Design, Construction & Performance Test of an Automotive Water Cooling System of Engine

Submitted By

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Dhaka-1215, Bangladesh

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Submitted to the:

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In partial fulfillment of the requirement for the award of the degree Of Bachelor of Science in Mechanical Engineering

May 2023

LETTER OF TRANSMITTAL

May 2023

To

Md. Ahatashamul Haque Khan Shuvo

Assistant Professor & Coordinator

Department of Mechanical Engineering.

Sonargaon University, Dhaka-1215

Subject: Submission of Project Report**.**

Dear Sir,

We are pleased to submit the project report on "**Design, Construction & Performance Test of an Automotive Water Cooling System of Engine".** It was a great pleasure to work on such an important topic. This project has been done per the instruction of your supervision and according to the requirements of Sonargaon University.

We expect that the concerned authority will accept the project. We are happy to explain anything further as you may feel necessary.

Thank You

Sincerely yours,

Md.Rahat Islam	BME-1903019250
Abdul Hannan Hauladar	BME-1903019249
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STUDENT'S DECLARATION

We do hereby solemnly declare that, the work presented here in this project report has been carried out by us and has not been previously submitted to any University/ Organization for the award of any degree or certificate.

We hereby ensure that the works that have been prevented here do not breach any existing copyright.

We further undertake to indemnify the university against any loss or damage arising from a breach of the foregoing obligation.

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First, we started in the name of Almighty Allah. This thesis is accomplished under the supervision of Md. Ahatashamul Haque Khan Shuvo. Assistant Professor & Coordinator. Department of Mechanical Engineering, Sonargaon University. It is a great pleasure to acknowledge our profound gratitude and respect to our supervisor for this consistent guidance, encouragement, helpful suggestion, constructive criticism, and endless patience through the progress of this work. The successful completion of this thesis would not have been possible without his persistent motivation and continuous guidance.

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ABSTRACT

The automotive water cooling system is a crucial component of an engine, responsible for maintaining optimal operating temperatures and preventing overheating. This project aims to design an efficient and reliable water cooling system for automotive engines. The system comprises various components, Arduino, water pump, Temperature sensor, coolant, hoses, and controls. A water pump circulates the coolant, ensuring a consistent flow between the engine and the radiator. A thermostat regulates the coolant flow, opening and closing based on the engine's temperature to maintain it within the desired range.A mixture of water and antifreeze serves as the coolant, absorbing heat from the engine. Electric cooling fans enhance airflow through the radiator when natural airflow is insufficient, controlled by temperature sensors or the engine control unit (ECU). Hoses and pipes connect the different components, facilitating the closed-loop flow of coolant.An expansion tank provides room for coolant expansion and contraction, preventing air pockets and maintaining a constant coolant supply.Sensors and controls monitor engine temperature, coolant level, and other parameters, allowing the ECU to optimize engine performance by adjusting water pump operation. EngineJust Sample Box used a Light. Automatic Cooling System and Auto Cutoff depend on Temperature

Keyword: Automotive water Cooling System Engine, Temperature sensor etc.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

The purpose of cooling system f is to keep the engine atits most efficient operating temperature as high as220oC may be reached during the engine operation.Although the cylinder wall, cylinder head, valves, pistonrings and the pistons absorbs some of this heat. Eventhough the average temperature in the internal vicinity ofthe cylinders stands at about 1400oC. If this heat is notdissipated, the surface of the combustion chamber willbecome red hot, the wall will burn and wrap, and variousparts of the engine will expand excessively resulting inseizure of piston and bearings. Cylinder walltemperature must not go as high as 250oC. Temperaturehigher than this causes the lubricating-oil film to breakdown and loose its lubricating properties. So the coolingsystem is preferred to cools the engine rapidly when it ishotEmbedded devices can be found in many different applications and industries, example, from consumer appliances like the CD alarm clock that wakes us in the morning to the GPS navigation systems in our cars, and Cell phones and PDAs that keeps us connected.

A number of embedded micro components in devices are also growing. A luxury car today has more than 150 embedded micro-controllers and microprocessors in all sorts of applications ranging from engine control mechanism to entertainment devices. The automotive industry is an important pillar of the world economy. Advanced automation supports manufacturing companies in there strive for increased efficiency and quality optimization. Further the biggest trends in automotive engineering are improving engine efficiency and fuel economy. Some companies are developing optimized and most advanced diesel engines to draw waste heat out of the engine in order to allow the engine to operate efficiently. Kenneth. J. Kelly described two approaches of engine cooling system where it describes about hybrid electric power inverters with separate cooling loop with water ethylene glycol coolant at 70˚C, the cost of cooling system is reduced by using silicon-carbide switches [1]. Jianwen Shao and his co workers described some experimentaltechniques for automotive applications, such as motor rotation detection, current sensing with brushless DC motor, which are currently using in power steering, engine cooling fan, fuel/water pump, air conditioning compressor etc [2].

