**Chapter-1**

**INTRODUCTION**

In general the forklift can be defined as a tool capable of lifting hundreds of kilograms. A forklift is a vehicle similar to a small truck that has two metal forks on the front used to lift cargo. The forklift operator drives the forklift forward until the forks push under the cargo, and can then lift the cargo several feet in the air by operating the forks. The forks, also known as blades or tines, are usually made out of steel and can lift up to a few tons.

Forklifts are either powered by gasoline, propane, or electricity. Electric forklifts relay on batteries to operate. Gasoline or propane forklifts are sometimes stronger or faster than electric forklifts, but they are more difficult to maintain, and fuel can be costly. Electric forklifts are great for warehouse use because they do not give off noxious fumes like gas powered machines do.

Forklifts are most often used in warehouses, but some are meant to be used outdoors. The vast majority of rough terrain forklifts operate on gasoline, but some use diesel or natural gas. Rough terrain forklifts have the highest lifting capacity of all forklifts and heavy duty tires (like those found on trucks), making it possible to drive them on uneven surfaces outdoors.

It is important for forklift operators to follow all safety precautions when using a forklift. Drivers should be careful not to exceed the forklift's weight capacity. Forklift operators also need to be able to handle forklift's rear wheel steering. Driving a forklift is similar to driving a car in reverse, meaning that the driver must constantly steer to keep it moving in a straight line. The driver must be aware of the forklift's ever-changing center of gravity and avoid making any quick sharp turns or going too fast. It is advisable that anyone who operates a forklift be fully trained and licensed.

Forklifts have revolutionized warehouse work. They made it possible for one person to move thousands of pounds at once. Well-maintained and safely operated forklifts make lifting and transporting cargo infinitely easier. This is the general description of a normal forklift truck. To enhances the technology further, this prototype module is constructed with remote technology, there by the operator can walk along with the forklift for better visibility & the container can be placed accurately (precision position). This increases the safety of the operator.

The mechanical structure of this prototype module is constructed with square metal pipes, this structure looks like a rectangular box & the vertical moving mechanism that contains metal forks is assembled over the structure at front side. Since it operates through a remote, it doesn’t contain any steering mechanism. The entire vehicle is designed to drive through four wheels, & four motors are used to drive all the four wheels directly. Two left side motors of front and rear are connected parallel, similarly the other two motors used to drive right side front and rear wheels are also connected parallel. All these four motors are driven through a single ‘H’ bridge DC motor drive package. All the four wheels are directly coupled to the motor shafts independently. The DC Motors are having reduction gear mechanism internally, there by speed is reduced and torque is increased. The detailed description is provided in following chapters.

The fundamental concept involved in the system is to create mechanical movements in the forklift according to the command signals generated and transmitted through the remote designed with RF module. In this concept, the command signal information produced through an activated key interfaced with data transmitting controller, & and accordingly based on the digital code generated by the controller chip, the data is super imposed over the carrier & transmitted as modulated signal. The received signal is demodulated through RF receiver module & the output is fed to another microcontroller unit arranged over the forklift. This controller is programmed to control the motors through H Bridge. This process is called Radio communication, and it is the process of sending information from one place and receiving it in another place without using any connecting wires. It is also called as wireless communication system. In general Radio waves are produced by rapidly changing currents flowing through a conductor. These radio waves spread out in space like ripples produced on the surface of a pond when a stone is dropped in the water. When these fast moving radio waves strike some other conductor placed in their path at a distant point, they produce in the second conductor weak currents of the same nature as the original current which produced these radio waves. Thus a communication link will be established between two distant points. In this project work this communication system is playing active roll it is essential to describe the system well, there fore it is described in detail in following chapters.

The forklift mechanism that controls through remote is designed with two different microcontroller chips; both the chips are selected from ATMEL family. The remote controlled card that generates command signals uses 89C2051 IC; this is a 20 pin chip & consumes less energy from the battery, thereby it is selected because this circuit is operated through a small 9V battery pack. The main control circuit accommodated over the forklift is designed with 89C51 chip; this IC is having 40 pins. These are 8- bit controllers widely used for instruments and control applications. The 89C51 is the integration of a microprocessor having 4kb memory, 32 I/O lines, timers, ROM, etc. on a single chip. As this chip is having four ports, two numbers of ‘H’ Bridge packages, manual control keys, RF receiver, etc are interfaced with this single chip. This control circuit is aimed to control the five DC motors according to the command signals received from the transmitter.

Any Micro-controller, that functions according to the program written in it. Here the program is prepared in such a way, so that the system performs the function of a forklift through motors. The program is nothing but an instruction set, & according to the instructions received from the remote, the controller unit carries out the specified task. The instruction set often prepared in binary code, & are referred as machine code, there by this software is called as machine language. Writing a program in such a code is a skilled and very tedious process. It is prone to errors because the program is just a series of 0’s and 1’s and the instructions are not easily comprehended from just looking at the pattern. An alternative is to use an easily comprehended form of shorthand code for the patterns 0’s and 1’s. Micro controller can read and it can store the information received from the remote control unit. Micro-controllers are dedicated to one task and run one specific program. The program is stored in ROM (read-only memory) and generally does not change. If there are any modifications in the function, or errors in the software, the existing program must be erased from the chip & again modified program must be loaded in the chip through chip burner.

Various fields of technologies are included in this project work, because this system falls under the subject of Mechatronics. The integration of electronic engineering, mechanical engineering, electrical engineering, & control technology is forming a crucial part in this design. Especially the control circuit designed with microcontroller plays dominant roll in this project work. The term mechatronics is used to describe this integrated approach, therefore all above subjects are described in this project report in following chapters. Most systems that provide motion and force contain a mixture of Mechanical, Electrical, Electronic, and Digital Components. In fact, today most systems are mixed systems. The design of these mixed systems requires knowledge from all these fields.

To make the project work more realistic, much importance is given for practical orientation, therefore a prototype module is constructed for the demonstration purpose. This module simulates the real working system & based on this technology with slight changes in the structure & motor ratings, the system can be converted for real applications. The method of converting rotary to linear motion is implemented in the mechanism. The forklift is designed to move in all directions including reverse direction also.

**Chapter-2**

**LITERATURE SURVEY**

The complete block diagram & circuit diagram of this project work is shown in the next chapter. As per these diagrams it is clear that the process begins with the remote control unit. This unit is designed with 89C2051 microcontroller; the out put of this controller is fed to the RF transmitter. This transmitter is designed to generate a very high frequency of 433 MHz & it is used as carrier frequency. As the frequency is increased, wavelength can be decreased, this is called as shortwave transmission. Generally shortwave transmitters are used for transmitting the information over long distances. There by this high frequency transmitter & its suitable receiver, available in the form of matched pair is used in this project work; these are readymade modules available in the market, which can transmit the information up to 50feet.

The command signals are generated through six keys; these keys are interfaced with 89C2051 microcontroller. The function of each key differs from one to other; whenever any key is depressed the controller generates corresponding digital data. This controller is programmed to generate six different digital codes according to the key pressed. The digital code produced by the controller is fed to the carrier oscillator (transmitter) input as a modulating signal; this digital data is mixed with the carrier frequency of 433 MHz. When the output is delivered from the antenna, the digital data is super imposed over the carrier and transmitted as modulated wave. The controller can identify the activated key & based on this interrupted signal at one particular I/O pin, controller generates corresponding digital code. This code is decoded in the receiver, & based on this code the controller in the receiver controls the mechanism through corresponding motors. Initially the data receiving module performs the function demodulation, there by the information signal is separated from the carrier & original code that is transmitted can be availed at receiver.

Based on the information produced by the activated key, the forklift mechanism performs different functions. For example if the first key is depressed, the forklift runs in forward direction, similarly if the second key is depressed the same vehicle moves in reverse direction. Like wise the remaining functions like movements in the lifting mechanism in vertical can be made in up & down directions through two keys, similarly the vehicle can take left & right turns through by another two keys. Likewise the forklift can be controlled in all directions through remote. The following is the detailed description about wireless communication.

**RF Remote technology**

Radio waves belong to a particular type of waves called electromagnetic waves, a form of energy resulting from a combination of electrical and magnetic effects of rapidly changing electric currents. Although not visible to the eye, radio waves travel with the velocity of light waves which is 1, 86,000 miles per second. In fact, both light waves and radio waves are electromagnetic waves. Sound also travels in the form of waves but sound waves are not electromagnetic waves. Compared to electromagnetic waves, sound waves travel at a much lower speed of 1100 feet per second. This is the reason why a flash of lighting is seen first and the sound of thunder follows a little later.

