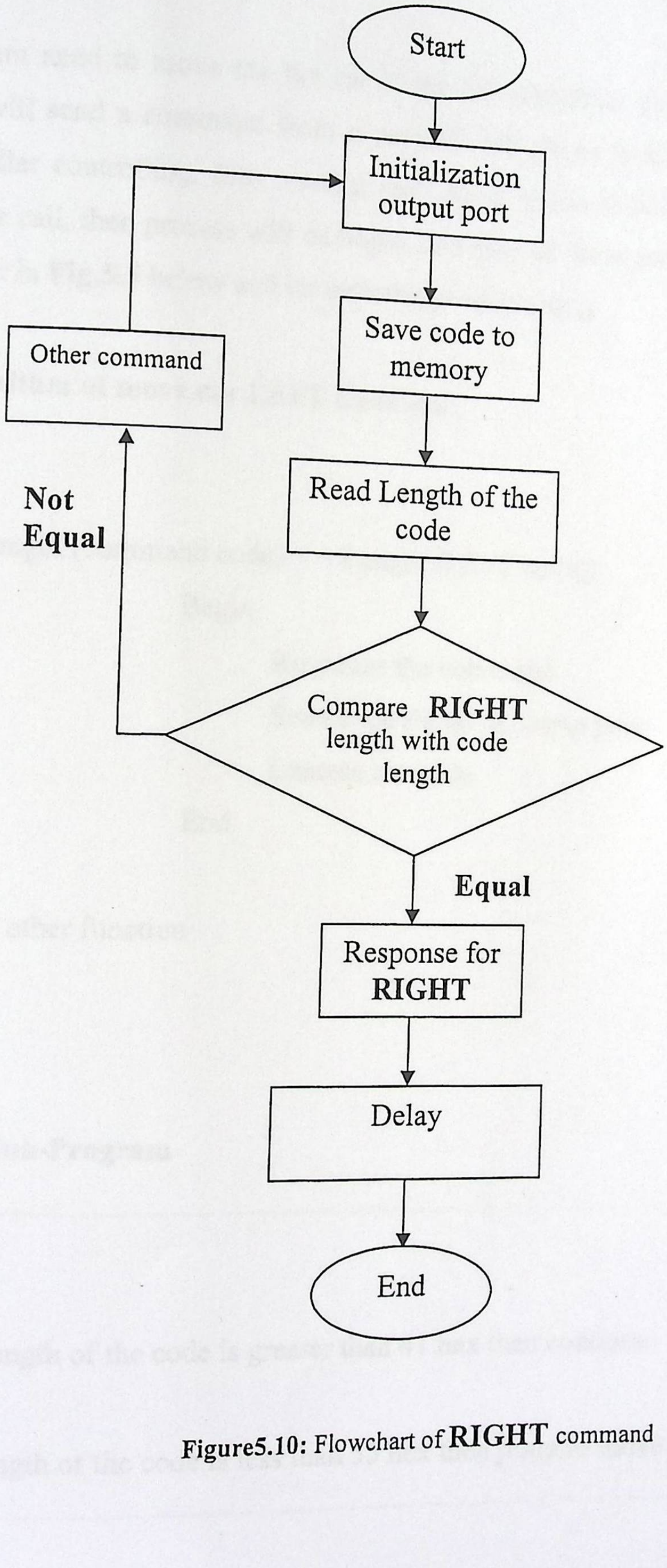

Figure5.10: Flowchart of **RIGHT** command

5.3.4 LEFT Command:

In this system need to move the toy car to the left direction, in order to perform this matter we will send a command from a portable cell phone to the toy car under 8051 microcontroller controlling, then another cell phone which is build on toy car will be accepting the call, then process will be begin, however all these procedure are explain in the flowchart in **Fig.5.5** below and its software programming.

- **Algorithm of move car LEFT direction:**

```
Begin call
    If (Length (command code) = = Length (LEFT code))
            Begin
                Response the command
                Send code signal to output port
                Execute the code
            End
    Else
        Call other function
    End if
End process
```

- **Code Sub-Program**

```
mov a,#0x41
subb a,r1
jnc test ;if the length of the code is greater than 41 hex then continue
mov a,#0x55
subb a,r1
jc test ; if the length of the code is less than 55 hex then jump to move car left
```

- **Flowchart:**

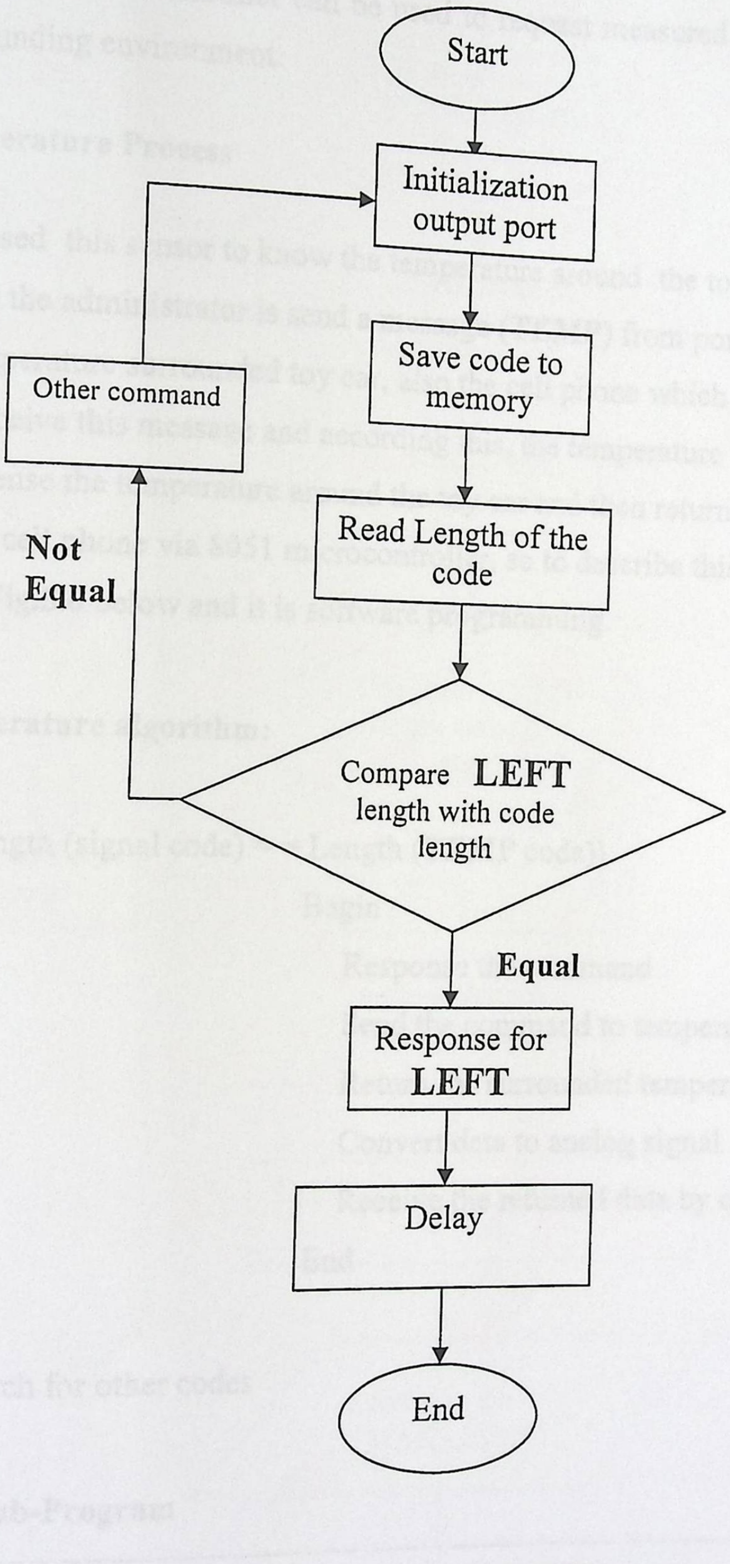

Figure5.11: Flowchart of LEFT command

5.4 Requesting Environmental Data

The cell phone-based controller can be used to request measured parameters from the toy car surrounding environment.