The theoretical model developed for analyzing the heat transfer of automotive cooling system with modular structure links with various cooling system sub models [3]. It was also focused to require much higher performance owing to the improved power output of engines. Engine thermal management system functionality was described with smart thermostat values and variable speed electric pumps and fans [4], [5]. All the above papers described on automotive applications stressing on engine cooling system. But some of them describe on thermal management systems, Motor speed. Efficiency of motor output and so on. But the papers dealing with advanced 32-bit ARM microprocessor are less. ARM is the industry leading RISC processor architecture in the world, dominant in the mobile industry and medical, industrial applications. For future projects designers are looking for the usage of 32-bit microprocessors.It is typically concentrates on applications of vehicle cooling system based on ARM Cortex M3 (LPC1768). PT100 temperature sensor is used to control the heat engine which in turn reduces the fuel wastage. Our main aim is to reduce the cooling time with low cost, occupying less space with simple hardware and software algorithm. Thermal energy flows are an important part of a vehicles energy balance. Even in the most advanced engines the vehicle drive uses barely one third of the fuel energy. The task of engine cooling is to draw waste heat out of the engine in order to allow the engine to operate efficiently.

Companies are developing optimized cooling systems by linking them with ECMs, intercoolers and exhaust gas recirculation coolers. On the other hand company engineers are developing thermal management system products based on applied waste heat recovery, heat exchange and other technologies. A typical cooling system consists of an engine water jacket, thermostat, water pump, radiator, cooling fan, hoses, heater core, oil cooler and overflow, or expansion tank. There are two types of cooling systems: air and water cooling. As the name suggests, air cooling systems involve fans which blow air over the engine block. Heat absorbed by the engine oil is dispersed by an air-cooled oil cooler mounted at a suitable position in the air stream. The noise emission level and the inefficiency in maintaining consistent engine temperatures are considered to bedisadvantages compared to liquid-cooled engines. Today, air cooling is mainly used for motorcycle engines and in special applications.

The oil cooler is a heat exchanger that uses an air-cooling system to maintain the optimized oil temperature of vehicle oils, including engine oil and automatic transmission oil. Water-cooled engines, on the other hand, have passages for the coolant to pass through the engine, absorbing the heat generated so it can be released through the radiator. The cooled fluid is recirculated around the engine while running. Water cooling has become the standard in both passenger cars and heavy-duty vehicles. Instead of pure water, coolants are now a mixture of water (drinking quality), anti-freeze and various corrosion inhibitors. An antifreeze concentration raises the coolant mixture boiling point to allow operating temperatures at a pressure bar in passenger cars. 'Thermal management' means products such as radiators, charge-air coolers and oil coolers that use a medium (air or liquid) to cool the heat that is produced by a vehicle engine. As the primary component of the cooling module, the radiator includes the radiator core, the coolant tank and all the connections. The radiator core itself consists of a finned tube system with tube headers and side supports. The cores of the coolant radiators in passenger cars are almost exclusively made of aluminum. Aluminum radiators are also being used to an increasing extent in a range of commercial vehicles worldwide. Figure 1 shows the example of engine cooling system

1.2 Objectives

The objectives of this project are:

- To design and construct a Project using **Automotive Water Cooling System of Engine**.
- Automotive Water Cooling Engine Box used a Light and Automatic Cooling System and Auto Cutoff depend on Temperature.
- To take necessary notes from the project for future improvements.

1.3 Thesis Overview

This Project is organized as follows:

Chapter 1 Introduction**:** The first chapter contains the statement of the introduction, our background study for the project, the problem statement, the objectives of the study, and the project outline.

Chapter 2 Literature Review**:** Chapter two contains our introduction and literature review part.

Chapter 3 Hardware and Software Analysis**:** Chapter three describes the theoretical model. Here we mainly discuss the proposed system Hardware and software development of our project etc.

Chapter 4 Methodology**:** Chapter three describes the theoretical model. Here we mainly discuss the proposed system architecture in detail with having a block diagram, circuit diagram, structural diagram, project working principle, complete project image, etc.