In a digital communication system, the information-bearing signal is processed so that it can be represented by a sequence of discrete messages. In analog communication, frequency and wavelength represents a complete cycle of a radio wave. The number of such complete cycles performed by the radio wave in one second is called the frequency of the radio wave. The unit of frequency is hertz, which is one cycle per second. This unit is named after Henrich Hertz, who discovered radio waves. Radio waves generally posses a frequency of millions of hertz, thus represented by megahertz. The wavelength of a radio wave is the distance traveled by the wave during one complete cycle.

Every communication system is allocated with a fixed frequency for operation which is required to be maintained constant within prescribed limits to avoid interference with neighboring stations. Every transmitting station is assigned with a radio frequency called as the carrier which can travel over long distances in free space with the speed of light. However, the human ear cannot respond to these high frequencies. If the radio waves are to carry a message or information, some feature of the radio wave must be varied in accordance with the information to be communicated. The process by which the information is superimposed on the carrier is called modulation. In the case of radio broadcasts the information or the message generally consists of low frequencies in the range of 20Hz to 20,000Hz. These low frequencies are called audio frequencies, because the human ear can respond to corresponding sound frequencies in the same range. But here the function is transmit the digital data, there by the information signal in the form of bits are transmitted.

When the receiver is synchronized with the transmitter it can be said as the receiver is tuned with the transmitter, if the receiver is tuned perfectly then the communication link will be established. The transmitting antenna sends out radio waves in all directions. When radio waves leaving through a conductor of specific size is called as transmitting antenna, similarly at the receiving end signals are picked up through another conductor of same length is called as receiving antenna. Here in this project work, as the range is very less, thin copper rods of 20 cm’s length each is used as antenna.

**Mechanical Actuation Section**

The mechanical system is considered as motion converter, this can be created by implementing electro-mechanical techniques. The concept is to transform the motion from one form to some other required form by using suitable mechanical & electrical devices. In this project work the technique of transform the rotational motion in to linear motion is implemented. For this purpose five DC motors are used to create motion in the mechanism that functions as forklift. These motors are constructed with reduction gear mechanism & it is built in with the motor internally. As the machine is designed as prototype module, lowest rating motors are used to drive the mechanism.

The advantage of selecting reduction gear mechanism motors are that a small motor can drive heavy loads, as these motors are purchased from local market, ratings regarding torque is not mentioned. Only speed and operating voltage is specified, as per this data these motors are designed to operate at 12V DC & the motor speed is 30 RPM. These motors driving capacity is tested practically, in our test we came to know that each motor can drive in independent load of maximum 3Kg. there by according to this driving capacity, one small forklift vehicle is designed for the demo purpose.

Rotary motion can be transferred from one shaft to another by a pair of rolling gears. Depending up on the ratio of final shaft speed number gears are arranged in to a group are called as gear trains, these gear trains are mechanisms which are widely used either to increase or to decrease the final shaft speed. When the speed is increased torque will be reduced, where as if the speed is decreased torque will be increased. In general these teethed gear wheels are coupled in between two parallel shafts. When two gears are in mesh, the larger gear wheel is often called as crown wheel and the smaller one is called as pinion.

The vertical moving mechanism coupled to a worm gear through a chain driving system is coupled with motor shaft. These types of gears are used to obtain angular transmission of power. These gears are classified as a special type of helical gear, the shafts of which make an angle of 90 degrees with one another, but are not in the same plane. Initially the power is transmitted from the pinion to ring gear, the pinion is directly coupled with motor shaft, when the motor is energized the ring gear starts rotating. This ring gear is coupled with metal shaft, now both ends of this shaft is coupled with bearings there by the shaft is rotated freely. With the help of another pinion coupled with the ring gear shaft, vertical moving mechanism is driven through chain system. The vertical moving mechanism is designed with ball bearing type smooth sliding channels; these channels are lubricated to avoid friction in the movements. The chain system is coupled with these sliding channels mechanism, there by the forks welded with the vertical moving mechanism are raised and lowered according to the command signals received from the receiver.

The second pinion coupled with ring gear shaft is intended to drive the chain system, this simple chain itself can be called as driven gear. For example, if the driven chain is 50 times bigger than the driving gear (pinion), then driving gear must made 50 revolutions to rotate the chain for one complete revolution. This type of gear train is referred to as a speed reducer. To avoid wheel slipping, here chain driving system is implemented. Chain drives operate with a constant ratio, due to the positive interaction between the chain and pinion, there is no slipping. The driving sprocket (a tooth on the rim of a wheel) and the driven sprocket each have a number of teeth designed to match the size and pitch of the chain. The transmission of rotational speed and power between the sprockets follows the following relationship.

The number of teeth in a gear is proportional to its diameter, if the number of teeth in a pinion be N1 and the teeth in the driven wheel denoted as N2, then the gear ratio is given by n = N1/N2, and the speed of the output with respect to the input is, output speed = gear ratio to be multiplied with input speed. Lubrication is an important factor in chain drive. A properly lubricated chain can last 100 times longer than an identical, improperly lubricated chain.

The forklift vehicle chassis is driven through four DC motors; all the four wheels are directly coupled with motor shafts. Two increases the torque left side motors and right side two motors are connected in parallel, when the vehicle is moving in forward direction, the right side motors will rotate in clock wise, where as the left side motors rotate in anti-clock wise. This phenomenon will be exactly reversed while traveling the vehicle in reverse direction. During right turn, both left motors & both right motors will rotate in anti-clock wise. Similarly to take left turn, all the four motors should rotate in clock wise.

**Manual Operation Keys**

In addition to the remote controlled keys, the forklift is equipped with 6 manual keys. By activating these keys manually, all the movements can be created in the forklift. All these 6 keys are directly interfaced with microcontroller at input side, one end of all the keys are shorted together and connected to the ground. When any key is depressed active low signal is generated for the controller, based on this signal the controller drives the DC motors through ‘H’ bridge.

**H – Bridge**

The motor driving circuit is designed with L293D chip; this is popularly known as ‘H’ bridge device generally used to drive the low power DC motors. The current flowing through each driver circuit is restricted to 600 ma & it can with stand up to a peak current of 1.2amps.This chip is having two drive circuits internally; therefore it can drive two DC motors simultaneously. As two motors are connected in parallel, single chip can drive four motors comfortably. Since the device can accept TTL logics, it can be interfaced with controller directly. This device is built in with four channel drivers, there by both motors can be rotated in both directions. The enable pins & channel inputs are controlled by the microcontroller.

The DC motors used to drive the wheels will not consume more than 200 milliamps at full load, two motors together consumes a maximum power of 400 milliamps, as the each drive circuit is capable of supply 600 milliamps comfortably, heat sink is not required. If any higher rating motor is used, heat sink is essential for long run & this heat sink must be coupled to the center 4 pins of the chip.

This motor driver package is interfaced with 89C51 microcontroller through IN1 to IN4 of H Bridge. Both the enable pins (EN1 and EN2) of motor driver L293D is combined together and fed to controller to access the command signals. Depending up on the command signals issued by the controller, the enable pins are activated to control all the four internal drivers of L293D respectively to drive two internal geared DC motors. Hear H Bridge is required, because the microcontroller output is not sufficient to drive the DC motors, so current drivers are required for motor rotation.

The L293D is a quad, high current, half-H driver designed to provide bidirectional drive currents of up to 600mA at voltages from 4.5V to 36V. It makes it easier to drive the DC motors. The L293D consists of four drivers. Pins IN1 through IN4 and OUT1 through OUT4 are input and output pins, respectively, of driver 1 through driver 4. Drivers 1 and 2, and drivers 3 and 4 are enabled by enable pin 1 (EN1) and pin 9 (EN2), respectively. When enable input EN1 (Pin1) is high, drivers 1 and 2 are enabled and the outputs corresponding to their inputs are active. Similarly, enable input EN2 (Pin9) enables drivers 3 and 4. The detailed description about ‘H’ bridges is provided in chapter – 10.