5. 4.1 Temperature Process

The system used this sensor to know the temperature around the toy car, so this sensor is work when the administrator is send a message (**TEMP**) from portable cell phone to know the temperature surrounded toy car, also the cell phone which is found on the cell phone will receive this message and according this, the temperature sensor will be activated to sense the temperature around the toy car and then return this value to the administrator cell phone via 8051 microcontroller, so to describe this operation see the flowchart in **Fig.5.6** below and it is software programming.

- **Temperature algorithm:**

Begin call

If (Length (signal code) = = Length (**TEMP** code))

Begin

Response the command

Send the command to temperature sensor

Return the surrounded temperature

Convert data to analog signal

Receive the returned data by cell phone client

End

Else

Search for other codes

End process

- **Code Sub-Program**

```
mov a,#0x56
subb a,r1
jnc test ;if the length of the code is greater than 56 hex then continue
mov a,#0x70
subb a,r1
jc test ; if the length of the code is less than 70 hex then jump to sense the temperature around toy car
```

- **Flowchart**

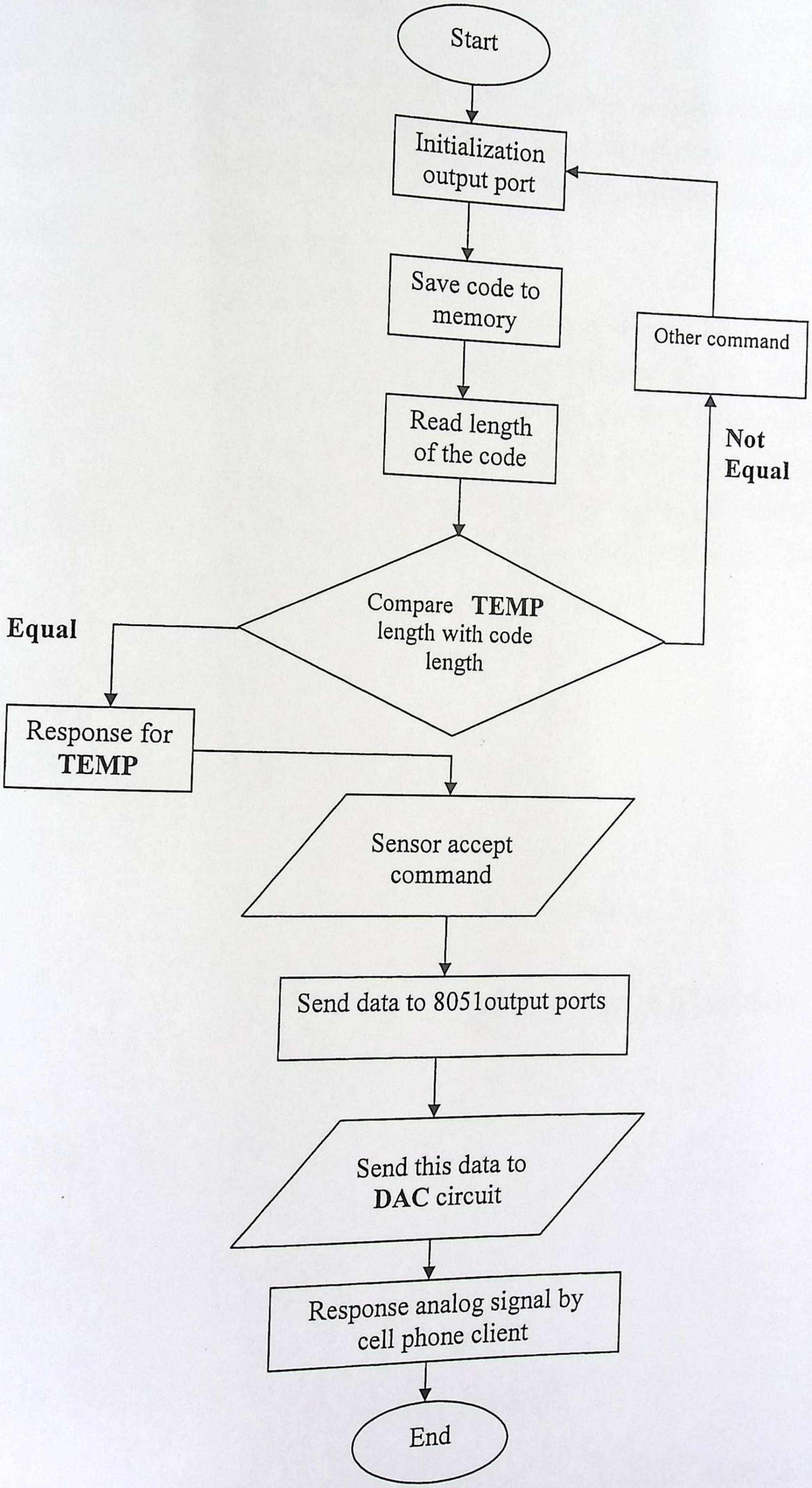

Figure5.12: Flowchart of **TEMP** command

5.4.2 Automatic Emergency back call

There are couples of automatic process in this project. The automatic process will send directly data or information when something happens; some of these cases are the LDR Sensor, where this sensor will send directly a feedback data to an external device.

Light Dependent Resistor (LDR) Sensor

The system need LDR Sensor in order to know if the area around the toy car is light or darkness, so this sensor is work when the administrator is send a message from portable cell phone to know that there are sunshine or dark surrounded the toy car, also this message will received by other cell phone which it is build on the toy car then the LDR sensor will sense if the surrounding area is sunshine or dark then replay the result to the administrator cell phone, so to describe these operations, the flowchart Figure 5.7 below and it is software programming is used.

- **Light/Dark algorithm:**

```
Begin call
        If (Length (signal code) = = Length (DARK code))
                                Begin
                                    Response the command
                                    Send the command to sunshine sensor
                                    Return the result
                                    Receive the returned data by cell phone client
                                End
        Else
            Search for other codes
End process
```

- **Code Sub-Program**

```
mov a,#0x71
subb a,r1
jnc test ;if the length of the code is greater than 56 hex then continue
mov a,#0x80
subb a,r1
jc test ; if the length of the code is less than 70h; then jump to sense the temperature around toy car
```