Chapter 5 Result and Discussion**:** Chapter four deals with the result and discussion and discuss our project's advantages and application.

Chapter 6 Conclusion**:** Chapter five is all about our project conclusion and future scope.

CHAPTER 2
LITERATURE REVIEW

2.1 Literature Review

Copper and brass were used in making radiator parts as they were good conductors of heat but were costly both as materials and for manufacturing. Ford company in 1983 tried to find different alternative material which will be used in radiators. After several experiments aluminium was selected for making radiator parts. The reason behindit was that it was lighter in weight, lower in cost, reliable and durable toits copper and brass counter parts. It was selected where cooling requirements were moderate. It was used in making tubes, fins and header of the radiator. 3003Al for tubes by extrusion process, hard 3003Alfor fins in flat plate design, 3005Al for header of the radiator. Fin pitch was kept from 1.1mmto2.2mm.

The air side interface of this radiator joint was sealed with one part epoxy to prevent seepage and strengthen the header. The tank of the radiator was joint to the core by sandwiching a nitrile rubber gasket between header and tank. After the whole assembly, the radiator was tested and its calorimeter performance, durability, corrosion resistance and qualification with respect to vehicle was noted down. It was concluded from these experiments aluminium performed better inall the tests and was used inall automobiles manufactured by ford from that time.After several years to the fulfill the demand of a corrosion resistant radiator.

For making in good corrosion resistant radiator tube the properties such ashigh corrosion resistant and high resistance to stress corrosion cracking due to solder flux should be satisfied. After testing different materials ‘CACTUS CB203’ was selected. Three main tests were performed onall the materials they were: - Salt Spray Test: -. According to ASTM-85 this test was conducted. In salt spray test mixture of salt and water is sprayed onthe radiator tubes in order to examine the corrosion resistance on the radiator tubes. Under Microscope this test was conducted and researcher found out that maximum dezincification of brass CACTUS CB203 is about 1/10thof that Phosphorous and Comparable arsenic brass.Corrosion Test- Corrosion test was performed on the radiator tubes in which specimen were immersed in the solution and the results were obtained that

1/5thof brass and phosphorus stress. Corrosion Cracking Test: - Stress Corrosion is performed on CACTUS CB203 brass. In which slight corrosion was observed on the material in the form of graph.

In year 1992an experiment was performed to increase the thermal efficiency of radiator. It was done by using a converge shape at the starting of coolant flow whichreduce the pressure of the tube in one size of tube made the coolant flow in smaller quantity from each tube. This helped the coolant to cool at faster rate increasing the thermal efficiency of tube [2].

After a decade it was discovered that the airflow around the radiator had a huge part in cooling the system and the system was not optimize to use the air efficiently. Different tests were done on a vehicle with a radiator installed init and all different measures that affects in cooling of the system were taken into account. Tests were done considering aerodynamic drag that acts on the vehicle and how it would influence the cooling airflow. Also, other test was done considering crosswind flowing through the vehicle when itsin yaw or lifted. Different thermal rejection methods were tested to achieve a radiator which was thermally balanced and was efficient throughout the test [3].

The high thermal conductivity graphite was less in weight and has density between 0.2to 0.6m/cm^3 & bulk thermal conductivity is 187w/m^2.k due to the bulk thermal conductivity of graphite it will increase the cooling which will result in reduction of tubes required for cooling the system. Using graphite in the radiator assembly will reduce the overall weight, cost & volume of the radiator thereby improving fuel efficiency of the vehicle [4].

The radiators required a higher heat flux. The carbon foam has higher heat transfer efficiency & better heat dissipation. Using carbon foam the material fins and tube had given great result in efficiency of cooling system. But the problem of carbon foam material was that it was not giving the required strength for the radiator and also there were bonding issue. To overcome this, carbon foam was coated with 2 different material made of Sic and metallization was done over it. This resulted increase in the strength and bonding of carbon foam material by 430%in which Sic coating gave increase 100% and metallization layer gave 330% improvement [5].

The era of 2007 normal radiators were using parallel tubes which had aluminium fins attached to them. They were not giving the heat transfer coefficient to improve cooling. They designed some different fins which were made upof carbon foam which had porosity of 70% thickness of 0.762mm and heat transfer coefficient 1000 w/m^2 k. This resulted in better heat dissipation which increased the cooling efficiency of radiator [6].

After several years an experiment was done which tested the radiator design with practical scenarios. The heat transfer rate of radiator was cross verified, internal flow of water through radiator tubes whichwas depended on area of tube, velocity of water flowing from the tubes,Reynold's number of water. Also, with these external flow of air over tubes and fins of the radiator, air Reynold's number, fin's dimension and its efficiency and effectiveness by NTU method [7].