**Microcontroller**

The controller used here is belongs to 8051 family architecture & often it is referred to as MCS-51. This microcontroller is having an 8-bit data bus. In this family some of the controllers are capable of addressing 64K of program memory and a separate 64K of data memory. The 8051 has 4K of code memory implemented as on-chip Read Only Memory (ROM). The 8051 has 128 bytes of internal Random Access Memory (RAM). The 8051 has two timer/counters, a serial port, 4 general purpose parallel input/output ports, and interrupt control logic with five sources of interrupts. Besides internal RAM, the 8051 has various Special Function Registers (SFR), which are the control and data registers for on-chip facilities. The SFRs also include the accumulator, the B register, and the Program Status Word (PSW), which contains the CPU flags. Programming the various internal hardware facilities of the 8051 is achieved by placing the appropriate control words into the corresponding SFR’s.

As stated, the 8051 can address 64K of external data memory and 64K of external program memory. These may be separate blocks of memory, so that up to 128K of memory can be attached to the microcontroller. Separate blocks of code and data memory are referred to as the Harvard architecture. The 8051 has two separate read signals, RD# and PSEN#. The first is activated when a byte is to be read from external data memory, the other, from external program memory. Both of these signals are so-called active low signals. That is, they are cleared to logic level 0 when activated. All external code is fetched from external program memory. In addition, bytes from external program memory may be read by special read instructions such as the MOVC instruction. There are separate instructions to read from external data memory, such as the MOVX instruction. That is, the instructions determine which block of memory is addressed, and the corresponding control signal, either RD# or PSEN# is activated during the memory read cycle. A single block of memory may be mapped to act as both data and program memory. This is referred to as the Von Neumann1 architecture. In order to read from the same block using either the RD# signal or the PSEN# signal, the two signals are combined with a logic AND operation. This way, the output of the AND gate is low when either input is low. The advantage of the Harvard architecture is not simply doubling the memory capacity of the microcontroller. Separating program and data increases the reliability of the microcontroller, since there are no instructions to write to the program memory. A ROM device is ideally suited to serve as program memory. The Harvard architecture is somewhat awkward in evaluation systems, where code needs to be loaded into program memory. By adopting the Von Neumann architecture, code may be written to memory as data bytes, and then executed as program instructions.

**Fork- Lift Trucks**

The basic module of forklift truck was built around hundred years ago, at that it was used for simple applications, but today it is found in everywhere at industries, godowns, dock yards, railway yards, warehouses, etc. wide variety of modules are in use for different applications. In fact today there is no such depot that functions without this fork lift truck. Most of the fork lifts world wide, more then 99%, they required human operators, they are suppose to sit in the driving cabin arranged over the fork lift to drive it. Some tomes accidents may take place because of poor visibility (poor visibility conditions may raise when the fork lift raises a huge container). Often poor visibility problems are more for the operator, because most of the forklifts are having lifting mechanism at its front side. This leads to human errors. To avoid these problems, here in this project work, remote operated forklift is designed for the demo purpose.

Today the technology of the forklifts expanded broadly & they are used for many applications. In this regard we decided to construct one small prototype module of forklift mechanism as our project work. To create some thing new technology in the field of forklifts & to make it as innovative, this forklift is designed to operate through remote. For this purpose RF remote control technology is implemented. This technology offers many benefits; mainly the operator is protected from all of sudden impacts. These days wireless remote control systems are widely used for many applications ranging from a small toy to heavy machines. Using wireless system for the forklift can increase the operational efficiency of the system and it is ensured 'accident free' operation.

In general in the conventional system, during loading or unloading at depots, the operator is required to be stationed inside the [driver's](http://www.allbusiness.com/primary-metal-manufacturing/iron-steel-mills-ferroalloy/439108-1.html) cabin to operate the forklift movements until completion of the task. A second person is required to be on the floor to hold the container that is to be lifted. Since the cabin, which houses all the controls and switches including steering wheel for manually driving the forklift is typically 6 feet above the floor; the person stationed on the ground has to give directions to the operator when moving the load. In such condition the visibility of the operator from the operator's cabin is restricted, because the load is existed in front of him. Most of the time, the operator is completely dependant on the signals from his co-workers. This creates a poor safety condition; accidents can take place as a result of incorrect signaling or interpretation due to human error. The poor visibility reduces the speed of operation and thus lowers productivity. To avoid all these problems, the remote control method is the best, by which the operator him self can judge perfectly, he him self can walk along with the forklift & additional person is not required to pass directions or hold the container.

As this development work falls under the subject of Mechatronics, various fields of technologies must be included to full-fill the target. The purpose of mechatronics is to provide knowledge regarding the Mechanical, Electrical, Electronics, Embedded Software, and Digital components required for the system. To make the project work more realistic, much importance is given for practical orientation, therefore a prototype module is constructed for the demonstration purpose. This mini module simulates the real working system & based on this technology huge machine can be constructed for real applications. The machine is constructed with electronics, electrical & mechanical components. The mechanical structure is constructed with a variety of devices as they relate to robots. The method of converting rotary to linear motion is implemented in the mechanism, for this reason three DC motors with reduction gear mechanism are used to create motion in the mechanism in three dimensions.

**Forklift Classifications**

There are seven classes of forklift that describe the fuel option of the forklift and the use. Each forklift operator must be certified to use on each class of forklift that they will operate.

* **Class 1 Electric Motor Rider Trucks:** These forklifts can be equipped with either cushion or pneumatic tires. The cushion tired lift trucks are intended for indoor use on smooth floors. The pneumatic tired models can be used in dry outdoor applications. These vehicles are very versatile and are found from the loading dock to the storage facility. They are generally used in applications where air quality factors need to be considered, i.e. non polluted areas.
* **Class 2 – Electric Motor Narrow Aisle Trucks:** This forklift is for companies that opt for very narrow aisle (passageway) operation. This allows them to maximize the use of storage space. These vehicles have been developed unique features that are designed to minimize the space occupied by the truck and to improve speed and efficiency.
* **Class – 3 Electrical Motor Hand or Hand Rider Trucks:** These are hand controlled where the operator is in from of the truck and controls the lift truck through a steering tiller. All controls are mounted on the top of the tiller and the tiller is moved side to side to steer the truck. These vehicles are battery powered with the smaller capacity units using industrial batteries.
* **Class – 4 – Internal Combustion Engine Trucks – Cushion Tires:** These forklifts are used inside on smooth dry floors for transporting palletized loads to and from loading dock and the storage area. The cushion tired forklifts are lower to the ground than pneumatic tired forklift truck. This allows cushion tired forklift trucks more useful in low clearance applications.
* **Class 5 – International Combustion Engine Trucks – Pneumatic Tires:** These trucks are most commonly seen in warehouse. They can be used either inside or outside and used in virtually any type of application. Because of the large capacity range of this series of lift truck, they can be found handling small single pallet loads to loaded 40 foot containers. These lift trucks can be powered by internal combustion engines and are available for use with LPG, Gasoline, and Diesel and Compressed Natural Gas fuel systems.
* **Class 6 – Electric and Internal Combustion Engine Tractors:** These are multipurpose vehicles & are versatile. They can be used in a variety of applications. They can be equipped with either internal combustion engines for outdoor use or battery powered electric motors for indoor use.
* **Class 7 – Rough Terrain Forklift Trucks:** Rough terrain forklifts are fitted with large flotation type tires for outdoor use on difficult surfaces. They are often used at construction sites to transport and lift building materials to various job site locations. They are also common with lumber yards and auto recyclers.

## Work Activities

Forklift trucks are vehicles designed to move and stack heavy or bulky goods. They are mainly used in warehouses, stockyards and other storage areas. Forklift trucks are highly mobile with a very small turning circle which allows them to move easily in confined spaces. On the front of the truck are two forks operated by hydraulics. The driver must fit these forks into the pallets on which goods are stored. The operator then uses the hydraulic forks to lift the pallet, takes it to where it is needed and sets it down.

Some goods, such as bricks, can be moved by fork-lift trucks without the need for pallets. They are stacked in bales with spaces for the forks. The operator must work carefully as these goods are not protected by pallets. Some trucks are fitted with small computer display panels that direct the operator where to place goods in the warehouse.

Operators may also have to keep records and follow instructions written on a worksheet. They are also responsible for the basic maintenance of the truck. This includes greasing or oiling parts and changing or recharging the battery. Forklift truck operators may have to work in a noisy and dusty environment. Working outdoors in all weather conditions may also be necessary.

Industrial lift trucks are used for handling materials, parts, products, tools, equipment, supplies and maintenance items. Forklifts are efficient for material handling because they are self-propelled, maneuverable and require only one operator to lift, transport, and stack or un-stack the material. Forklifts may be used for indoor or outdoor use depending on their size, tires and load capacities. The major factors that lead to injuries involving the use of forklifts include unsafe driving and material handling practices.