- **Flow chart:**

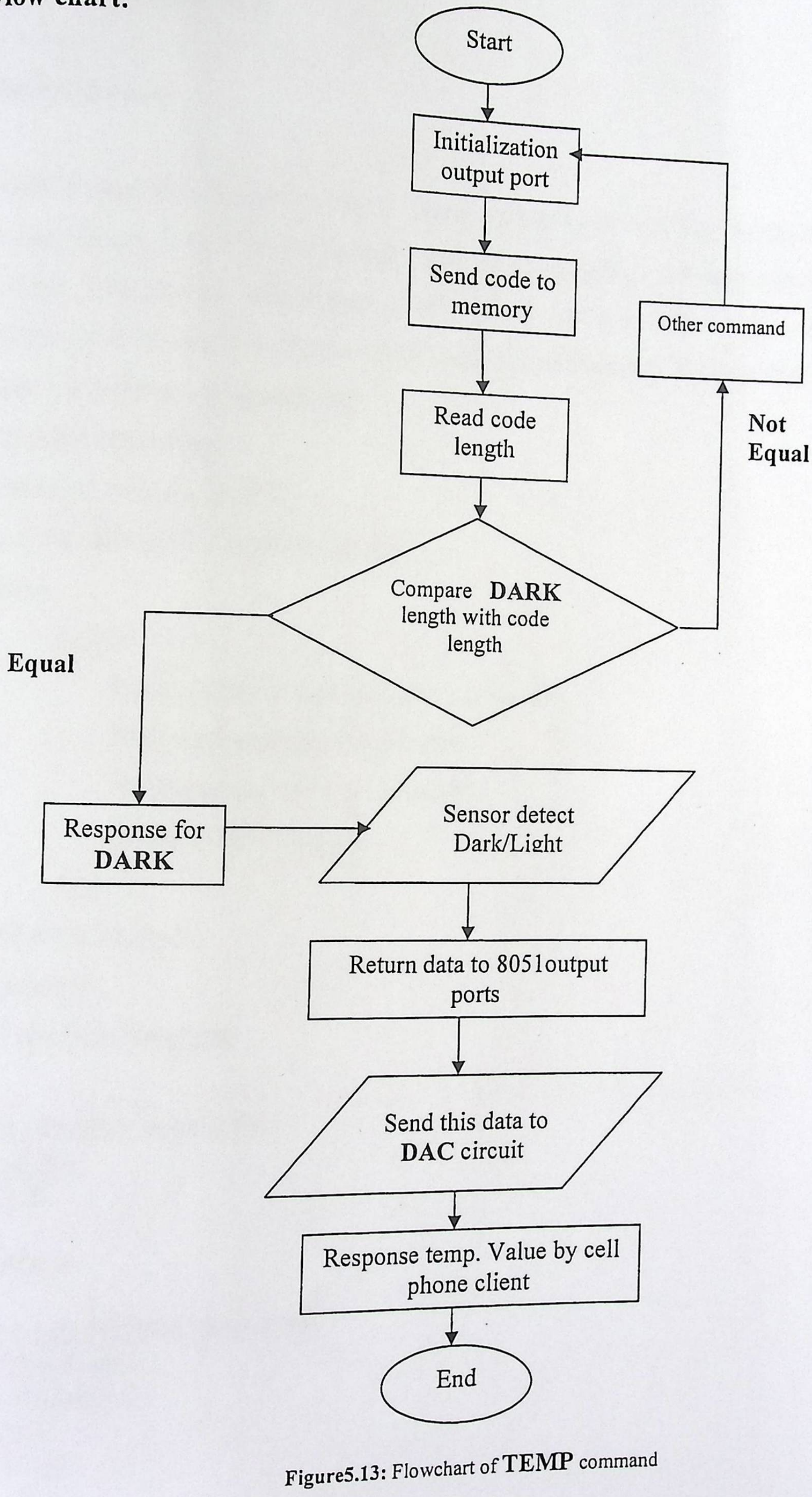

Figure5.13: Flowchart of **TEMP** command

5.5 Sending Command Only

5.5.1 Border Sensor

The system is used this sensor in order to check the border around the toy car, that it is mean when the car is motion and found a wall then this sensor can send a message to the portable cell phone "administrator cell phone" or any other object and the administrator will be response to this request and then will deal it, flow chart in Fig.**5.8** below and it is software programming.

- **Border algorithm**

Initialize an output port (PF)

Detect the data on the output ports (PF)

If (data)

Begin

Send request to administrator cell phone

Wait until command is received

Response the coming command

Execute the command

End if

Continue the motion

End process

- **Code Sub-Program**

```
Mov dptr,#0xf902, declare PF
Movx a,@dptr
Anl a,#0xff
Jz  nop
Mov r0,#0x03
Next:
     Mov dptr,#0xf900, declare PE
     Movx a,#0x01
     Movx @dptr,a
     Dec r0
     Mov a,r0
     Jnz next
```

- **Flow chart:**

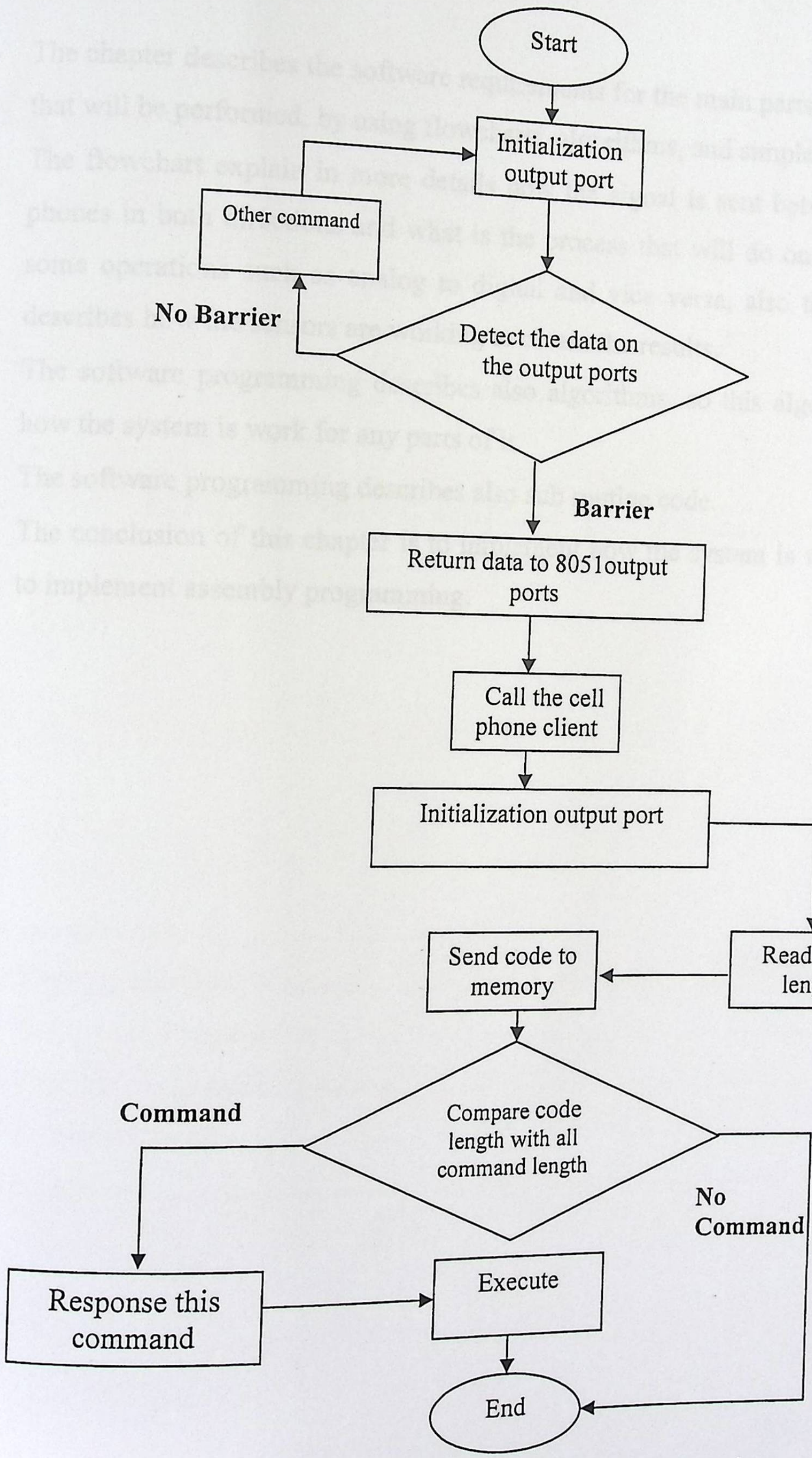

Figure5.14: Flowchart of **Barrier** command

5.6 Summary

- The chapter describes the software requirements for the main parts of the project that will be performed, by using flowcharts, algorithms, and simple code.
- The flowchart explain in more details how the signal is sent between two cell phones in both directions and what is the process that will do on it to perform some operations such as analog to digital and vice versa, also the flow chart describes how the sensors are working to obtain the results.
- The software programming describes also algorithms, so this algorithm shows how the system is work for any parts of it.
- The software programming describes also sub routine code.
- The conclusion of this chapter is to implement how the system is work in order to implement assembly programming.

6

Chapter Six
Implementation & Testing

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Chapter six

Implementation and Testing

6.1 Introduction

This chapter describes the whole parts of the system that had implemented and tested successfully. An implementation has done for each unit separately and prepared to present its formal work. Then a list of testing has been done for each unit to put it in its final manner. The system has been tested to emphasize operating correctness . The interface was done between those circuits and the main brain of the project which is the 8051 microcontroller.

The interface of the system was controlled by the human voice using a cellular phone on the toy car as an environment of sending and receiving commands.