In the year 2009 using the side podfor improving the efficiency of radiator an fsae team used aerodynamic consideration in which they used converging and diverging roles. The Design were tested on Ansys CFD Simulation. From the results they concluded that using an aerodynamically shape side pod was directing the air on face of the radiator which increased the cooling rate of the radiator and the issue of overheating was overcome [8].

After a year a new material was discovered as carbon foam it was tested for material of fins. During research of the material it was discovered that it has extremely high thermal conductivity and had an open cell structure which will helpto make a radiator efficient from a huge margin. The researcher also found out that they can improve the rate of heat dissipation through radiator by lowering the coolant inlet temperature and decreasing the air side resistance. After all the testings they observed that carbon foam's heat transfer coefficient was 40% greater than aluminium and it was28% lighter in weight than aluminum [9].

In year 2015 to reduce the size of radiator and also not come across overheating issues, the inlet port of radiator was provided with sensor attach toit. Same sensor was attach in the outlet port. Both sensor were connected to the ECU and were monitored continuously. Also with these the coolant tank was brought closer to inlet port which made sure the flow of water was continuous without any lag; by doing this the overheating of engine was reduced by a huge margin. This resulted in reduction of the size of cooling system. The

cooling system overall weight was reduced by45% from its previous results. This not only reduce weight of the vehicle but also power loss done by radiator that was generated by the engine was reduced by huge margin. Also fuel efficiency was increased [10].

step method in which synthesis of nanofluid was done, other method was called two step methods in which particles were directly mixed with base fluids. It was concluded that the density, viscosity and thermal conductivity of nanofluid will increase with increase in volume concentration of particles in fluid [11].

He also considers different ways and methods in different scenarios in which the first approach was by theoretical and numerical. From this calculation the size of tube and thickness of fin of radiator was determined. This calculation was then converted into a CAD model and it was simulated on 1-D simulation software. From the results he found out that overall radiator efficiency was improved [12].

In year 2016 the different assembly of tubes in the radiator were tested on software and calculation basis different setups of tube were considered like parallel flow, cross flow, flat tube, helical tube structure, dual pass flow in which they found out that parallel flow setup was not providing better result in cooling the system but also the material required to build the assembly was less hence overall cost was reduced [13].

2.2Methodology

Our used methodology for the project:

- Creating an idea for the design and construction of **Automotive Water Cooling System of Engine.**And designing a block diagram & circuit diagram to know which components we need to construct it.
- Collecting all the components and programming the micro-controller to control our desired system.
- Setting up all the components in a PCB board & soldering. Then assembling all the blocks in a board and finally running the system to check if it actually works or not.

2.3TYPES OF COOLING SYSTEM

There are two types of cooling systems:

(i) Air cooling system and

(ii) Water-cooling system.

AIR COOLING SYSTEM

In this type of cooling system, the heat, which is conducted to the outer parts of the engine, is radiated and conducted away by the stream of air, which is obtained from the atmosphere. In order to have efficient cooling by means of air, providing fins around the cylinder and cylinder head increases the contact area. The fins are metallic ridges, which are formed during the casting of the cylinder and cylinder head The amount of heat carried off by the air-cooling depends upon the following factors:

(i) The total area of the fin surfaces

ii) The velocity and amount of the cooling air and

(iii) The temperature of the fins and of the cooling air.

Air-cooling is mostly tractors of less horsepower, motorcycles, scooters, small cars and small aircraft engines where the forward motion of the machine gives good velocity to cool the engine. Air-cooling is also provided in some small industrial engines. In this system, individual cylinders are generally employed to provide ample cooling area by providing fins. A blower is used to provide air.

1. Its design of air-cooled engine is simple.
2. It is lighter in weight than water-cooled engines due to the absence of water jackets, radiator, circulating pump and the weight of the cooling water.
3. It is cheaper to manufacture.
4. It needs less care and maintenance.
5. This system of cooling is particularly advantageous where there are extreme climatic conditions in the arctic or where there is scarcity of water as in deserts.
6. No risk of damage from frost, such as cracking of cylinder jackets or radiator watertubes.

WATER COOLING SYSTEM

It serves two purposes in the working of an engine:

a) It takes away the excessive heat generated in the engine and saves it from over heating.
b) It keeps the engine at working temperature for efficient and economical working. This cooling system has four types of systems:

(i) Direct or non-return system,
(ii) Thermo-Syphone system,
(iii) Hopper system and
(iv) Pump/forced circulation system.