Although the term 'forklift', 'fork lift', or 'fork truck' is instantly recognizable, their full, official title is a Fork Lift Truck, due to the fork shaped tool at the front that traditionally was used to lift pallets. But now, like any other piece of equipment, the forklift has evolved and is available in a wide variety of styles, with varying functions and capacities, depending on where and how they are to be used.

All lift truck operators must be trained prior to operating a lift truck. Training is provided by the concern manufacturer and consists of both formal instruction and practical training. Training is both vehicle- and workplace-specific. The training is a one-time requirement unless the operator is involved in a lift truck accident or is observed operating the truck in an unsafe manner.

Industrial lift trucks must be inspected prior to each day of service. A daily inspection checklist must be completed and any defects should be reported and corrected immediately. A truck may not be placed into service if any defects are found during the inspection.

**Capacity**  
 Usually forklifts start at around 600 kg load lifting capacity and go up to 52,000 kg, which is a staggering 52 tons. Most forklifts are rated for less than 3 tons. However, weight is not as straightforward as it may seem. The size of the load will also impact the capacity. Weight capacity is usually based on a 600 mm (24 inch) load centre, although this can vary. This means that the distance from the centre of the load the edges can be no more than 600 mm. If the load is bigger and/or longer, the truck will not be able to lift as much weight.

**Height**

The height that fork lift trucks can lift to varies enormously. Some can lift up to 11 meters or more (some 36 feet) whereas the basic ones will lift less than 3 meters (10 feet). Generally, height requirements are fairly static; depending up on the requirement, lifting height can be adjusted by the manufacturer.

**Fork lift safety awareness**

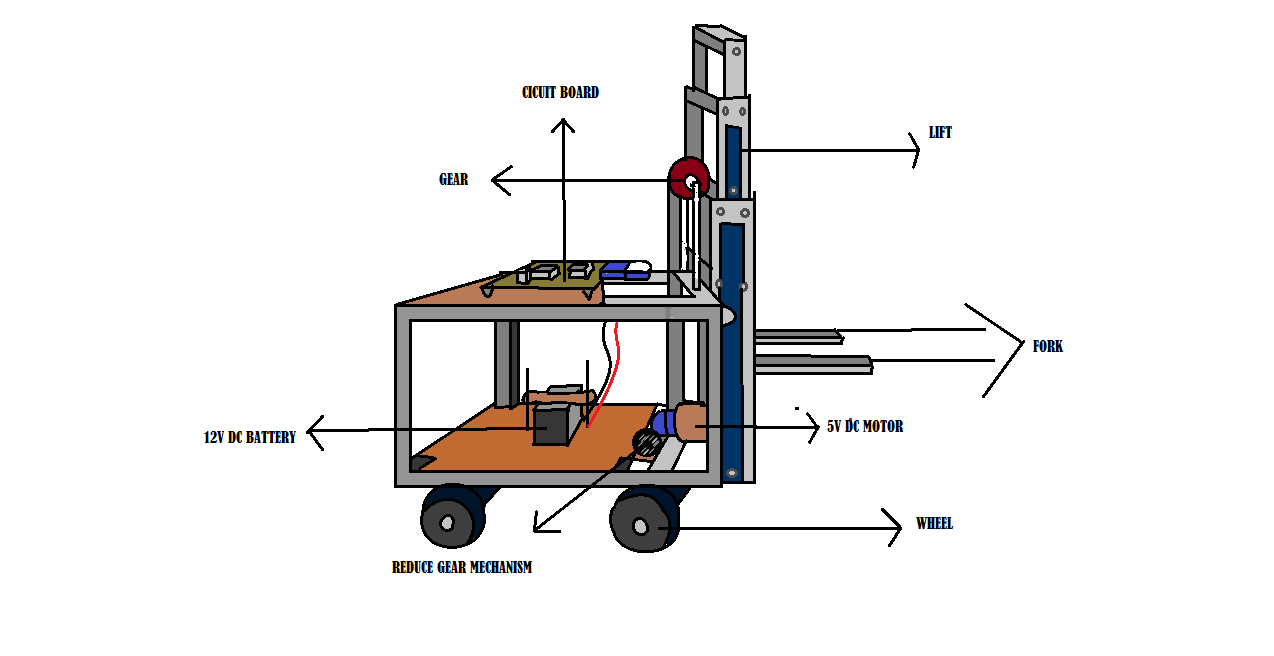
In every wholesaler-distributor operation, stacks, bundles and rolls of raw material and finished products of various shapes, sizes and weights must be moved. Excessive and inefficient material handling affects the productivity and profits. And manual material handling may be dangerous. Efficient material handling systems and safe operation of material handling equipment such as powered industrial trucks are the solution.

A powered industrial truck is defined as a mobile, power-driven vehicle used to carry, push, pull, lift, stack or tier material. Forklifts are one type of powered industrial truck used by many wholesaler-distributors. Other powered industrial trucks are known as pallet trucks, rider trucks, fork trucks, or lift trucks. There are many types and sizes of powered industrial trucks designed for different jobs. Many are named by the function they perform, such as high lift trucks, counterbalanced trucks, rider trucks and forklift trucks. Powered industrial trucks refer to as “forklifts” are used throughout the wholesale distribution industry to move raw materials and stock and to elevate personnel.

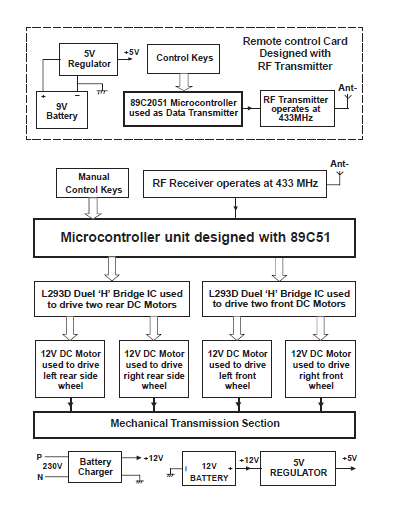
**Chapter-3**

**BLOCK DIAGRAM, CICUIT DIAGRAM & PROGRAM FLOW CHART**

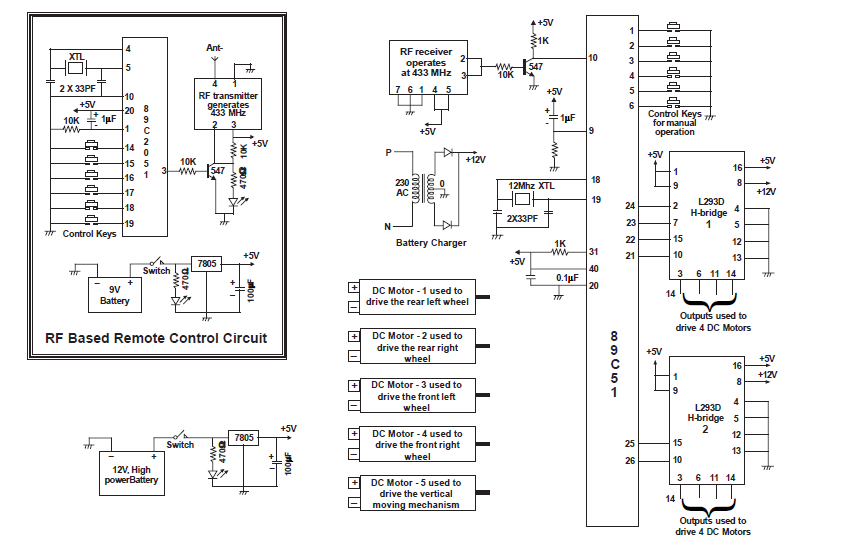
**Schematic Diagram of the Fork Lift:**

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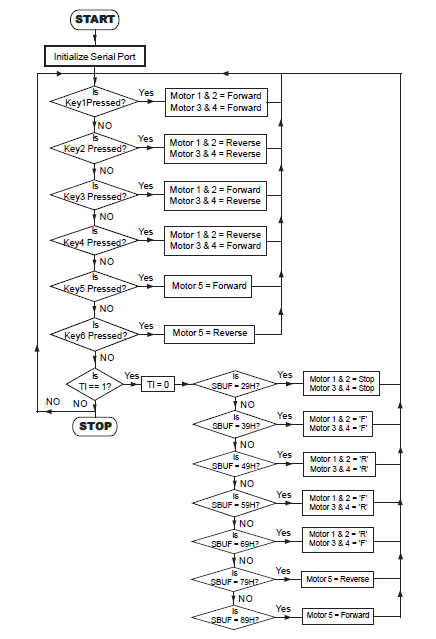
**Block Diagram:**

