DUAL TONE MULTIPLE FREQUENCIES CONTROLLED BY PAINTING ROBOT

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Abstract

Conventionally, wireless-controlled robots use RF circuits, which have the drawbacks of limited working range, limited frequency range and limited control. Use of a mobile phone for robotics control can overcome these limitations. In this Project DTMF Controlled by Painting Robot technique is used. "DTMF is capable of receiving a set of command (instructions) in the form of DTMF tones and performs the necessary actions of the robotic moments like forward, backward, left, right, stop, up and down functions are controlled by a mobile phone that makes a call to the mobile phone attached to the robot. In the course of a call, if any button is pressed, a tone corresponding to the button pressed is heard at the other end of the call. Here tone is DTMF. It stands for "Dual Tone Multiple Frequencies". ARM7 controller perceives this DTMF tone with the help of the phone. The received tone is processed by the microcontroller with the help of DTMF decoder. The decoder decodes the DTMF tone into its equivalent binary digit and this binary number is sent to the microcontroller. The microcontroller is pre-programmed to take a decision for any given input and outputs its decision to motor drivers in order to drive the motors for forward or backward motion or a turn or Robotic hand need to move up and down and sprinkle water. The mobile that makes a call to the mobile phone stacked in the robot acts as a remote. DTMF signaling is used for telephone signaling over the line in the voice-frequency band to the call switching centre. The version of DTMF used for telephone tone dialing is known as 'Touch-Tone.' DTMF assigns a specific frequency (consisting of two separate tones) to each key so that

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it can easily be identified by the electronic circuit. The signal generated by the DTMF encoder is a direct algebraic summation, in real time, of the amplitudes of two sine (cosine)waves of different frequencies, i.e., pressing '5' will send a tone made by adding 1336 Hz and 770 Hz to the other end of the line. Because recording DTMF tones and play back will be control painting/spraying automatically.

Keywords- DTMF (Dual Tone Multiple Frequency), RF, ARM7 controller, Touch-Tone

1. INTRODUCTION

Wall painting, conventionally, has been carried out by human hands on scaffolds provisionally built around a subject wall. This, however, not only is a kind of work performed on dangerous elevated spots and in unclean environment but also requires extra wok to take down the scaffolds, thus often making it difficult to shorten a construction term or to reduce cost. There were some robots available on the markets which were, however, able to perform painting in a single color. Few of them had wide applicability and their use was rather limited depending on a structure applied. Further, prior to drawing of a picture, a rough sketch needs to be prepared on a wall, taking much time for drawing the original picture as being enlarged. The actual targets for development of the wall painting robot, in order to solve the aforementioned situation, were set as follows are to improve safety by eliminating works on scaffolds, to make machine structure simple to enable easy mounting, to perform not only painting in a single color but also drawing in multiple colors and to be usable not only on external walls of structures but also in various other places such as on walls of civil structures.

1.1 Block Diagram Description

This block diagram consists of LPC2148 Microcontroller, DTMF Decoder, L293D (Driver IC), ULN2003, Relays, water pump motor. The power supply is connected to Microcontroller and DFMF Decoder output is connected to the Microcontroller. Microcontroller is connected to the L293D enable pins, the output of L293D is connected to the motors and ULN2003 via relay is connected to the water pump motor. The Microcontroller which is the heart of the project is used to control the devices like forward, backward, right, left spraying, stop etc., We can drive the appliances with the help of IC drivers, which drives the relays etc. We are using drivers here to amplify low current signals to high current signals, as the output of Microcontroller is about 1 to

2 mA and this is not sufficient to drive some circuits which require input 10 mA of current. The following block diagram of LPC2148 ARM-7 Micro Controller as shown below Fig: 1.1