Though the present tractor has a forced circulation system, it is still worthwhile to get acquainted with the other three systems. Non-Return Water Cooling System This is suitable for large installations and where plenty of water is available. The water from a storage tank is directly supplied to the engine cylinder. The hot water is not cooled for reuse but simply discharges. The low H.P. engine, coupled with the irrigation pump is an example. Thermo-Syphone Water Cooling System This system works on the principle that hot water being lighter rises up and the cold water being heavier goes down. In this system the radiator is placed at a higher level than the engine for the easy flow of water towards the engine. Heat is conducted to the water jackets from where it is taken away due to convection by the circulating water. As the water jacket becomes hot, it rises to the top of the radiator. Cold water from the radiator takes the place of the rising hot water and in this way a circulation of water is set up m the system. This helps in keeping the engine at working temperature. Disadvantages of Thermo-Syphone System

1. Rate of circulation is too slow.
2. Circulation commences only when there is a marked difference in temperature.
3. Circulation stops as the level of water falls below the top of the delivery pipe of the radiator. For these reasons this system has become obsolete and is no more in use.

Hopper Water Cooling System

This also works on the same principle as the thermo-syphone system. In this there is a hopper on a jacket containing water, which surrounds the engine cylinder. In this system,

as soon as water starts boiling, it is replaced by cold water. An engine fitted with this system cannot run for several hours without it being refilled with water.

Water Pump

This is a centrifugal type pump. It is centrally mounted at the front of the cylinder block and is usually driven by means of a belt. This type of pump consists of the following parts: (i) body or casing, (ii) impeller (rotor), (iii) shaft, (iv) bearings, or bush, (v) water pump seal and (vi) pulley. The bottom of the radiator is connected to the suction side of the pump. The power is transmitted to the pump spindle from a pulley mounted at the end of the crankshaft. Seals of various designs are incorporated in the pump to prevent loss of coolant from the system. Fan The fan is generally mounted on the water pump pulley, although on some engines it is attached directly to the crankshaft. It serves two purposes in the cooling system of a engine.

(a) It draws atmospheric air through the radiator and thus increases the efficiency of the radiator in cooling hot water.
(b) It throws fresh air over the outer surface of the engine, which takes away the heat conducted by the engine parts and thus increases the efficiency of the entire cooling system.

CHAPTER 3

HARDWARE AND SOFTWARE ANALYSIS

3.1 Required instrument

Hardware

- Arduino Nano
- SMPS
- Temperature Sensor
- Pump Motor
- Relay

3.2Arduino Nano

Arduino is open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling Lights, motors, and other actuators.

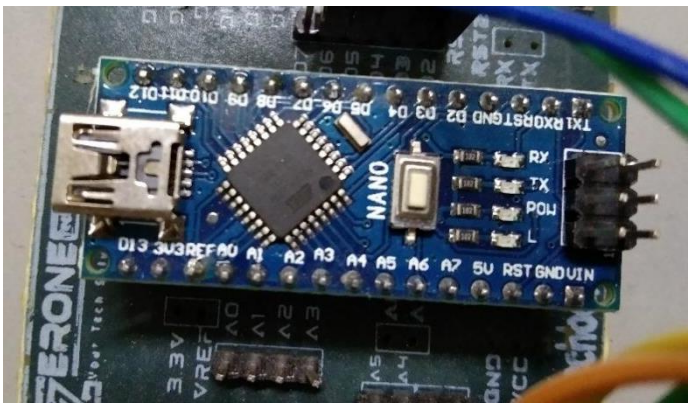

Figure 3.1**:** Arduino Nano

The micro-controller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, MaxMSP).