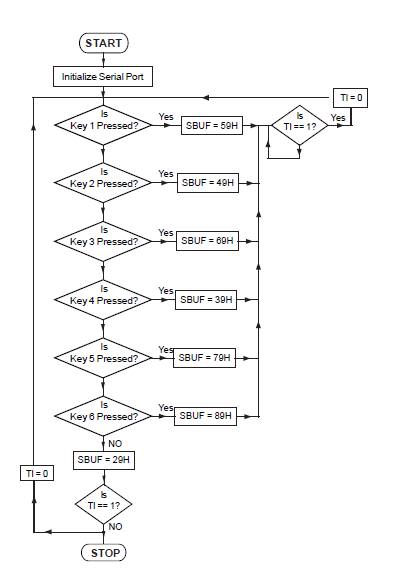
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**Complete Circuit Diagram Of Remote Operated Fork Lift:**

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**Program Flow Chart:**

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**Chapter-4**

**POWER SOURCE DESCRIPTION**

The subject of forklift is related to automobile & it moves in the field, it can not be driven through mains; hence it is designed to operate through a heavy duty battery. This battery is nothing but a chemical voltage source, and there by the power source it self moves along with the forklift, because it is assembled over the fork lift chassis. A chemical voltage source is one of the most important sources of electrical energy. It is a self contained voltage source and does not need any out side energy. When the battery is discharged it is supposed to be charged with suitable charger which acquires energy from mains supply, i.e. single phase conventional energy source. The electrical energy supplied by a chemical source of voltage is produced by chemical action within the source itself. Chemical voltage sources normally exist in the form of batteries and cells of various types. These batteries are extensively used for mobile applications.

The required power to drive the forklift is obtained from 12V battery, here heavy duty battery of 7.5AH (Ampere Hour) current rating is used for long back-up time. This is a maintenance free battery built in with a group of cells combined together to increase the voltage and current to the required level. A cell or battery is classified as a ‘primary’ or ‘secondary’ depending up on the manner in which the chemical energy is converted in to electrical energy. The primary cell cannot be re-charged, it is a type of use and through concept battery. A secondary cell must be charged with electrical energy first to enable it to convert the chemical energy into electrical energy. Because of its action of storing energy supplied to it, a battery consisting of secondary cells is often called a storage battery. Here in this project work this kind of re-chargeable storage battery is used.

The forklift is designed to operate at 12V DC, therefore here 12V DC lead acid re-chargeable battery is used and it is accommodated over the chassis. To calculate the back up time, first we must calculate the overall power consumption of forklift. Back-up time = battery rating / consumption, according to this equation back up time is depends up on the power consumption of the system. As this fork lift is designed with 5 DC motors & each motor consumes 200 milliamps, all the motors together consumption is 1amp approximately. In addition the control circuit designed with microcontroller & its associated hardware will consume another 200 milliamps. So the entire system may consume 1200 milliamps from the battery. Therefore the battery back-up time = 7.5/1.2 = 6.25 hours approximately.

Batteries are maintenance free sealed lead acid rechargeable batteries. The batteries are having excellent economy stability and superior output. Various characteristics have been improved such as leak proof, overcharging and over discharging. This compact & powerful sealed lead-acid battery with higher performance can be used as a power source for portable instruments and also for power backup use. Batteries are now being used in a wide range of applications.

**Charging method**

These Batteries are maintenance free. There is no need to add water. Battery performance and service life are greatly affected by the charging method. There are various different charging methods: constant voltage charging, constant current charging, tapered current charging and some combination systems.

Batteries can be charged by any of those methods. However, constant voltage charging combined with limited current is recommended for obtaining maximum capacity and service life together with acceptable recharge times and economy.

### Chapter-5

### DESCRIPTION RF COMMUNICATION SYSTEM

# Model of a communication system: The overall purpose of the communication system is to transfer information from one point to in space and time, called the source to another point, the user destination. As a rule, the message produced by a source is not electrical. Hence an input transducer is required for converting the message to a time varying electrical quantity called a message signal. At the destination point another transducer converts the electrical waveform to the appropriate message.

The information source and the destination point are usually separated in space. The channel provides the electrical connection between the information source and the user. The channel can have many deferent forms such as a microwave radio link over free space a pair of wires, or an optical fiber. Regardless of its type the channel degrades the transmitted single in a number of ways. The degradation is a result of signal distortion due to imperfect response of the channel and due to undesirable electrical signals (noise) and interference. Noise and signal distortion are two basic problems of electrical communication. The transmitter and the receiver in a communication system are carefully designed to avoid signal distortion and minimize the effects of noise at the receiver so that a faithful reproduction of the message emitted by the source is possible.

The transmitter couples the input message signal to the channel. While it may sometimes be possible to couple the input transducer directly to the channel, it is often necessary to process and modify the input signal for efficient transmission over the channel. Signal processing operations performed by the transmitter include amplification, filtering, and modulation. The most important of these operations is modulation a process designed to match the properties of the transmitted signal to the channel through the use of a carrier wave.

Modulation is the systematic variation of some attribute of a carrier waveform such as the amplitude, phase, or frequency in accordance with a function of the message signal. Despite the multitude of modulation techniques, it is possible to identify two basic types of modulation: the continuous carrier wave (CW) modulation and the pulse nodulation. In continuous wave (CW) carrier modulation the carrier waveform is continuous (usually a sinusoidal waveform), and a parameter of the waveform is changed in proportion to the message signal. In pulse modulation the carrier waveform is a pulse waveform (often a rectangular pulse waveform), and a parameter of the pulse waveform is changed in proportion to the message signal. In both cases the carrier attribute can be changed in continuous or discrete fashion. Discrete pulse (digital) modulation is a discrete process and is best suited for messages that are discrete in nature such as the output of a teletypewriter. However, with the aid of sampling and quantization, continuously varying (analog) message signal can be transmitted using digital modulation techniques.

Modulation is used in communication systems for matching signal characteristics to channel characteristics, for reducing noise and interference, for simultaneously transmitting several signals over a single channel, and for overcoming some equipment limitations. A considerable portion of this article is devoted to the study of how modulation schemes are designed to achieve the above tasks. The success of a communication system depends to a large extent on the modulation.

The main function of the receiver is to extract the input message signal from the degraded version of the transmitted signal coming from the channel. The receiver performs this function through the process of demodulation, the reverse of the transmitter’s modulation process. Because of the presence of noise and other signal degradations, the receiver cannot recover the message signal perfectly. Ways of approaching ideal recovery will be discussed later. In addition to demodulation, the receiver usually provides amplification and filtering. Based on the type of modulation scheme used and the nature of the output of the information source, we can divide communication systems into three categories:

1. Analog communication systems designed to transmit analog information using analog modulation methods

2. Digital communication systems designed for transmitting digital information using digital modulation schemes and

3. Hybrid systems that use digital modulation schemes for transmitting sampled and quantized values of an analog message signal.

**Chapter-6**

**DESCRIPTION ABOUT MICROCONTROLLERS**

Today, there is no such instrument or machine that can function without Micro controller. Micro controllers have become an integral part of all instruments. Many tedious from simple to dedicated tasks are left over to the controller for solutions. The Micro controller used in this project work is ATMEL 89C51, basically this IC belongs to 8051 family. In1981, Intel Corporation introduced an 8- bit Micro controller, which is named as 8051. This controller is having 128 bytes of RAM, 4K bytes of ROM, two timers, one serial port, and four ports. This IC is called as 8- bit Processor, means that the CPU can work on only 8-bits of data at a time. The 8051 is having four ports and each port contain 8 input / output lines. This IC became very popular after Intel allowed other manufacturers to make and market any flavors of the 8051 they please with the condition that they remain code compatible with the 8051. This has led to many versions of the 8051 with different speeds and amounts of on-chip ROM marketed by many manufacturers. ATMEL is one of the major manufacturers of these devices and are compatible with the original 8051 as far as the instructions are concerned. The original 8051 of Intel are having a maximum of 64K bytes of on-chip ROM, where as the ATMEL 89C51 is having only 4K bytes on the chip. ATMEL 89C52 is designed with 8K memory, like wise up to 20K bites on the chips are available from ATMEL Company. The Atmel Corporation has a wide selection of 8051 chips and out of, the AT 89C51 is a popular and inexpensive chip used for many applications. It has 4K bytes of flash ROM; ‘C’ stands for ‘CMOS’, which has low power consumption.