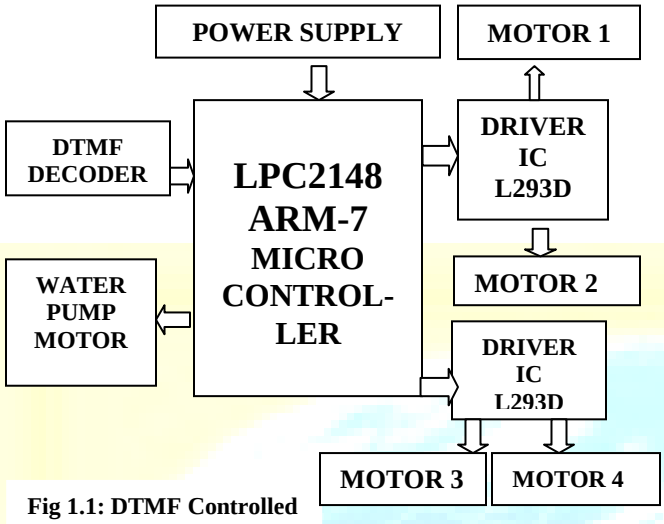


Fig 1.1: DTMF Controlled by Painting Robot

1.2 Schematic Diagram:

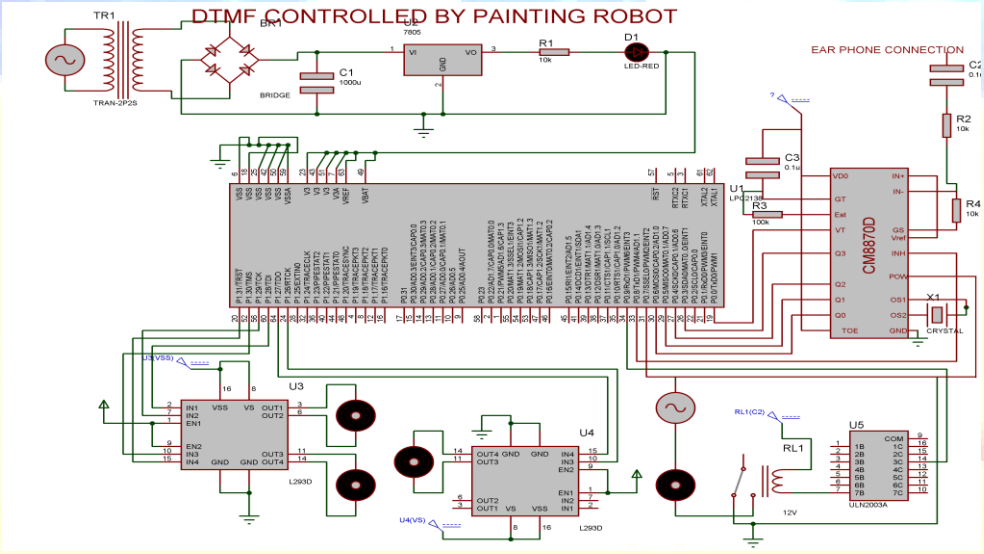


Fig 1.2: DTMF Controlled by Painting Robot Schematic Diagram

Here we used an embedded system architecture can be represented as a layered architecture as shown in Fig. 1.3. The operating system runs above the hardware, and the application software runs above the operating system. The same architecture is applicable to any computer including a

desktop computer. However, there are significant differences. It is not compulsory to have an operating system in every embedded system.

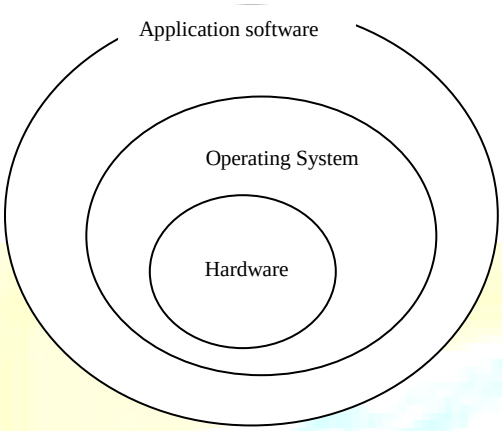


Fig 1.3: Layered Architecture of an Embedded System

1.3 ARM7 MICROCONTROLLER

The LPC2148 microcontrollers are based on a 32/16 bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combines the microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, thealternative16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty. Due to their tiny size and low power consumption. A blend of serial communications interfaces ranging from a USB 2.0 Full Speed device, multiple UARTs, SPI, SSP to I2Cs, and on-chip SRAM of 8 kB up to 40kB,make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers particularly suitable for industrial control and medical systems. It is most widely 32-bit Architecture. The main difference between 8051 and ARM is 8051 is based on CISC design where as ARM is based on RISC design. In ARM all most all instructions will execute in single machine cycle.

1.4 LPC2148 Processor Features:

16-bit/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package.8 kB to 40 kB of on-chip static RAM and 32 kB to 512 kB of on-chip flash memory. 128-bit wide interface/ accel-

erat -or enables high-speed 60 MHz operation. In-System Programming/In-Application Programming (ISP/IAP) via on-chip boot loader software. Single flash sector/full chip erase in 400 ms and programming of 256 bytes in 1 ms. USB 2.0 Full-speed compliant device controller with 2 kB of endpoint RAM. In addition, the LPC2146/48 provides 8 kB of on-chip RAM accessible to USB by DMA.One or two (LPC2141/42 vs. LPC2144/46/48) 10-bit ADCs provide a total of 6/14 analog inputs, with conversion times as low as 2.44 µs per channel.Single 10-bit DAC provides variable analog output (LPC2142/44/46/48 only). Two 32-bit timers/external event counters (with four capture and four compare channels each), PWM unit (six outputs) and watchdog. Low power Real-Time Clock (RTC) with independent power and 32 kHz clock input. Multiple serial interfaces including two UARTs (16C550), two Fast I2C-bus (400 kbit/s), SPI and SSP with buffering and variable data length capabilities. Vectored Interrupt Controller (VIC) with configurable priorities and vector addresses. Up to 45 of 5 V tolerant fast general purpose I/O pins in a tiny LQFP64 package. Up to 21 external interrupt pins available. 60MHz maximum CPU clock available from programmable on-chip PLL with settling time of 100µs.On-chip integrated oscillator operates with an external crystal from 1 MHz to 25 MHz. Power saving modes include Idle and Power-down. Individual enable/disable of peripheral functions as well as peripheral clock scaling for additional power optimization.