6.2 Toy-Car Navigation

One of the main parts of the project is a toy car. The needed toy car has to have set of requirements. These requirements are represented in the control media. A prepared car passes through several steps to be ready for navigation. These steps are:

1. Purchase the toy car

Remote control toy cars are hardly available in the local markets. This is governed by the political situation. The specifications of the toy car were hardly founded, so we took a lot of time searching for these specifications.

2. The toy car Requirement Specifications

The purchased car has met the project requirements. It consists of two (nearly 12V) DC motors for controlling the four directions. In addition, a receiver circuit that receives wave signals from the transmitter circuit of the remote control. It consists also leds that indicates the directions of the car. The car has a 9.6V DC battery that supplies the motors with the operation power. Its switch is used to turn on /off the system.

Figure 6.1: The real Toy car remote control

This system uses a toy car that has already main features of remote control. In fact it consists of a transmitter and receiver circuits that can be navigated by a remote control technology. We cut the transceiver circuits off and isolated the car from the control media to use our own controlling technology by using human-voice recognition.

Figure 6.2: The Toy car after change

The first circuit had been done to explain and confine the principle work of the toy car directions by controlling its motors. The DC motors of the toy car were prepared to navigate the car directions. It has two DC motors; one of them is used to control both forward and backward directions. The other is used to control both right and left directions. The test was done by using two DC power supplies, these sources supply motors with +5V for forward and right directions, and -5V for backward and left directions. The testing and navigating of the car was done without the cell phone. It was tested by using switch circuits on the bread board. The switching circuit has four switches, each one was a button to control a separate direction. Since the forward and backward were operated from the same motor and also the right and left directions were operated from the same motor, we took our whole care when using the switches. No two directions from the same motor must be operated in the same time since a pulse of +5V and -5V would be shorted down and attacked the motor. While operating two directions from two different motors causes no problem, as to operate right and forward in the same moment.

6.3 Cell-Phone Preparation

The system uses the cellular phone as a communication media of the toy car. It uses two cellular phone communications for sending and receiving the needed commands of navigation.

1. Purchasing the Cell-phone

The main interest was directed towards the cellular phone of the toy car. This cellular phone was cut off its internal connections of Speakers, Microphone, Ring, and both OK & C buttons of opening and closing connection, respectively. This process had been done under accurate treatment and special equipments that used to connect the internal dots of buttons with external wire rapping. The OK and END buttons have several internal constructors, some of them have two lines, and others have three lines to complete the operation. The cellular phone of the project has three internal lines for OK and END buttons. They were carefully connected with wire-rapping to do their tasks.

2. Amending Cell phone

The cell phone's OK and ENDing buttons are cut off and prepared to communicate directly with the client without any human hand. This process requires the building of special circuits that can perform the task.

- **The OK-Ring Connection**

This circuit contains a 5V Relay, 10μF capacitor and 0.5KΩ resistor. The ring lines are connected to the coil of the relay. This relay will pulse a signal with the first tune of ring. The ring-signal represents 2.7 DC voltage that will short the relay's coil to pass the pulse to sides of the OK button. The resistor is used to delay the second pulse of ring-voltage and the capacitor discharged these pulses. The first tune will communicate the cell phone with the client's phone.

The values of the capacitor and resistor were earned after several tests. The complexity appeared in the communication part. After implementing the required cell phone unit we tested it experimentally.

After the first tune, the ring signals will be cut off and the cell phone will be ready to pass come/back signals from/to administrator cell phone.

- **The OK-Microcontroller Connection**

The other circuit is built to receive the output port signal of the microcontroller. This signal is loaded by a 3.6V voltage that will operate the relay. Through software this signal will be repeated three times within 2 seconds each time. This repetition is done to suite the contracture of the cell phone and allows giving three pulses to OK button in order to dial up the stored code-number of the admin-cellular phone. This connection will tell the client about the barrier founded in its path.

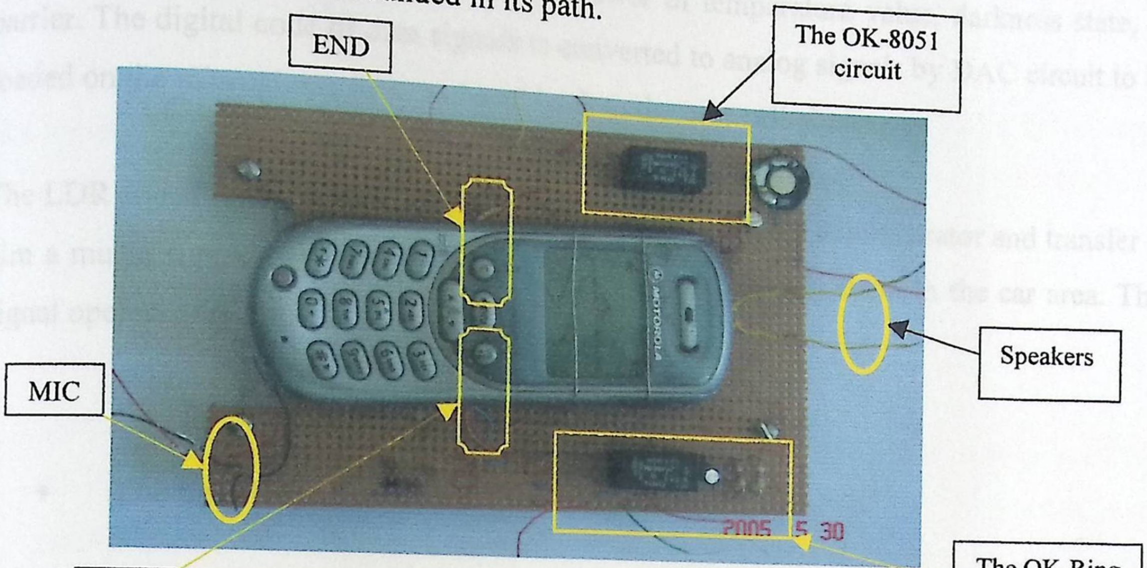

Figure 6.2: The cell-phone of the toy-car

- **The END button**

The ENDing button was cut-off internally and three wire rapping were connected. In fact, the system does not deal with this button and it will use the OK button instead . according to the nature of the cell phone. But it is prepared to deal with manually in the testing. When the sides of the OK button were connected to the relay, the situation was difficult to deal manually with it (OK button) at that moment. So this was prepared for this task.

- **The MIC-Connection**

The internal connection of the microphone was cut-off and connects its two dots with wire rapping to deal with them externally.

The microphone signals are used to receive data from the microcontroller and send it to the administrator cell phone. This data is an answer of temperature value, darkness state, The microphone signals are used to receive data from the microcontroller and send it to the administrator cell phone. This data is an answer of temperature value, darkness state, or barrier. The digital code of data signals is converted to analog signals by DAC circuit to be loaded on the microphone lines and sent back to the user cell phone.

The LDR signal is reached to the cellular phone to contact the administrator and transfer to him a music signal that implements the darkness(or a barrier) event in the car area. This signal operates the OK button by the relay circuit.

- **The Speaker-Connection**

The internal connection of the speakers was disconnected and its output was connected with two wire rapping. The two lines were prepared to transfer the voice signal to the system. The output signal is entered to the oscilloscope to be analyzed. It is found that an analog signal, so an ADC circuit is built to convert these analog signals to digital codes since the microcontroller deals only with the digital codes.

On the other hand, the voltage value of the analog signals is too tiny to be treated and understood. It ranges from 0.2V ac to 0.7V ac maximum. This value can not be read by the microcontroller, so an amplifier circuit was prepared to duplicate this value five times before going to the ADC circuit.

Here, a lot of processes were prepared and tested to check the valid codes when repeating the commands of the system such as GO, BACK, RIGHT, LEFT.

In this state, we used the PC-MIC with the amplifier circuit to explain our strategy of work and repeating the system commands.

6.4 8051 Microcontroller

The system needs the 8051 microcontroller in order to navigate the whole operations of the toy car. We choose the 8051 microcontroller board after a deep study of all features and important chips that needed to simulate the system requirements.