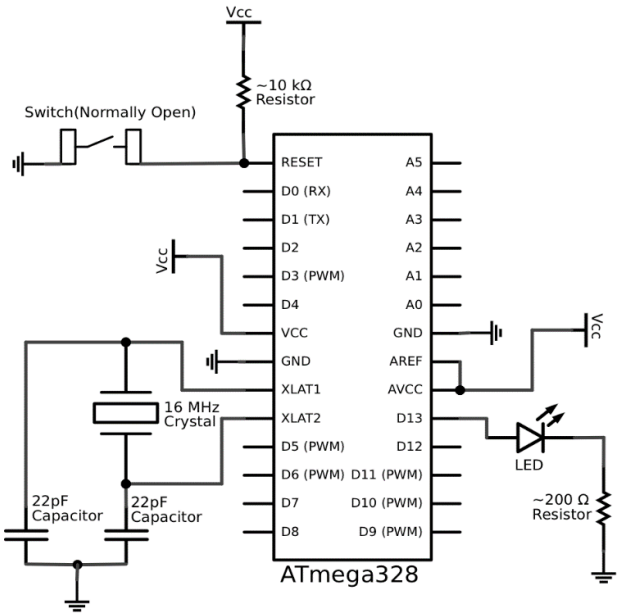

Figure 3.2: Arduino schematic diagram

Arduino Nano is a surface mount breadboard embedded version with integrated USB. It is a smallest, complete, and breadboard friendly. It has everything that Diecimila / Duemilanove has (electrically) with more analog input pins and onboard +5V AREF jumper. Physically, it is missing power jack. The Nano is automatically sense and switch to the higher potential source of power.

Nano's got the breadboard-ability of the Boarduino and the Mini+USB with smaller footprint than either, so users have more breadboard space. It's got a pin layout that works well with the Mini or the Basic Stamp (TX, RX, ATN, GND on one top, power and ground on the other). This new version 3.0 comes with ATMEGA328 which offer more programming and data memory space. It is two layers. That make it easier to hack and more affordable.

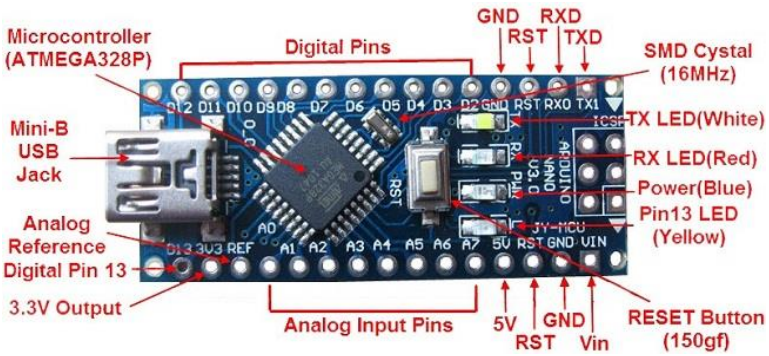

Figure 3.3: Section of Arduino Nano.

Specifications:

- Micro-controller: Atmel ATmega328
- Operating Voltage (logic level):5 V
- Input Voltage (recommended):7-12 V
- Input Voltage (limits):6-20 V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 8
- DC Current per I/O Pin: 40 mA
- Flash Memory: 32 KB (of which 2KB used by boot loader)
- SRAM : 2 KB

Features:

- Automatic reset during program download
- Power OK blue LED
- Green (TX), red (RX) and orange (L) LED
- Auto sensing/switching power input
- Small mini-B USB for programming and serial monitor

Micro-controller IC ATmega328p:

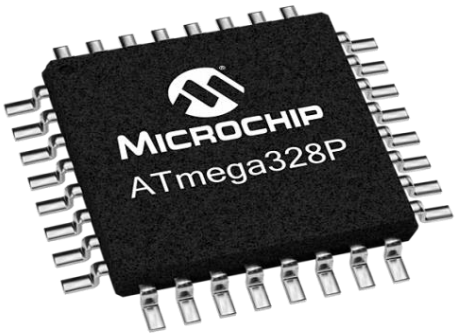

Figure 3.4: Micro-controller IC AT mega 328p.

The high-performance Microchip pico Power 8-bit AVR RISC-based micro-controller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts.

3.3 Switch Mode Power Supply (SMPS):

A switched-mode power supply (switching-mode power supply, switch-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS transfers power from a DC or AC source (often mains power) to DC loads, such as a personal computer, while converting voltage and current characteristics. Unlike a linear power supply, the pass transistor of a switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy. A hypothetical ideal switched-mode power supply dissipates no power. Voltage regulation is achieved by varying the ratio of on-to-off time (also known as duty cycles). In contrast, a linear power supply regulates the output voltage by continually dissipating power in the pass transistor. This higher power conversion efficiency is an important advantage of a switched-mode power supply. Switched-mode power supplies may also be substantiallysmaller and lighter than a linear supply due to the smaller transformer size and weight.

Figure 3.5: SMPS

Switching regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter weight are required. They are, however, more complicated; their switching currents can cause electrical noise problems if not carefully suppressed, and simple designs may have a poor power factor.