The ATMEL AT89C51 is a low power, higher performance CMOS 8-bit microcomputer with 4K bytes of flash programmable and erasable read only memory (PEROM). Its high-density non-volatile memory compatible with standard MCS-51 instruction set makes it a powerful controller that provides highly flexible and cost effective solution to control applications. Micro-controller works according to the program written in it. Most microcontrollers today are based on the [Harvard architecture](http://en.wikipedia.org/wiki/Harvard_architecture), which clearly defined the four basic components required for an embedded system. These include a [CPU](http://en.wikipedia.org/wiki/Central_processing_unit) core, [memory](http://en.wikipedia.org/wiki/Computer_storage) for the program ([ROM](http://en.wikipedia.org/wiki/Read-only_memory) or [Flash memory](http://en.wikipedia.org/wiki/Flash_memory)), memory for data ([RAM](http://en.wikipedia.org/wiki/Random_Access_Memory)), one or more timers (customizable ones and [watchdog timers](http://en.wikipedia.org/wiki/Watchdog_timer)), as well as [I/O](http://en.wikipedia.org/wiki/I/O) lines to communicate with external peripherals and complementary resources — all this in a single [integrated circuit](http://en.wikipedia.org/wiki/Integrated_circuit). A microcontroller differs from a general-purpose CPU chip in that the former generally is quite easy to make into a working computer, with a minimum of external support chips. The idea is that the microcontroller will be placed in the device to control, hooked up to power and any information it needs, and that's that. A traditional microprocessor won't allow you to do this. It requires all of these tasks to be handled by other chips. For example, some number of RAM memory chips must be added. The amount of memory provided is more flexible in the traditional approach, but at least a few external memory chips must be provided, and additionally requires that many connections must be made to pass the data back and forth to them. For instance, a typical microcontroller will have a built in [clock generator](http://en.wikipedia.org/wiki/Clock_generator) and a small amount of RAM and ROM (or [EPROM](http://en.wikipedia.org/wiki/EPROM) or [EEPROM](http://en.wikipedia.org/wiki/EEPROM)), meaning that to make it work, all that is needed is some control software and a [timing crystal](http://en.wikipedia.org/wiki/Timing_crystal) (though some even have internal [RC](http://en.wikipedia.org/wiki/RC_circuit) clocks). Microcontrollers will also usually have a variety of [input/output](http://en.wikipedia.org/wiki/Input/output) devices, such as [analog-to-digital converters](http://en.wikipedia.org/wiki/Analog_to_digital_converter), timers, [UARTs](http://en.wikipedia.org/wiki/UART) or specialized [serial communications](http://en.wikipedia.org/wiki/Serial_communications) interfaces like [I²C](http://en.wikipedia.org/wiki/I2C), [Serial Peripheral Interface](http://en.wikipedia.org/wiki/Serial_Peripheral_Interface) and [Controller Area Network](http://en.wikipedia.org/wiki/Controller_Area_Network). Often these integrated devices can be controlled by specialized processor instructions.

Originally, microcontrollers were only programmed in [assembly language](http://en.wikipedia.org/wiki/Assembly_language), or later in [C](http://en.wikipedia.org/wiki/C_programming_language) code. Recent microcontrollers integrated with on-chip debug circuit accessed by [In-circuit emulator](http://en.wikipedia.org/wiki/In-circuit_emulator) via [JTAG](http://en.wikipedia.org/wiki/JTAG) (Joint Text Action Group) enables a programmer to debug the software of an embedded system with a [debugger](http://en.wikipedia.org/wiki/Debugger).

With all latest features, this chip can be called as a mini computer. The prime use of a microcontroller is to control the operation of a machine using a fixed program that is stored in ROM and that does not changeover the lifetime of the system. The microcontroller design uses a much more limited set of instructions that are used to move code and data from internal memory to the ALU. Many instructions are coupled with pins on the IC package. The pins are programmable independently, that is capable of having several different functions depending on the program. The microcontroller is concerned with getting data from and to its own pins; the architecture and instruction set are optimized to handle data in bit, byte, and word size. Generally for any application, often designers chose the 8 – bit controller, because they are most popular microcontrollers in use today, another important aspect is cost effective.

The following are the features of 8051 microcontroller

1. Eight – bit CPU with registers
2. 16 – bit program counter and data pointer
3. 8 – bit program status word
4. 8 – bit stack pointer
5. Internal ROM or EPROM (4k)
6. Internal RAM of 128 bites
7. Four register banks, each containing eight registers
8. 16 bytes, which may be addressed at the bit level
9. 80 bytes of general purpose data memory
10. 32 input / output pins arranged as four 8 – bit ports
11. Two sixteen bit timer / counter
12. Full duplex serial data receiver / transmitter
13. Two external and three internal interrupt sources
14. Oscillator and clock circuits
15. Control registers

**The 8051 Microcontroller Family Architecture**

The roll of microcontroller is very important in this project work, 89C51 is used here, this is quit popular IC generally used for all applications. The prime use of a microcontroller is to function like a minicomputer using a fixed program that is stored in ROM and that does not changeover the lifetime of the system. The microcontroller design uses a much more limited set of instructions that are used to move code and data from internal memory to the ALU. Many instructions are coupled with pins on the IC package. The pins are programmable independently, that is capable of having several different functions depending on the program. The microcontroller is concerned with getting data from and to its own pins; the architecture and instruction set are optimized to handle data in bit, byte, and word size.

Every application demands a microcontroller, today there is no such electronic instrument or robot that functions with out microcontroller. Generally for any application, often designers chose the 8 – bit controller, because they are most popular microcontrollers in use today, another important aspect is cost effective.

**Memory unit**

Memory is part of the microcontroller whose function is to store data. The easiest way to explain it is to describe it as one big closet with lots of drawers. If we suppose that we marked the drawers in such a way that they can not be confused, any of their contents will then be easily accessible. It is enough to know the designation of the drawer and so its contents will be known to us for sure.

Memory components are exactly like that. For a certain input we get the contents of a certain addressed memory location and that’s all. Two new concepts are brought to us: addressing and memory location. Memory consists of all memory locations, and addressing is nothing but selecting one of them. This means that we need to select the desired memory location on one hand, and on the other hand we need to wait for the contents of that location. Besides reading from a memory location, memory must also provide for writing onto it. This is done by supplying an additional line called control line. We will designate this line as R/W (read/write). Control line is used in the following way: if r/w=1, reading is done, and if opposite is true then writing is done on the memory location. Memory is the first element, and we need a few operation of our microcontroller.

**Central Processing Unit**

Let add 3 more memory locations to a specific block that will have a built in capability to multiply, divide, subtract, and move its contents from one memory location onto another. The part we just added in is called “central processing unit” (CPU). Its memory locations are called registers.

Registers are therefore memory locations whose role is to help with performing various mathematical operations or any other operations with data wherever data can be found. Look at the current situation. We have two independent entities (memory and CPU) which are interconnected, and thus any exchange of data is hindered, as well as its functionality. If, for example, we wish to add the contents of two memory locations and return the result again back to memory, we would need a connection between memory and CPU. Simply stated, we must have some “way” through data goes from one block to another.

**Bus**

That “way” is called “bus”. Physically, it represents a group of 8, 16, or more wires.  There are two types of buses: address and data bus. The first one consists of as many lines as the amount of memory we wish to address, and the other one is as wide as data, in our case 8 bits or the connection line. First one serves to transmit address from CPU memory, and the second to connect all blocks inside the microcontroller.

**Input - output unit**

Those locations we’ve just added are called “ports”. There are several types of ports: input, output or bi-directional ports. When working with ports, first of all it is necessary to choose which port we need to work with, and then to send data to, or take it from the port.

When working with it the port acts like a memory location. Something is simply being written into or read from it, and it could be noticed on the pins of the micro-controller.