1.5 Board Features:

- Processor: LPC2148
- 2xSerial ports(One for ISP and other for Serial Communication)
- 12.00 MHz crystal
- On board Reset Circuit with a switch.
- Dual Power supply (either through USB or using external power adapter).
- Power on LED supply.
- Three on-board voltage regulators 1.8V, 3.3V and 5V with up to 800mA current
- Extension headers for µC ports.
- Graphic LDC display interfacing port.
- USB Ports.
- CAN controller Interfacing.
- MMC/SD card interfacing.
- 8 Bit LED interfacing.

- EEPROM Interfacing.
- On board UART.

Connectors:

- Mini-B USB connector to UART#0 UART-to-serial bridge)

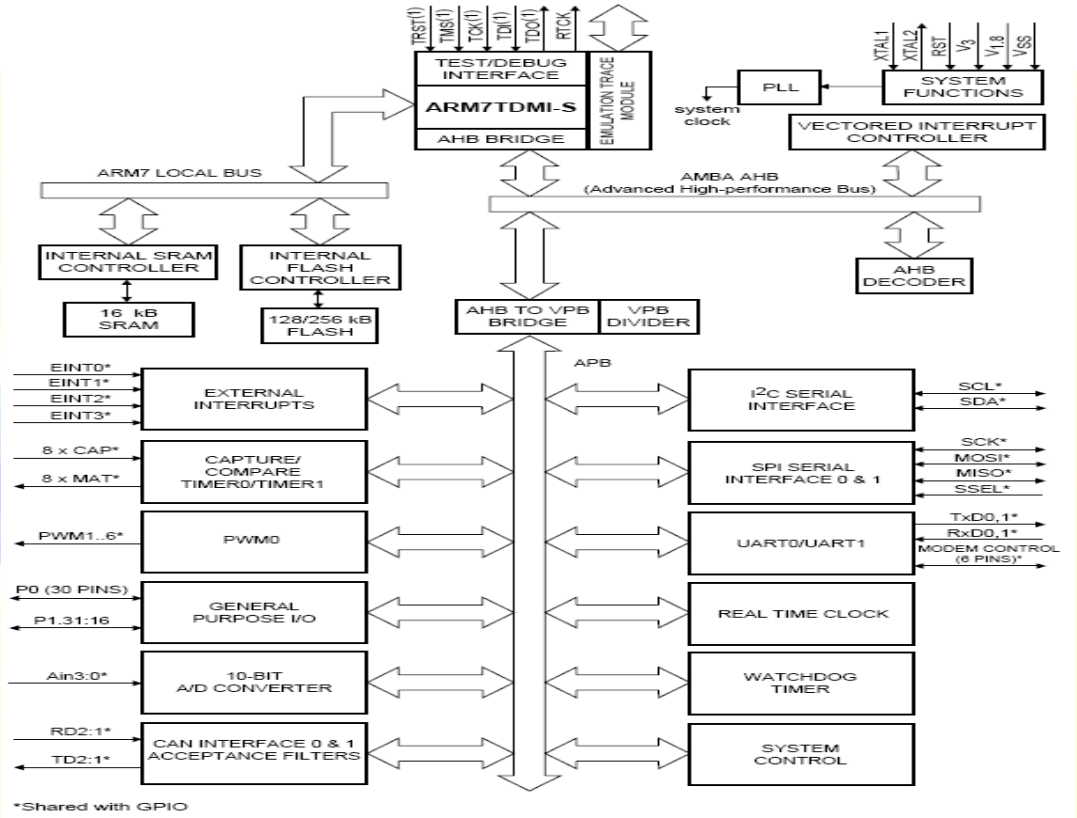


Fig 1.4: Arm-7 Block diagram

- Mini-B USB con
- MMC/SD memory card connector
- JTAG
- 64 pin expansion connector, all LPC2148 I/O pins are available on connector
- 2.1 mm power supply connector.

Power supply:

- 9-15 VDC, ≥200 mA from 2.1 mm power connector.
- Can also be powered directly from any of mini-B USB connectors.