Switched-mode power supplies are classified according to the type of input and output voltages. The four major categories are:

- AC to DC
- DC to DC
- DC to AC
- AC to AC

A basic isolated AC to DC switched-mode power supply consists of:

- Input rectifier and filter
- Inverter consisting of switching devices such as MOSFETs
- Transformer
- Output rectifier and filter
- Feedback and control circuit

The input DC supply from a rectifier or battery is fed to the inverter where it is turned on and off at high frequencies of between 20 KHz and 200 KHz by the switching MOSFET or power transistors. The high-frequency voltage pulses from the inverter are fed to the transformer primary winding, and the secondary AC output is rectified and smoothed to produce the required DC voltages. A feedback circuit monitors the output voltage and instructs the control circuit to adjust the duty cycle to maintain the output at the desired level.

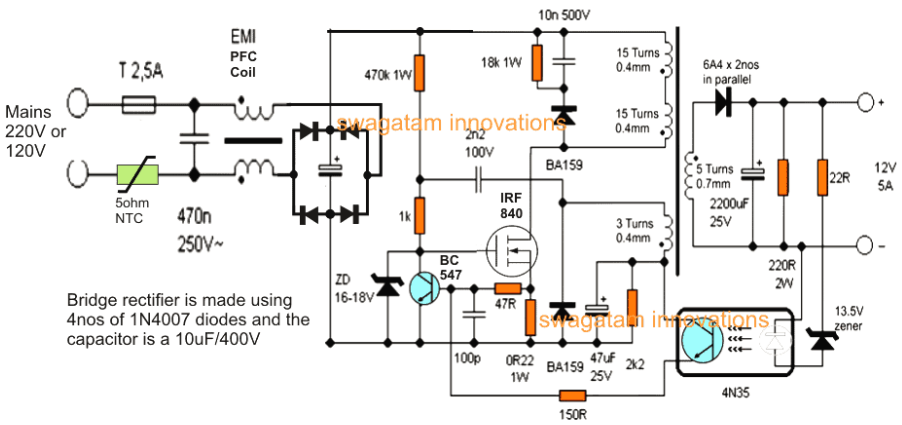

Figure 3.6: SMPS Circuit

Basic working concept of an SMPS

A switching regulator does the regulation in the SMPS. A series switching element turns the current supply to a smoothing capacitor on and off. The voltage on the capacitor controls the time the series element is turned. The continuous switching of the capacitor maintains the voltage at the required level.

Design basics

AC power first passes through fuses and a line filter. Then it is rectified by a full-wave bridge rectifier. The rectified voltage is next applied to the power factor correction (PFC) pre-regulator followed by the downstream DC-DC converter(s). Most computers and small appliances use the International Electrotechnical Commission (IEC) style input connector. As for output connectors and pinouts, except for some industries, such as PC and compact PCI, in general, they are not standardized and are left up to the manufacturer. There are different circuit configurations known as topologies, each having unique characteristics, advantages and modes of operation, which determines how the input power is transferred to the output. Most of the commonly used topologies such as flyback, push-pull, half bridge and full bridge, consist of a transformer to provide isolation, voltage scaling, and multiple output voltages. The non-isolated configurations do not have a transformer and the power conversion is provided by the inductive energy transfer.

Advantages of switched-mode power supplies:

- Higher efficiency of 68% to 90%
- Regulated and reliable outputs regardless of variations in input supply voltage
- Small size and lighter
- Flexible technology
- High power density
- Disadvantages:
- Generates electromagnetic interference
- Complex circuit design
- Expensive compared to linear supplies

Switched-mode power supplies are used to power a wide variety of equipment such as computers, sensitive electronics, battery-operated devices and other equipment requiring high efficiency.

Linear voltage IC regulators have been the basis of power supply designs for many years as they are very good at supplying a continuous fixed voltage output. Linear voltage regulators are generally much more efficient and easier to use than equivalent voltage regulator circuits made from discrete components such a zener diode and a resistor, or transistors and even op-amps.

The most popular linear and fixed output voltage regulator types are by far the 78… positive output voltage series, and the 79… negative output voltage series. These two types of complementary voltage regulators produce a precise and stable voltage output ranging from about 5 volts up to about 24 volts for use in many electronic circuits.There is a wide range of these three-terminal fixed voltage regulators available each with its own built-in voltage regulation and current limiting circuits. This allows us to create a whole host of different power supply rails and outputs, either single or dual supply, suitable for most electronic circuits and applications. There are even variable voltage linear regulators available as well providing an output voltage which is continually variable from just above zero to a few volts below its maximum voltage output.