1. Preparing the Microcontroller

During the first semester and after a deep study, we were being able to put a good plan with our supervisor for the specifications and requirements that must exist in the microcontroller. Through research, the following 8051 microcontroller was found to contain all the requirements and most needed of all.

In fact, this microcontroller can be built manually and achieves the system requirements, but since this board is not the whole system and it is a part of the system work, we are not interested in loosing the time in building it at the moment, for it is available in the markets.

This microcontroller was brought from the PHILIPS Company of USA. We shipped it, but unfortunately, it took nearly two months at this semester before reaching us.

2. Using the PPU-8051 microcontroller

Since the microcontroller was late and the time passed smoothly, we decided to use the special PPU-microcontroller and begin to build sub-programs and made the required tests. The microcontroller helped us to do several needed experiments .It requires to learn the assembly language and use it in the programs.

The system microcontroller is a compatible board with the PPU-microcontroller. So we continued our software by the assembly language to keep the two-months efforts, although the system board can be programmed by C-Language.

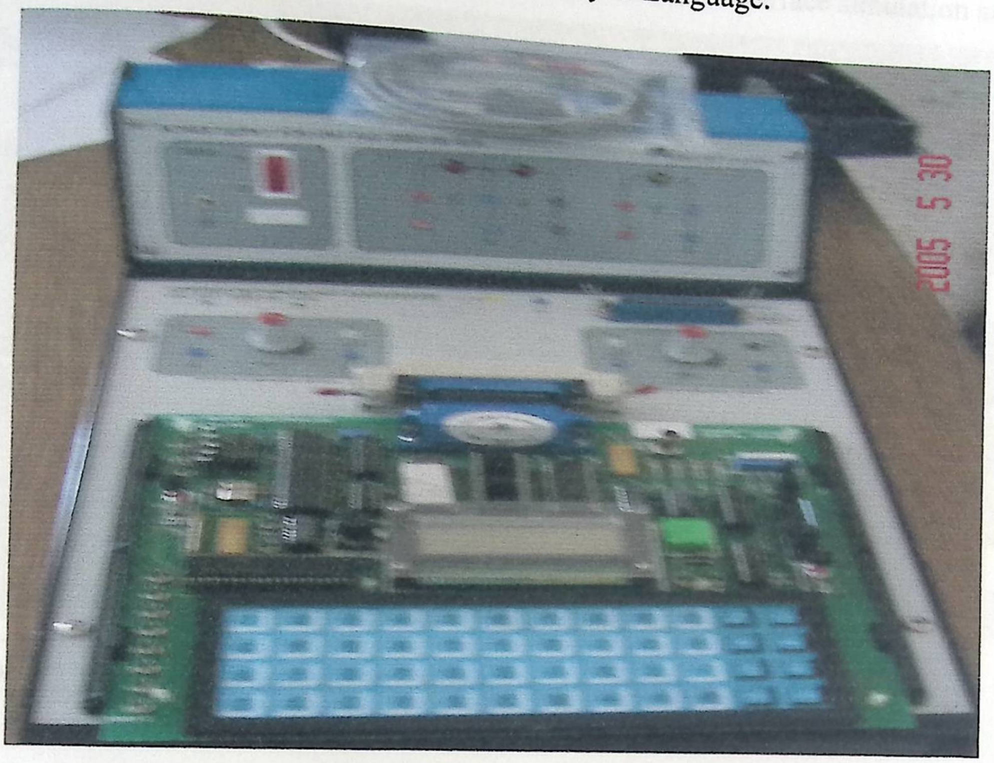

Figure 6.4: The PPU-8051 Microcontroller

3. The 8051MC Interfacing

The most important and necessary features that implement the interface simulation are:

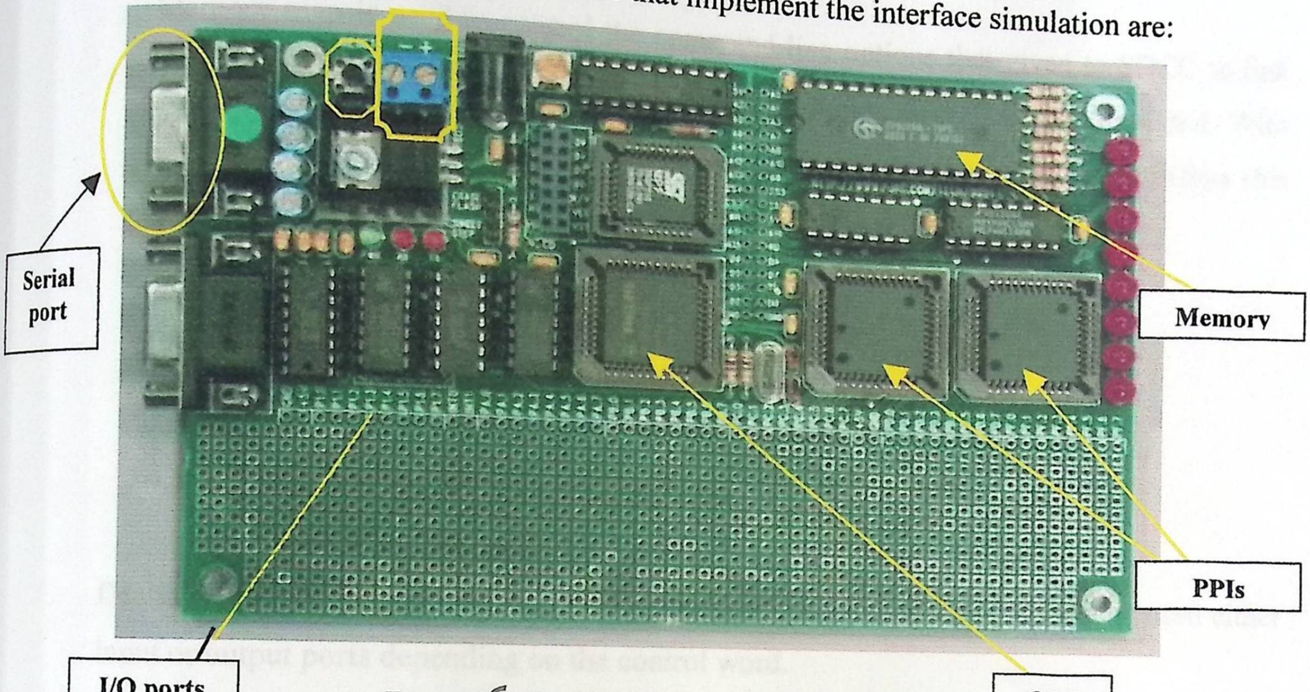

Figure 6.5: The 8051 Microcontroller System

- **PPI** (Peripheral Programmable Interface)

There are two main PPIs that built in the 8051 board which have 48 I/O pins. The first PPI has A,B, and C ports that is used to receive data from the Cell phone and transmitted commands to the toy car, while the second PPI has D,E, and F ports that is used to receive data from the sensors and transmitted commands to the toy car and to the client cell phone.

To configure the ports of the 8051 microcontroller there is a need to declare the control word in each program. At the beginning, we used the port E as a testing point for each step to see the I/O results on its LEDS.
The system has been implemented with all PPIs' ports. Each port has its own process to operate the needed circuit.

- **Memory Map**

Memory map is used to control the command line options that given to SDCC to link the code. This linker places the code at the beginning of RAM to be executed. With as31, the program location is controlled by ORG directed within the code to allow this code to be moved more easily.

The 8051 memory has 64 KB divided into four codes:

1. RAM: from 0000 to 7FFF of 32 KB size.
2. Flash ROM: from 8000 to F7FF of 30 KB size.
3. Peripheral: from F800 to FEFF of 1.75 KB size.
4. Unused: from FF00 to FFFF of 255 B size.

Dealing with 8051 memory requires determining the specific ports that must be used either input or output ports depending on the control word.

- **Flash ROM**

Flash ROM is a programming procedure different from simple writing to RAM. It can only turn 1's to 0's. The erasure causes all the bytes of the erased area to turn back into zeros. The Flash ROM must be erased before it is written.