1.6 Registers:

ARM7 Microcontroller consists of 37 Registers. All are 32-bit in length. Out of 37 Registers 30 are General purpose Registers, six are status Registers and one is a program counter

1.8 Memory Architecture: There are two types of memory systems are used firstly On-chip flash memory system is LPC2148 incorporate a 512 kB Flash memory system. This memory may be used for both code and data storage. When the LPC2148 on-chip boot loader is used, 500 kB of Flash memory is available for user code. The LPC2148 Flash memory provides minimum of 100,000 erase/write cycles and 20 years of data-retention. Secondly On-chip Static RAM (SRAM) may be used for code and/or data storage. The on-chip SRAM may be accessed as 8-bits, 16-bits, and 32-bits. The LPC2148 provide 32 kB of static RAM. The LPC2148 SRAM is designed to be accessed as a byte-addressed memory.

2. MATERIALS, METHODS AND DISCUSSION

2.1 DTMF (Dual Tone Multiple Frequency):

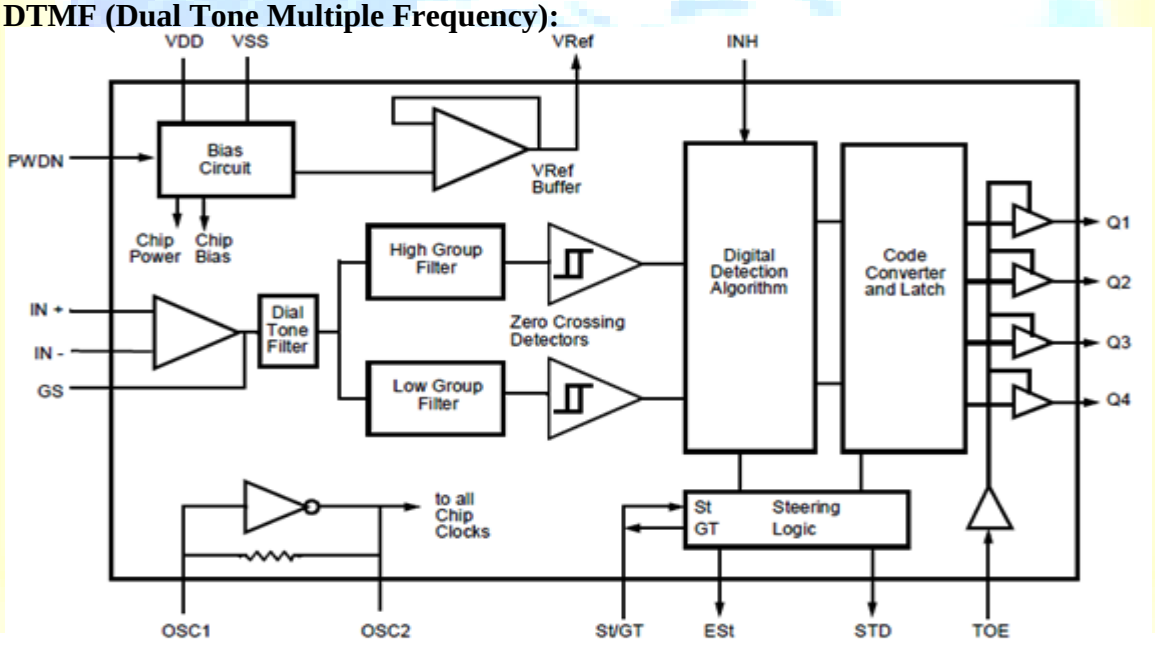


Fig 2.1: DTMF Block Diagram

Filter Section:

Separation of the low-group and high group tones is achieved by applying the DTMF signal to the inputs of two sixth-order switched capacitor band pass filters, the bandwidths of which correspond to the low and high group frequencies. The filter output is followed by a single order switched capacitor filter section which smoothes the signals Prior to limiting. Limiting is performed by high-gain comparators which are provided with hysteresis to prevent detection of unwanted low-level signals.

Decoder Section:

Digital counting techniques to determine the frequencies of the incoming tones and to verify that they correspond to standard DTMF frequencies. When the detector recognizes the presence of two valid tones the "Early Steering" (ESt) output will go to an active state. Any subsequent loss of signal condition will cause ESt to assume an inactive state.

Steering Circuit:

Before registration of a decoded tone pair, the receiver checks for a valid signal duration (referred to as character recognition condition). This check is performed by an external RC time constant driven by ESt. The steering circuit works in reverse to validate the inter digit pause between signals. Thus, as well as rejecting signals too short to be considered valid, the receiver will tolerate signal interruptions (dropout) too short to be considered a valid pause. This facility, together with the capability of selecting the steering time constants externally, allows the designer to tailor performance to meet a wide variety of system requirements.

Crystal Oscillator:

The internal clock circuit is completed with the addition of an external 3.579545 MHz crystal

Differential Input Configuration:

The input arrangement of the MT8870D/MT8870D-1 provides a differential-input operational amplifier as well as a bias source (VRef) which is used to bias the inputs at mid-rail. Provision is made for connection of a feedback resistor to the op-amp output (GS) for adjustment of gain. The op-amp connected for unity gain and Vref biasing the input at 1/2VDD.