**89C51 MICROCONTROLLER – DESCRIPTION**

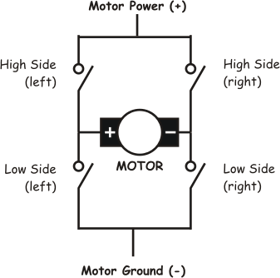
Intel Corporation introduces 89c51; it is an 8-bit microcontroller. This microcontroller has 128 bytes of RAM, 4K of on-chip ROM, two timers, one serial port, and four ports of 8-bits each all on a single chip. 89c51 is basically Flash ROM version of 8051 families. 89c51 is basically a 40 pin Dual-in-package. Block diagram of 89c51 is as shown in chapter-10, i.e., hardware details. The main features of 89c51 Hardware can be labeled as below:

* 1. It has 8-bit CPU with registers A (the accumulator) and B.  
     2. Sixteen-bit program counter (PC) and data pointer (DPTR).  
     3. Eight-bit program status word (PSW).  
     4. Eight-bit stack pointer (SP).  
     5. Internal ROM of 0 to 4K.  
     6. Internal RAM of 128 bytes.  
     7. 32 I/0 pins arranged as four 8-bit ports: P0-P3  
     8. Two 16-bit Timer/Counters: T0 and T1  
     9. Full duplex serial data receiver/transmitter: SBUF  
     10. Control registers: TCON, TMOD, SCON, PCON, IP, and IE.  
     11. Two external and three internal interrupt sources.  
     12. Oscillator and Clock circuits.

**Chapter-7**

**DESCRIPTION ABOUT ‘H’ BRIDGES**

Whenever a robotics hobbyist talk about making a robot, the first thing comes to his mind is making the robot move on the ground. And there are always two options in front of the designer whether to use a [DC motor](http://www.8051projects.net/dc-motor-interfacing/introduction.php) or a stepper motor. When it comes to speed, weight, size, cost... DC motors are always preferred over stepper motors. There are many things which we can do with DC motor when interfaced with a microcontroller. For example we can control the speed of motor, we can control the direction of rotation, we can also do encoding of the rotation made by DC motor i.e. keeping track of how many turns are made by the motors etc. So we can see DC motors are better then stepper motors.  
 In this part of tutorial we will learn to interface a DC motor with a microcontroller. Usually H-bridge is preferred way of interfacing a DC motor. These days many IC manufacturers have H-bridge motor drivers available in the market like L293D is most used H-Bridge driver IC. H-bridge can also be made with the help of transistors and Mosfets etc. rather of being cheap, they only increase the size of the design board, which is some times not required so using a small 16 pin IC is preferred for this purpose. L293D is having two ‘H’ Bridges inside, so that we can drive two DC motors simultaneously. Before discussing about this device, first we must learn basic theory of ‘H’ Bridges. The following is the description.



**Basic Theory;** The name H-bridge sometimes called a "full bridge" is so named because it has four switching elements at the "corners" of the H and the motor forms the cross bar. The basic bridge is shown in the figure above. The key fact to note is that there are, in theory, four switching elements within the bridge. These four elements are often called, high side left, high side right, low side right, and low side left (when traversing in clockwise order).

The switches are turned on in pairs, either high left and lower right, or lower left and high right, but never both switches on the same "side" of the bridge. If both switches on one side of a bridge are turned on it creates a short circuit between the battery plus and battery minus terminals. If the bridge is sufficiently powerful it will absorb that load and your batteries will simply drain quickly. Usually however the switches in question melt.

To power the motor, turn on two switches that are diagonally opposed. The current flows and the motor begins to turn in a "positive" direction. Switch off these two switches and switch on other two switches diagonally in other direction then the motor starts rotating in opposite direction. Actually it is quite simple, the tricky part comes in when we decide what to use for switches. Anything that can carry a current will work, from four SPST switches, one DPDT switch, relays, transistors, to enhancement mode power MOSFET’s.

One more topic in the basic theory section is quadrants. If each switch can be controlled independently then we can do some interesting things with the bridge, some folks call such a bridge a "four quadrant device" (4QD). If we built it out of a single DPDT relay, we can really only control forward or reverse. We can build a small truth table that tells us for each of the switch's states, what the bridge will do. As each switch has one of two states, and there are four switches, there are 16 possible states. However, since any state that turns both switches on one side on is "bad", there are in fact only four useful states (the four quadrants) where the transistors are turned on.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **High Side Left** | **High Side Right** | **Low Side Left** | **Low Side Right** | **Quadrant Description** |
| On | Off | Off | On | Forward Running |
| Off | On | On | Off | Backward Running |
| On | On | Off | Off | Braking |
| Off | Off | On | On | Braking |

In the above table the last two rows describes condition about short circuit the motor which causes the motors generator effect to work against itself. The turning motor generates a voltage which tries to force the motor to turn the opposite direction. This causes the motor to rapidly stop spinning and is called "braking" on a lot of H-bridge designs. Of course there is also the state where all the transistors are turned off. In this case the motor coasts freely if it was spinning and does nothing if it was doing nothing.

### Chapter-8

### DESCRIPTION ABOUT DC MOTORS

Permanent magnet DC motor responds to both voltage and current. The steady state voltage across a motor determines the motor’s running speed, and the current through its armature windings determines the torque. Apply a voltage and the motor will start running in one direction; reverse the polarity and the direction will be reversed. If you apply a load to the motor shaft, it will draw more current, if the power supply does not able to provide enough current, the voltage will drop and the speed of the motor will be reduced. However, if the power supply can maintain voltage while supplying the current, the motor will run at the same speed. In general, you can control the speed by applying the appropriate voltage, while current controls torque. In most cases, DC motors are powered up by using fixed DC power supply, therefore; it is more efficient to use a chopping circuit.

Consider what happens when a voltage applied to a motor’s windings is rapidly turned ON and OFF in such a way that the frequency of the pulses produced remains constant, but the width of the ON pulse is varied. This is known as Pulse Width Modulation (PWM). Current only flows through the motor during the ON portion of the PWM waveform. If the frequency of the PWM input is high enough, the mechanical inertia of the motor cannot react to the ripple wave; instead, the motor behaves as if the current were the DC average of the ripple wave. Therefore, by changing the width of pulse, we can control the motor speed.

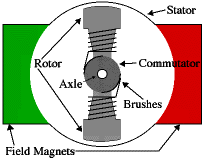
At the most basic level, electric motors exist to convert electrical energy into mechanical energy. This is done by way of two interacting magnetic fields -- one stationary, and another attached to a part that can move. A number of types of electric motors exist, but most BEAM bots use DC motors in some form or another. DC motors have the potential for very high torque capabilities (although this is generally a function of the physical size of the motor), are easy to miniaturize, and can be "throttled" via adjusting their supply voltage. DC motors are also not only the simplest, but the oldest electric motors.

Oersted, Gauss, and Faraday discovered the basic principles of electromagnetic induction in the early 1800’s. By 1820, Hans Christian Oersted and Andre Marie Ampere had discovered that an electric current produces a magnetic field. The next 15 years saw a flurry of cross-Atlantic experimentation and innovation, leading finally to a simple DC rotary motor. A number of men were involved in the work, so proper credit for the first DC motor is really a function of just how broadly you choose to define the word "motor

**Principles of operation**

In any electric motor, operation is based on simple electromagnetism. A current carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current -carrying conductor and an external magnetic field to generate rotational motion. Let's start by looking at a simple 2-pole DC electric motor (here dark black represents a magnet or winding with a "North" polarization, while light colour represents a magnet or winding with a "South" polarization).

Every DC motor has six basic parts -- axle, rotor (a.k.a., armature), stator, commutator, field magnet’s, and brushes. In most common DC motors, the external magnetic field is produced by high-strength permanent magnets. The stator is the stationary part of the motor -- this includes the motor casing, as well as two or more permanent magnet pole pieces. The rotor (together with the axle and attached commutator) rotates with respect to the stator. The rotor consists of windings (generally on a core), the windings being electrically connected to the commutator. The above diagram shows a common motor layout -- with the rotor inside the stator (field) magnets.



The geometry of the brushes, commutator contacts, and rotor windings are such that when power is applied, the polarities of the energized winding and the stator magnet(s) are misaligned, and the rotor will rotate until it is almost aligned with the stator's field magnets. As the rotor reaches alignment, the brushes move to the next commutator contacts, and energize the next winding. Given our example two-pole motor, the rotation reverses the direction of current through the rotor winding, leading to a "flip" of the rotor's magnetic field, driving it to continue rotating.

In real life, though, DC motors will always have more than two poles (three is a very common number). In particular, this avoids "dead spots" in the commutator. You can imagine how with our example two-pole motor, if the rotor is exactly at the middle of its rotation (perfectly aligned with the field magnets), it will get "stuck" there. Meanwhile, with a two-pole motor, there is a moment where the commutator shorts out the power supply (i.e., both brushes touch both commutator contacts simultaneously). This would be bad for the power supply, waste energy, and damage motor components as well. Yet another disadvantage of such a simple motor is that it would exhibit a high amount of torque "ripple" (the amount of torque it could produce is cyclic with the position of the rotor).