We implement it every time we need to test the used program.

- **RAM** (Read Access memory)

This memory is used to store all the software programs of a specific time that written in assembler language on the PC. Those programs were transfer via serial cable to microcontroller and execute them by using autostart.

All the system programs were downloaded and tested to get the satisfaction and documentation correctly.

- **EPROM** (Erasable Programmable Read Only Memory)

This external memory is used to store all the software programs to be executed at any time by using autostart. These programs were tested after storing on the ROM to check their validity and completeness at work.
The simulation between these chips occurs by using the serial port that passes the data software from the PC to 8051 microcontroller to be readable.

6.5 External Circuits

The following circuits were built and tested separately as a unit. They were built and processed on the breadboards. Their results were recorded and documented to be compared with the final results.

6.5.1 ADC Circuit

The Analog to Digital Converter is used to convert the input signal of voice recognition that comes from the cellular phone into a digital code. This digital code is transferred to the 8051 microcontroller during the PPI ports. According to this code the 8051 microcontroller can analyze the coming command and operate the needed process. This command implies either a direction code or asking for a target.

Figure 6.7: ADC circuit

The ADC circuit was built on a breadboard and tested successfully as a unit then it is documented in its final manner and used to interface the cell phone with the microcontroller. The ADC logic circuit consists mainly of ADC0804 chip, 8-4N25 Optocouplers that used as saving chips and isolating the error from expanding. In addition, there is a 7414 inverter to give 8-bit of digital code sent to microcontroller ports.

The analog signals were tested by the Oscilloscope and drawn on the Excel system. The digital signals were tested and read by using C-Language. This data was entered to PC through the parallel port.

The following data is a sample of examples of the experiments that had been done during the semester.

1. **GO Sample**

Analog Signal

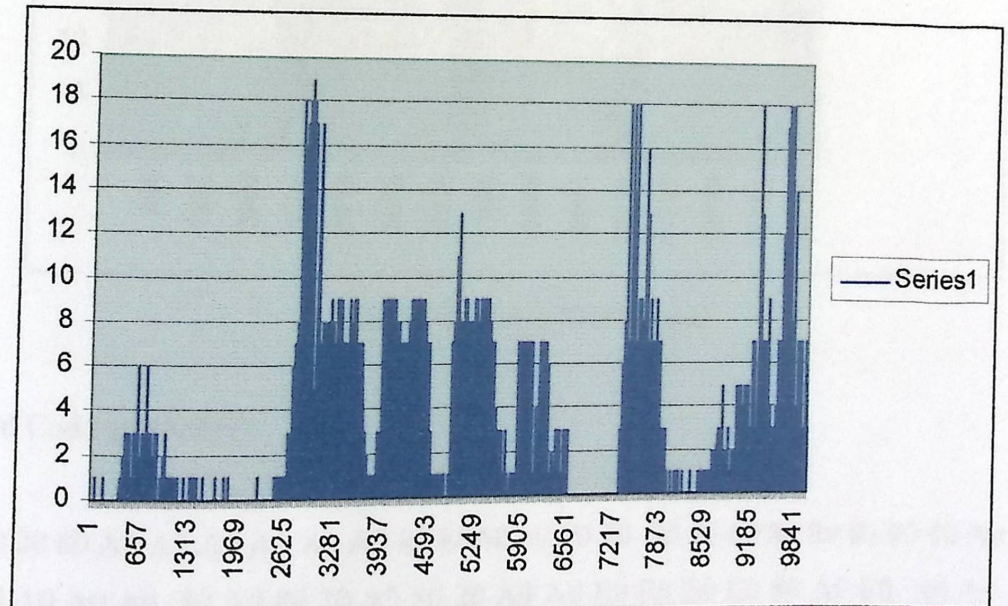

Figure 6.5: Analog GO signal

The following code is the digital signal that represents the GO sample. This code is converted by the ADC circuit and transfers to the 8051 microcontroller.

Digital Code of GO:

20 20 E0 E0 E0 E0 80 A0 E0 A0 A0 20 E0 80 A0 80 E0 E0 80 A0 A0 80 E0 A0 A0 20 A0 20 A0 A0 A0 A0 A0 A0 80 80 A0 80 80 80 80 80 80 80 80 80 80 80 A0 A0 A0 80 80 20 A0 A0 20 A0 A0 A0 A0 A0 A0 A0 20 A0 A0 A0 80 A0 A0 80 20 20 80

2. The RIGHT Signal

The Right signal is compared with other signals and the difference appears through the resulted samples.

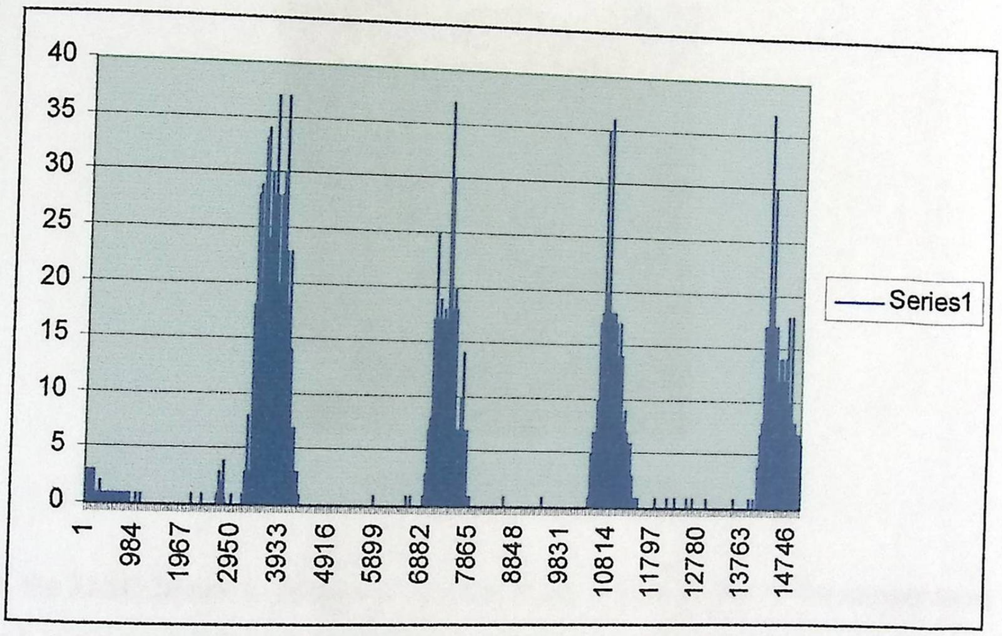

Figure 6.9: Analog RIGHT signal

Digital Code of RIGHT:

20 80 20 80 A0 A0 A0 A0 A0 A0 80 80 80 80 20 20 80 80 80 80 80 80 80 80 A0 A0 80 A0 80 A0 A0 A0 80 A0 80 20 A0 80 20 A0 A0 E0 E0 E0 E0 80 A0 E0 A0 A0 A0 E0 A0 80 A0 80 A0 A0 A0 80 A0 80 80 80 80 A0 80 80 20 A0 A0 80 80 80 80 20 80 A0 A0 80 80 20 20 20 80 A0 A0 A0 20 20 20 A0 20 A0 80 A0 80 80 A0 80 80 80 A0

6.5.2 DAC Circuit

The Digital to Analog Converter (1408DAC) is used to convert the input code of stored signals into analog signals . This signal is transferred into the 8051 microcontroller during the PPI ports. According to this signal the 8051 microcontroller can analyze the purpose of this signal. The digital result is compared with the data stored in memory and returns it (the digital code) to DAC circuit. The DAC circuit encoded the output analog signal to the MIC of the cell phone as a potable voice. The DAC signal is tested on a breadboard then it was built in its final manner to use it when needed.