Power-down Mode:

Logic high applied to pin 6 (PWDN) will power down the device to minimize the power consumption in a standby mode. It stops the oscillator and the functions of the filters.

Inhibit Mode:

Inhibit mode is enabled by a logic high input to the pin 5 (INH). It inhibits the detection of tones.

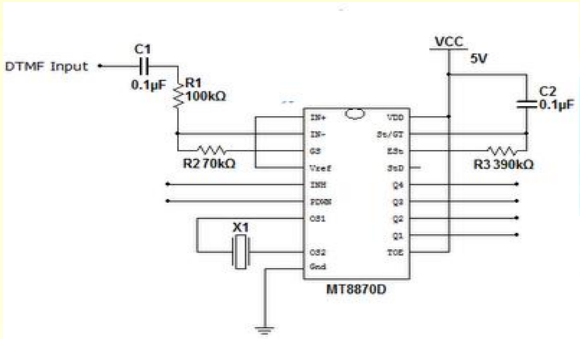


Fig 2.2: Inhibit Mode

DTMF data output table:

Low Group	H	Digit	Vt	D	D	D1	D0
	1209	1	H	L	L	L	H
697	1336	2	H	L	L	H	L
697	1477	3	H	L	L	H	H
770	1209	4	H	L	H	L	L
770	1336	5	H	L	H	L	H
770	1477	6	H	L	H	H	L
852	1209	7	H	L	H	H	H
852	1336	8	H	H	L	L	L
852	1477	9	H	H	L	L	H
941	1336	0	H	H	L	H	L

941	1209	*	H	H	L	H	H
941	1477	#	H	H	H	L	L
697	1633	A	H	H	L	H	H
770	1633	B	H	H	H	H	L
852	1633	C	H	H	H	H	H
941	1633	D	H	L	L	L	L
		ANY	L	Z	Z	Z	Z

2.2 A DC motor is designed to run on DC electric power. Types are used as brushed and brush-less types, which use internal and external commutation respectively to create an oscillating AC current from the DC source.

2.3 L293, L293D (QUADRUPLE HALF H-DRIVERS)

The L293 and L293D are used as a quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications. All inputs are TTL compatible. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo- Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. When an enable input is high, the associated drivers are enabled, and their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled, and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications.

Features:

- Featuring Unitrode L293 and L293D
- Wide Supply-Voltage Range: 4.5 V to 36 V
- Separate Input-Logic Supply
- Internal ESD Protection
- Thermal Shutdown

- High-Noise-Immunity Inputs
- Functionally Similar to SGS L293 and

SGS L293D

Output Current 1 A Per Channel - (600 mA for L293D)

Peak Output Current 2 A Per Channel - (1.2 A for L293D)

Output Clamp Diodes for Inductive - Transient Suppression (L293D)

2.6 H-BRIDGE:

We can better control our motor by using transistors or Field Effect Transistors (FETs). Fig 2.5 showing the solid state circuits provide power and ground connections to the motor, as did the relay circuits. The high side drivers need to be current "sources" which is what PNP transistors and P-channel FETs are good at. The low side drivers need to be current "sinks" which is what NPN transistors and N-channel FETs are good at.

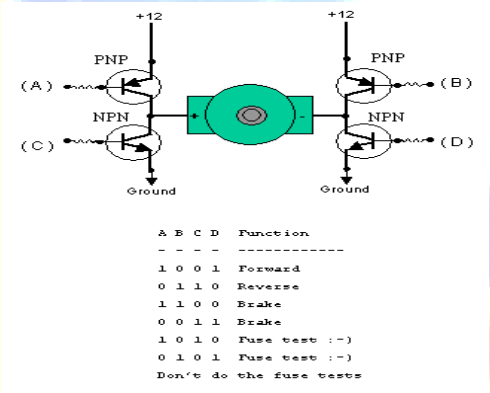


Fig 2.3: H-Bridge operation

If you turn on the two upper circuits, the motor resists turning, so you effectively have a breaking mechanism. The same is true if you turn on both of the lower circuits. This is because the motor is a generator and when it turns it generates a voltage. If the terminals of the motor are connected (shorted), then the voltage generated counteracts the motors freedom to turn. It is as if you are applying a similar but opposite voltage to the one generated by the motor being turned. Vis-ã-vis, it acts like a brake.

2.4 H-Bridges Devices: The L293D has 2H-Bridges, can provide about 1A to each and occasional peak loads to 2A. Motors typically controlled with this controller are near the size of

a 35 mm film plastic canister. The L298 has 2 h-bridges on board, can handle 1A and peak current draws to about 3A. You often see motors between the size a of 35 mm film plastic canister and a coke can, driven by this type H-Bridge. The LMD18200 has one h-bridge on board, can handle about 2 or 3 amps and can handle a peak of about 6 amps. This H-Bridge chip can usually handle an average motor about the size of a coke. That's the basics about motors and H-Bridges. Hope it helps and be safe. But in our project we are using only semiconductor H-bridge i.e. using four transistors.