## Chapter-9

## HARDWARE DETAILS

The IC’s and other important components used in this project work, procured from Electronics Market. The details or data sheets of the IC’s are down loaded from the Internet. The following are the web sites that can be browsed for collecting the data sheets.

1. www. Texas Instruments.com

2. www. National semiconductors.com

3. www. Fairchild semiconductors.com

The following are the IC’s and other important components used in this project work

1. 89C51 Microcontroller
2. L293D - H Bridge
3. 89C2051 Microcontroller
4. Voltage Regulator
5. 547 Transistor

The required PCB’S (Printed Circuit boards) for the project work fabricated by SUN RISE CIRCUITS, Kushaiguda Industrial Estate, Hyderabad. Kushaiguda Industrial Estate is very famous for fabricating the Industrial grade PCB’s.

**Chapter-11**

**ADVANTAGES OF REMOTE OPERATED FORK LIFT:-**

1. The vehicle can move in any direction even though rotational movement is also possible to transfer the goods.
2. They do not give any noxious fumes like gas powered machine and hence used for warehouses.
3. It can be operated by remote as well as manually also.
4. Heavy duty tyres make it possible to drive them on uneven surfaces outdoors.
5. Well maintained and safety operated fork lift makes lifting and transporting cargo infinitely easier.

**DISADVANTAGES OF REMOTE OPERATED FORK LIFT:-**

1. Driver should be careful not to exceed the fork lift weight capacity.
2. Heavy weight goods can’t be lifted from this device.
3. Forklift operators also need to be able to handle forklift rear wheel steering.
4. Fuel (like gasoline, propane) can be costly.

**Chapter-12**

**COST EVALUATION**

**MECHANICAL COMPONENETS:-**

|  |  |  |
| --- | --- | --- |
| *COMPONENTS WITH SPECIFICATION* | *QUANTITY* | *PRICE* |
| Frame construction (including welding and painting),Mild steel | 1 | 1050/- |
| Fork lift of height 13cm. Of mild steel | 1 | 700/- |
| Mechanical chain of alloy of brass and mild steel | 1 | 400/- |
| Support bar of mild steel upto 15 cm height | 2 | 250/- |
| Ball bearing of dia 1.5 mm | 1 | 50/- |
| Rubber Wheel of 3m dia | 4 | 600/- |

**Total – 3050/-**

**ELECTRICAL AND ELECTRONIC COMPONENTS:*-***

|  |  |  |
| --- | --- | --- |
| *COMPONENTS WITH SPECIFICATION* | *QUANITY* | *PRICE* |
| 5-12V D.C. Motor,1.5 amp | 5 | 1250/- |
| Limiting switch on fork lift | 2 | 100/- |
| Microcontroller AT89C51 | 1 | 150/- |
| Software installation | 2 | 500/- |
| P.C.B | 1 | 400/- |
| L293D Dual H- Bridge IC | 2 | 300/- |
| 12V Battery,5.5amp | 1 | 600/- |
| On-Off switch of 5 amp. | 1 | 10/- |

**Total-3310/-**

**REMOTE:*-***

|  |  |  |
| --- | --- | --- |
| *COMPONENTS WITH SPECIFICATION* | *QUANTITY* | *PRICE* |
| Microcontroller AT89C2051 | 1 | 150/- |
| Receiver & Transmitter of 10 feet | 1 | 300/- |
| PCB Board | 1 | 400/- |
| 9V Battery,1.5 amp. | 1 | 150/- |
| On-Off Switch of 5amp. | 1 | 10 |

**Total-1010/-**

**BATTERY CHARGER:*-***

|  |  |  |
| --- | --- | --- |
| *COMPONENTS WITH SPECIFICATION* | *QUANTITY* | *PRICE* |
| 12-0-12 Transformer | 1 | 60/- |
| Rectifier,001 | 2 | 20/- |
| Resistance 4ohm | 1 | 20/- |
| Capacitor 10 microfarad | 1 | 40/- |
| 2 LED | 1 | 10/- |
| VGA Serial Socket | 1 | 80/- |

**Total-230/-**

**TOTAL COST OF REMOTE OPERATED FORK LIFT: - 7600/-**

## Chapter-13

## CONCLUSIONS & FUTURE WORK

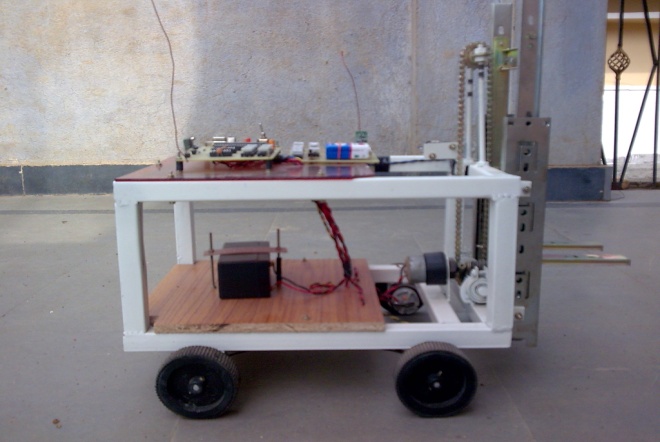
The project work “Remote operated forklift” is aimed to control through wireless communication network designed with RF modules. The main advantage of using this technology is to increase the safety of operator by operating the forklift from certain distance. This increases the efficiency of the productivity, because human errors due to the poor visibility can be minimized. The system is designed and developed successfully, for the demonstration purpose prototype module (mini module) is constructed & results are found to be satisfactorily. The RF modules used in the project work are purchased from the market, they are working well. During the trail run we have tested the range & we found that the transmitter is able control the forklift from a distance of 40feet.

While designing and developing this proto type module, especially while fabricating the mechanical parts, we have consulted few experts those who are having knowledge in Mechatronics, these professionals working at different organizations belongs to Hyderabad helped us while fabricating the forklift. Except mechanical parts, remaining electrical & electronic components are easily available. Since it is a prototype module, much amount is not invested, the whole machine is constructed with locally available components, especially the mechanical components used in this project work are procured from mechanical fabricators, and they are not up to the requirement, lot of modifications must be carried out in design & is essential to make it as real working system. Hence, the forklift is to be enhanced further for obtaining better results. Although a good amount of work has been done in the project work, even though additional features like speed control, high speed, etc. must be incorporated in the real working system. In this regard there is still scope of further improvement in the control structure by providing more flexible control. The mechanical design must be improved by using suitable gears and bearings. Speed must be increased, when the speed is increased, during emergencies breaking system must be employed. Likewise many modifications can be carried over in the future work.

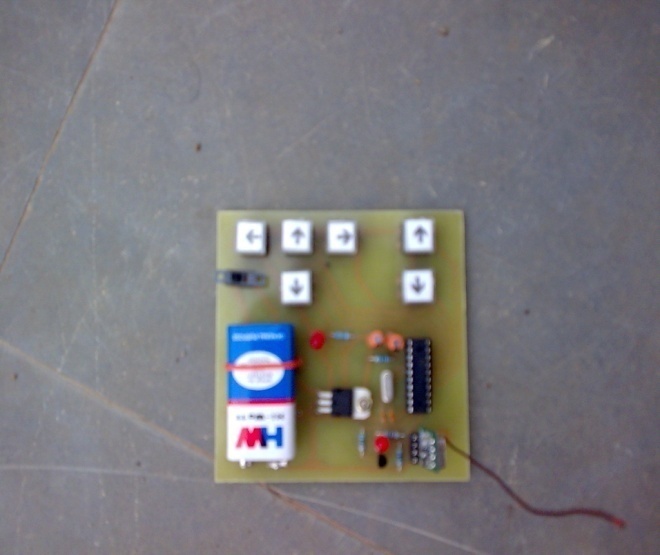
**PHOTOS OF THE REMOTE OPERATED FORK LIFT:-**

**FORK LIFT:-**

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**REMOTE: - BATTERY CHARGER: -**

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**BIBLIOGRAPHY**

While designing and fabrication of this project work, we studied lot of material gathered from websites, consulted experts of various field. The information is gathered from yahoo.com search Engine. Regarding micro controllers plenty of books are available, the following are the references made during design, development and fabrication of the project work.

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