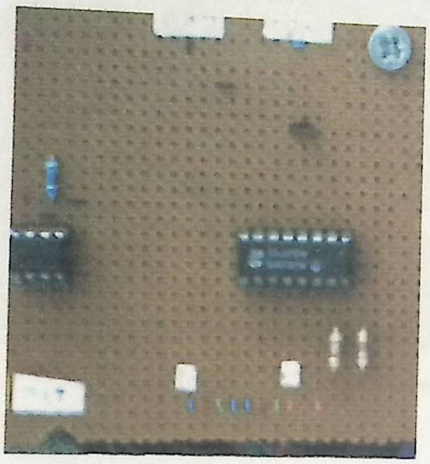

Figure 6.[illegible]: The DAC Signal

In fact, the DAC board is designed to convert the digital codes of the temperature values that had been stored in the memory. Its output has planed to be transferred into the cellular-phone MIC. But unfortunately, one of the PPIs was attacked. This drops the task, so we could not complete this part of project.

6.5.3 LDR Circuit

The LDR (Light Dependent Resistance) sensor really was built in this system to test the surrounded area of the toy car continuously either Darkness or Sunshine. But the team has programmed the LDR sensor to be used as a barrier sensor since the last one was not functioning .

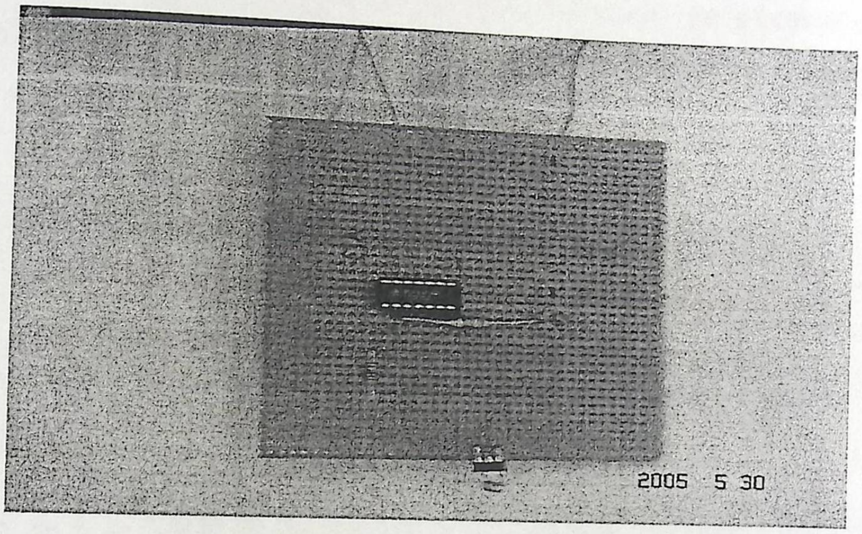

Figure 6.[illegible]: The LDR sensor

The LDR circuit was built on a bread board and tested successfully as a unit then used to interface the 8051 microcontroller with the cell phone. The output of the sensor is connected to a bit-port of the microcontroller as an input digital signal either 1(Open-Way) or 0(Barrier). The result will be loaded from the output bit-port to the cell phone of the toy car to operate it by giving 3-pulse voltages during the relay. The three pulse voltages were needed to simulate the nature of the cell phone software to dial up the administrator directly. This operation makes this cell phone to call the administrator's cell-phone and telling him the state.

6.5.4 Temperature Circuit

The temperature circuit was built to sense the temperature of the toy car's environment. This can be operated by asking the toy car about the temperature. This question will be converted to digital code and transferred by the microcontroller to the input of this circuit. The output is a digital code and must be compared with those stored codes of temperature in the memory to return the analog voice of the specified temperature during the MIC cell-phone to the administrator cell-phone.

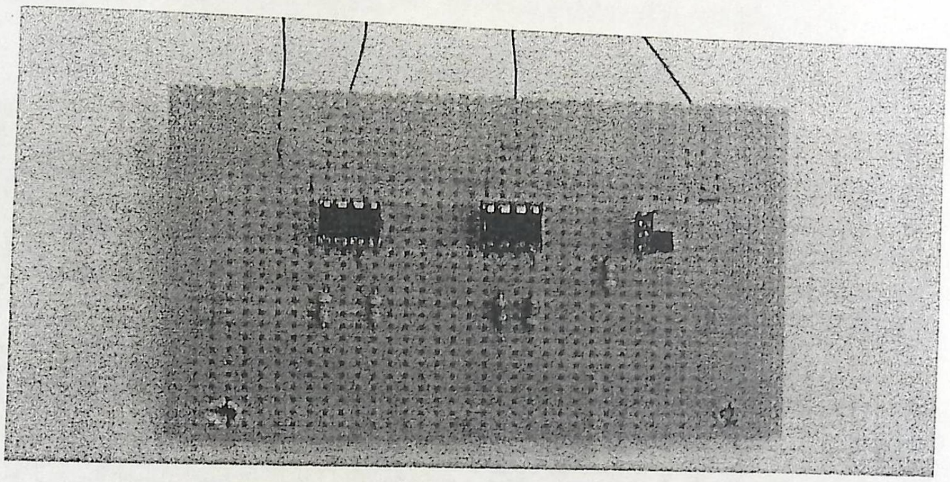

Figure 6.10: The Temperature sensor

This circuit had been tested many times to emphasize good results. We read these results on memory and then stored them as a database to compare any new result with them. This circuit operates only by a command which comes to it asking the sensor to sense.

Also the temperature circuit is an application of two-dimensional simulation; the user asks the car and waits the result.

6.5.5 Relay-Based Directing Circuit

This circuit was built to control the directions of the toy car. It consists of 4-Relays 5V of each one with a 2N2219A transistor and a 4N25 Optocoubler with necessary resistors. This circuit first is built and controlled by 4-Switches. Each switch implements a command to a specific direction. Here the care is taken when giving a 5V pulse to two switches with others, the DC motor must take one pulse either +5V or -5V but not both of them at the same time. And we don't care to operate two directions from two motors. After switches did a test, we connected the circuit with the microcontroller port. Moreover, through software we could control the directions successfully.

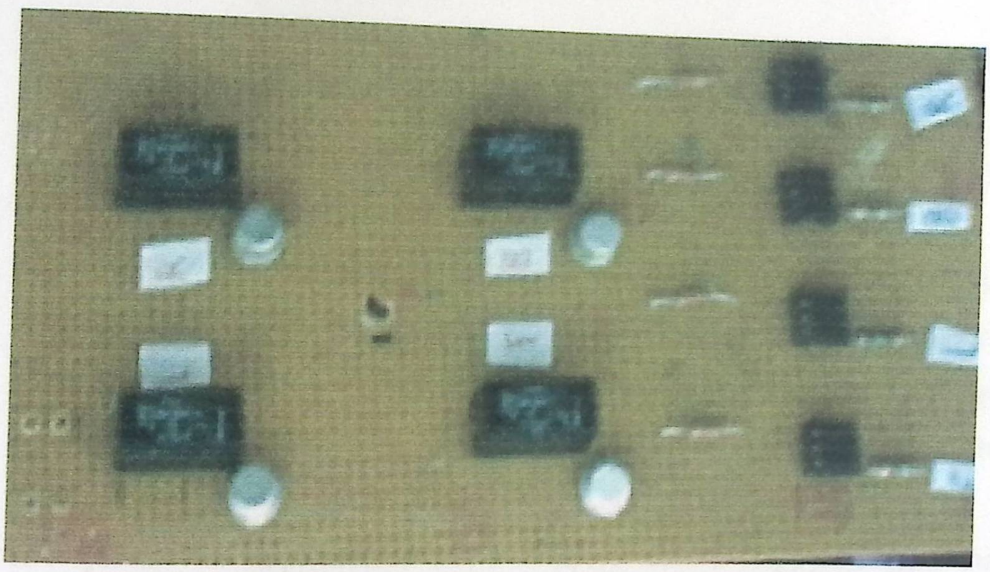

Figure 6.13: The Relay-Based Directing Circuit

6.6 Summary

- Each unit is prepared and tested separately, and then results were recorded to check its validity.
- A software code program is written to each one to test the results that have been taken manually.
- These units were tested and implemented all as a unit and interface had been done to simulate them.
- The control of these hardware units was made by software programs to decide which circuit must operate at one time.
- The main ideas of the system have been achieved by building and testing the required circuits of simulation.
- The receiving-command part was achieved and implemented by a Relay-Connection circuit that operates by a voice command.
- The sending-receiving part was achieved and successfully implemented in the temperature circuit by asking for the temperature and waiting for results.
- The sending part was also tested, successfully implemented, and documented by LDR, and Barrier circuits that send data tells the administrator the state of car conditions.
- The system was implemented and a complete control happened .Also the interface and the hardware and software sides achieved simulation.
- The supervisor was satisfied and comfortable to the system results and gave his recommendations to pass to the final chapter of future work.