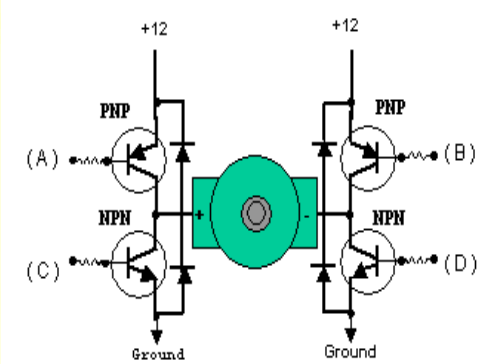


Fig 2.4: H-Bridge operation

2.5 MT8870 (INTEGRATED DTMF RECEIVER)

The MT8870D/MT8870D-1 monolithic DTMF receiver offers small size, low power consumption and high performance. It is a complete DTMF (Dual Tone Multiple Frequency) receiver integrating both the band split filter and digital decoder functions. The filter section uses switched capacitor techniques for high and low group filters; the decoder uses digital counting techniques to detect and decode all 16 DTMF tone pairs into a 4-bit code. External component count is minimized by on chip provision of a differential input amplifier, clock oscillator and latched three-state bus interface.

Features:

- Complete DTMF Receiver
- Low power consumption
- Internal gain setting amplifier
- Adjustable guard time
- Central office quality
- Power-down mode
- Inhibit mode

- Backward compatible with MT8870C/MT8870C-1

2.6 ULN 2003 was used as high-voltage, high-current Darlington driver comprised of seven NPN Darlington pairs. Ideally suited for interfacing between low-level logic circuitry and multiple peripheral power loads. The ULN2003A/L have series input resisters selected for operation directly with 5V TTL or CMOS. The ULN2003 A/L are the standard Darlington arrays. The outputs are capable of sinking 500mA and will with stand at least 50V in the OFF state. Outputs may be paralleled for higher load current capability. The Darlington arrays are furnished in 16-pin Dual-in-line plastic package and 16-lead surface- mountable SOIC's. All devices are rated for operation over the temperature range of -20˚ C to 85˚ C.

2.7 RELAYS

A relay is used as an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. A relay is able to control an output circuit of higher power than the input circuit, it can be considered to be, in a broad sense, a form of a electrical amplifier.

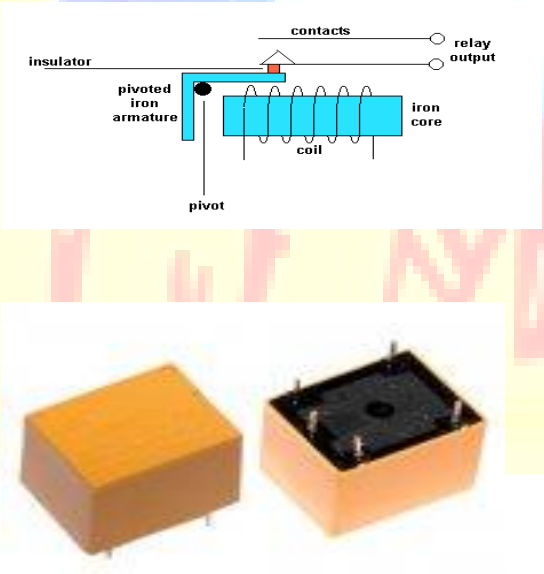


Fig2.5: Relay

Relays are usually SPDT (single pole double through switch) or DPDT (double pole double through switch) but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available.

2.8 Basic operation of a relay:

An electric current through a conductor will produce a magnetic field at right angles to the direction of electron flow. If that conductor is wrapped into a coil shape, the magnetic field produced will be oriented along the length of the coil. The greater the current, the greater the strength of the magnetic field, all other factors being equal.

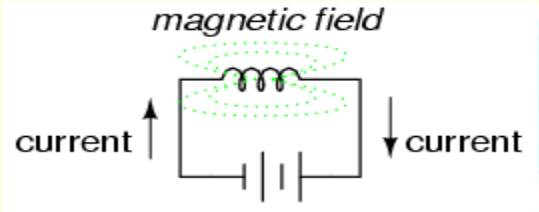
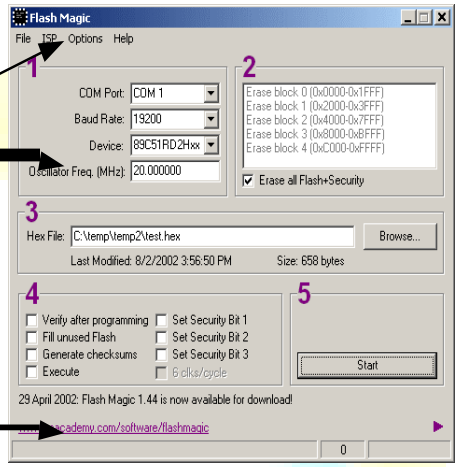


Fig 2. 6 : Basic Operation of Relay

Inductors react against changes in current because of the energy stored in this magnetic field. When we construct a transformer from two inductor coils around a common iron core, we use this field to transfer energy from one coil to the other. However, there are simpler and more direct uses for electromagnetic fields than the applications we've seen with inductors and transformers. The magnetic field produced by a coil of current-carrying wire can be used to exert a mechanical force on any magnetic object, just as we can use a permanent magnet to attract magnetic objects, except that this magnet (formed by the coil) can be turned on or off by switching the current on or off through the coil. If we place a magnetic object near such a coil for the purpose of making that object move when we energize the coil with electric current, we have what is called a solenoid. The movable magnetic object is called an armature, and most armatures can be moved with either direct current (DC) or alternating current (AC) energizing the coil. The polarity of the magnetic field is irrelevant for the purpose of attracting an iron armature. Solenoids can be used to electrically open door latches, open or shut valves, move robotic limbs, and even actuate electric switch mechanisms and is used to actuate a set of switch contacts

2.9 In This Project a Water Pump Motor is used as an DC motor which is used for pumping paint to the wall. In the synchronous motor, which does not rely on induction and as a result can rotate exactly at the supply frequency or a sub-multiple of the supply frequency and stepper motor is used as an brushless AC synchronous electric motor that can divide a full rotation into a large number of steps. The motor's position can be controlled precisely, without any feedback mechanism (see open loop control).



3. SOFTWARE REQUIREMENTS

In our project we mainly used softwares they are Keil software, Flash Magic and Proload. In Keil compiler is a software used where the machine language code is written and compiled. After compilation, the machine source code is converted into hex code which is to be dumped into the microcontroller for further processing. Keil compiler also supports C language code. Keil can be used to create source files, automatically compile, link and convert using option set. The simulator /debugger in KEIL can perform a very detailed simulation of a microcontroller along with external signals. Keil compiler is a software used where the machine language code is written and compiled. After compilation, the machine source code is converted into hex code which is to be dumped into the microcontroller for further processing. Keil compiler also supports C language code.

Minimum requirements:

Windows95/98/ME/NT, Mouse, COM Port, 16MbRAM, 3MbDiskSpace

Main Window:

The following is a screenshot of the main Flash Magic window. The appearance may differs lightly depending on the device selected.

Five Step Programming:

Step 1 – Connection Settings: Before the device can be used the settings required to make a connection must be specified. Select the desired COM port from the drop down list or type the desired COM port directly into the box. If you enter the COM port yourself then you must enter it in. Any other format will generate an error. So if you want to use COM 5 (which is not present on the drop down list) you can directly type in either "COM 5" or "5".Select the baud rate to connect at. Try a low speed first. The maximum speed that can be used depends on the crystal frequency on your hardware. You can try connecting at higher and higher speeds until connections fail. Then you have found the highest baud rate to connect at. Alternatively, some devices support high speed communications. Select the interface being used, if any. An interface is a device that connects between your PC and the target hardware. Do not round the frequency, instead enter it as precisely as possible. Once the options are set ensure the device is running the on-chip Bootloader if you are using a manual ISP entry method. Note that the connection settings affect all ISP features provided by Flash Magic.

Menus

Section 1

Section 2

Embedded Hints

Progress Information

Programmed Count

Progress bar

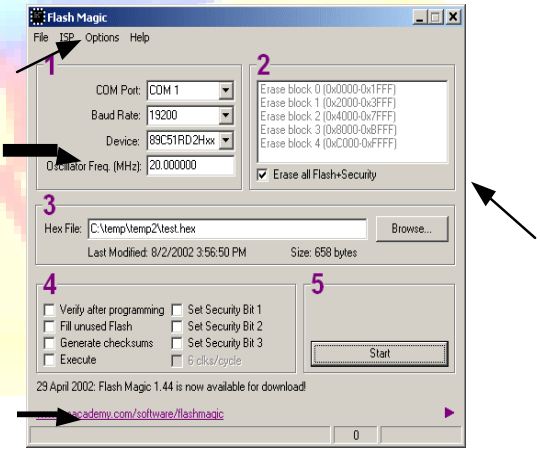


Fig 3.1: Main Window

Step 2 – Erasing:

This step is optional, however if you attempt to program the device without first erasing atleast one Flash block, then Flash Magic will warn you and ask you if you are sure you want to program the device. Select each Flash block that you wish to erase by clicking on its name. If you wish to erase all the Flash then check that option. If you check to erase a Flash block and all

the Flash then the Flash block will not be individually erased. If you wish to erase only the Flash blocks used by the hex file you are going to select, then check that option. Only when programming a Hex File has been completed will the Status Byte be set to 00H to allow the code to execute. This will be indicated by the text next to the Erase all Flash option. Flash will also erase the speed setting of the device (the number of clocks per cycle) setting it back to the default. This will be indicated by the text next to the Erase all Flash option.