7

Chapter Seven
Future Work

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Chapter Seven

Future Work

7.1 Introduction

The system of controlling a toy car using cellular phone has achieved the main ideas prepared to. It is now ready to be used as a robot controlled by the cellular phones on sight. The main features that achieved are:

1. Controlling a toy car by the voice recognition commands. These commands are GO, BACK, LEFT, RIGHT. The team enables to send these commands from their mobile to the cellular phone and they enable to differentiate between the commands' codes that are stored in the memory of 8051 microcontroller. The input code must be compared with those stored codes of memory after converted to a digital code by ADC. Receiving data from the toy car about its local environment. These data comes to the administrator after he asks about something like Temperature. The microcontroller does the interface which controlled and recognized by the system software. The simulation with these hardware circuits and their software programs has converted from one form to another to do its task. This conversion passes in several stages from ADC to DAC and vice versa. The code although enters in comparison to be compared with stored-memory data. This will return the valid results that achieve the goals.
2. The car enables to predict and tell its administrator about the area it is found in. These data like Boarder or Dark codes has been understood to be converted into analog voice.

7.2 Future View

During the system period the team enables to achieve the main goals he started to do them. Although there are some techniques that could be used to reach the objects in less time but we started our system from the zero and we used the most available and simple equipments to emphasize the results and prove this new technology of controlling an object by the human voice recognition.

There are some media that can be used as an advance for the system, these media will be our recommendation to help other students achieve more results. So the future view includes the following improvements:

- The system can use the recognition of voice Using FFT (Fast Fourier Transform)and Wavelet technology.

- There are cell phones that have some features and suited the idea of interface. This kind of cell phones can deal with the 8051 microcontroller directly by a serial cable that converts the signals without needing to ADC circuits. This cell phone uses numbers as remote commands but not voice recognition.

- The system can use a digital camera to indicate the situation of the toy car. This design enables to control the toy car from any place in the world without needing to be on sight.

- This system can be improved and reprogrammed to present other goals. It can be designed to transfer the patients in the hospitals in an easy way of controlling. In addition, it may be designed to service the manufactures and does their demands.

- This technology can be applied on a real car to be controlled under cellular phone. This part of work is special for Mecatronics department students who know the main features of car control. They can analyze this technology and use their experience to navigate the car without needing a driver.

Appendix

```
; *******************************
Program*******************************Rout
; * This program is move the toy car Forward, Backward, Right,
and Left *
; * dependent on the signal thats appear at PD0, PD4,PD6, and PD7
  *
; * seriuosly where this program will repeat it self many times
until *
; * press on autostart to stop this program
  *
;
*********************************************************************
****

.org 0x8000 ;load the program on the memory address 8000
mov a,#0x8a
mov dptr,#0xf903
movx @dptr,a;display the control word on the address configuration
(f903hex)

mov dptr,#0x2000
push dph
push dpl
mov r0,#0xf0 ;this value is used to make a delay for reading the
input signal

ah1:

;the follow codes are used to make a delay between each reading 2
bytes to
;check there is an hexadeciaml code or not for each commands

;####################################################################
##########
;begin the delay
mov r1,#0x02
st0:
dec r1  ;decrease the register r1 by one hexadecimal
mov a,r1
jnz st50 ;if the r1 is not zero go to st50
ljmp st60 ;if the r1 is zero go to st60

st50:
mov r2,#0x1f
st10:
dec r2 ;decrease the register r2 by one hexadecimal
mov a,r2
jnz st10 ;if the r2 is not zero go to st10

mov r3,#0x1f
```

```
st20:
dec r3 ;decrease the register r3 by one hexadecimal
mov a,r3
jnz st220 ;if the r3 is not zero go to st220
ljmp st660 ;if the r3 is zero go to st660

st220:
mov r4,#0xff
st30:
dec r4 ;decrease the register r4 by one hexadecimal
mov a,r4
jnz st30 ;if the r4 is not zero go to st30
ljmp st20 ;if the r4 is zero go to st20

st660:
mov r5,#0xff
st430:
dec r5 ;decrease the register r5 by one hexadecimal
mov a,r5
jnz st430 ;if the r5 is not zero go to st430

mov r6,#0xff
st330:
dec r6 ;decrease the register r6 by one hexadecimal
mov a,r6
jnz st330 ;if the r6 is not zero go to st330

mov r7,#0xff
st340:
dec r7 ;decrease the register r7 by one hexadecimal
mov a,r7
jnz st340 ;if the r7 is not zero go to st340
ljmp st0 ;if the r7 is zero go to st0
; End the delay
;###############################################################
##########

st60:
dec r0 ;decrease the register r0 by one hexadecimal
mov a,r0
jz ahmad ;if the r0 is zero go to ahmad
mov dptr,#0xf902
movx a,@dptr ;read 2 bytes from PF and stored them in the
Accumulator
jz ah1 ;if the data of Accumulator is zero go to ah1


pop dpl
pop dph
movx @dptr,a ;stored the 2 bytes begin from address 2000


inc dptr ;increase the value of dptr by one hexadecimal
push dph
push dpl
```

```
;###############################################################
##########
;the follow codes are used to make a delay between each reading 2
bytes to
;read all the hexadeciaml code for each commands correctlly, where
each 2
;bytes will stored on the memory begin from 2000
mov r1,#0x02
st:
dec r1
mov a,r1
jnz st5
ljmp st6

st5:
mov r2,#0xff
st1:
dec r2
mov a,r2
jnz st1

mov r3,#0xff
st2:
dec r3
mov a,r3
jnz st22
ljmp st66

st22:
mov r4,#0xff
st3:
dec r4
mov a,r4
jnz st3
ljmp st2

st66:
mov r5,#0xff
st43:
dec r5
mov a,r5
jnz st43

mov r6,#0xff
st33:
dec r6
mov a,r6
jnz st33

mov r7,#0xff
st34:
dec r7
mov a,r7
jnz st34
ljmp st
```

```
;end delay between reading each 2 bytes

st6:
ljmp ah1 ;jump to ah1 to read again
;######################################################################
##########
;######################################################################
##########
;the follow codes are used to determine the length of the command
that has
;already stored in the memory begin from 2000 then stored this
length code
;with others pre-commands length then send a commands to the toy
car

ahmad:
mov r1,#0x00 ;Initialize the register r1 to store the length of
command in it
mov dptr,#0x2000

l2:
movx a,@dptr ;store the value which stored on 2000 memory
jz l1 ;check if the value of the Accumulator is zero then jump to
l1 or not
;zero then continue
inc dptr ;increase the pointer by one hexadecimal to read the next
value
inc r1 ;increment the register r1 by one hexadecimal
ljmp l2 ;jump to l2

l1:
mov dptr,#0x2040
mov a,r1
movx @dptr,a ;store the value of r1 (command length) on the memory
address
;2040

;the follow codes are checking if the command length between 2hex
and 12hex
;then execute the follow code
mov a,#0x02
subb a,r1 ;substract the Accumulator from r1
jnc test  ;if there is a carry then jump to test else continue
mov a,#0x12
subb a,r1  ;substract the Accumulator from r1
jc test   ;if there is a carry then jump to test else continue

; send GO command to toy car
mov dptr,#0xf900
mov a,#0X80
movx @dptr,a
jj:
ljmp jj
```

```
;send RIGTH command to toy car
test:
mov dptr,#0xf900
mov a,#0X10
movx @dptr,a
;finish program
;################################################################################
##########
```

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