Step 3 – Selecting the Hex File:

This step is optional. If you do not wish to program a Hex File then do not select one. You can either enter a path name in the text box or click on the Browse button to select a Hex File by browsing to it. Also you can choose Open… from the File menu. The information includes the range of Flash memory used by the Hex file, the number of bytes of Flash memory used and the percentage of the currently selected device that will be filled by programming the Hex file.

If the device supports programming and execution from RAM, for example the ARM devices, then the hex file may contain records for the RAM. First the flash will be program followed by the RAM. Programs loaded into RAM via a hex file may be executed using such features as the Go option.

Step 4 – Options:

Flash Magic provides various options that may be used after the Hex File has been programmed. This section is optional, however Verify After Programming, Fill Unused Flash and Gen Block Checksums may only be used if a Hex File is selected (and therefore being programmed), as they all need to know either the Hex File contents or memory locations used by the Hex File. Checking the Verify After Programming option will result in the data contained in the Hex File being read back from Flash and compared with the Hex File after programming. This helps to ensure that the Hex File was correctly programmed.

Step 5 – Performing the Operations:

Step 5 contains a Start button.

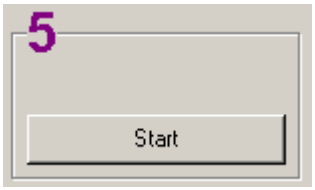


Fig 3.2 start button

Clicking the Start button will result in all the selected operations in the main window taking place.

They will be in order:

- Programming the Hex File
- Erasing Flash
- Verifying the Hex File
- Filling Unused Flash
- Generating Checksums
- Programming the clocks bit
- Programming the Security Bits
- Executing the firmware

4. RESULT

The robot is controlled by mobile i.e.,[DTMF] technology, the mobile is attached to the robot when call to that phone automatically call lift when '2' pressed it will go forward ,'8' pressed it will move backward, '4' pressed it will move left, '6' pressed it will move right side, and '5' pressed the robot will be stopped. as shown in fig.4.1

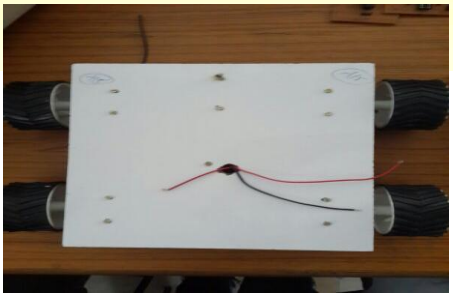


Fig 4.1 Initial stage of the project

The robot arms will be developed and then it will be move up and down the arms it will controlled by the microcontroller. The water pump will be used in the project to pump the water / paint it also controlled by the mobile. When '7' pressed it will pump the motor and when'9' pressed it will stop the pump. As shown in fig. 4.2

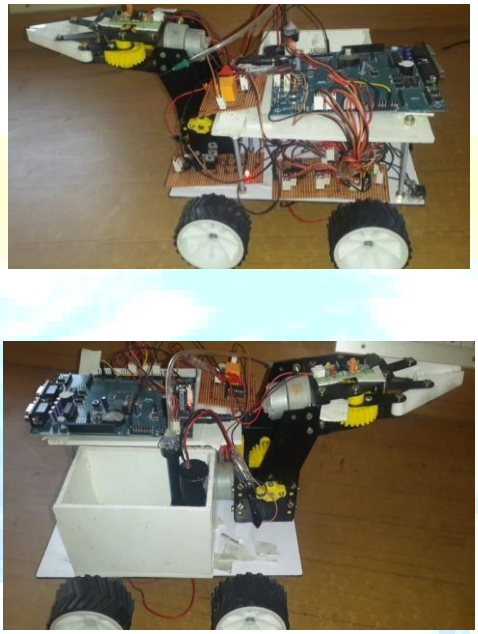


Fig 4.2: Overall View of the Project

5. CONCLUSION

Automatically paint the wall controlled by mobile [DTMF] technology has been designed and implemented in this project. The microcontroller unit to control the movement of the dc motor and spraying. The robot eliminates the hazards caused due to the painting chemicals to the human painters such as eye and respiratory system problems and also the nature of painting procedure that requires repeated work and hand rising makes it boring, time and effort consuming. The robot reduces work force for human workers and reduces time consumption. Our aim of the project to impress our objects like buildings and automobiles.

6. FUTURE SCOPE

In the future the painting robot can be enhanced by using image processing in order to scan the objectives and obstacles that are present in the wall so that those objects can be automatically omitted while painting.By keeping wireless camera in the robot we can see the painting objects clearly in the office itself.

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