Switch Mode Power Supply

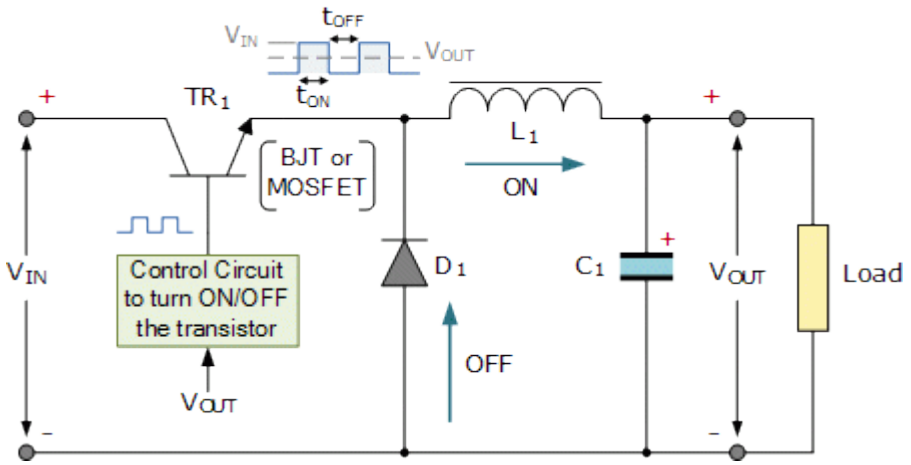

Figure 3.7: SMPS Circuit Connection

Most d.c. power supplies comprise of a large and heavy step-down mains transformer, diode rectification, either full-wave or half-wave, a filter circuit to remove any ripple content from the rectified d.c. producing a suitably smooth d.c. voltage, and some form of voltage regulator or stabiliser circuit, either linear or switching to ensure the correct regulation of the power supplies output voltage under varying load conditions. Then a typical d.c. power supply would look something like this:

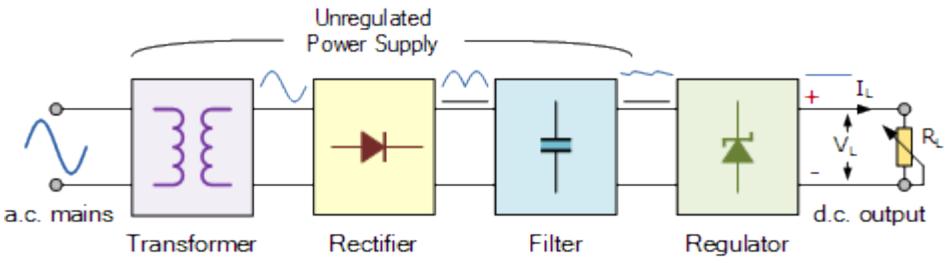

Figure 3.8: SMPS Supply Connection

These typical power supply designs contain a large mains transformer (which also provides isolation between the input and output) and a dissipative series regulator circuit. The regulator circuit could consist of a single zener diode or a three-terminal linear series regulator to produce the required output voltage. The advantage of a linear regulator is that the power supply circuit only needs an input capacitor, output capacitor and some feedback resistors to set the output voltage.

3.4 Temperature Sensor

The DHT11 is a basic, ultra-low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use, but requires careful timing to grab data.

DHT11 Specifications:

- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring) 60uA (standby)
- Output: Serial data
- Temperature Range: 0°C to 50°C

- Humidity Range: 20% to 90%
- Resolution: Temperature and Humidity both are 16-bit
- Accuracy: ±1℃ and ±1%

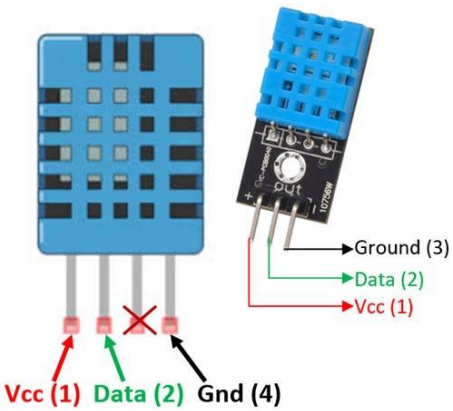

Figure 3.9: DHT11 Temperature Sensor

3.5 Pump Motor

This is a low cost, small size Submersible Pump Motor which can be operated from a 2.5 ~ 6V power supply. It can take up to 120 litters per hour with very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it. Make sure that the water level is always higher than the motor. Dry run may damage the motor due to heating and it will also produce noise.

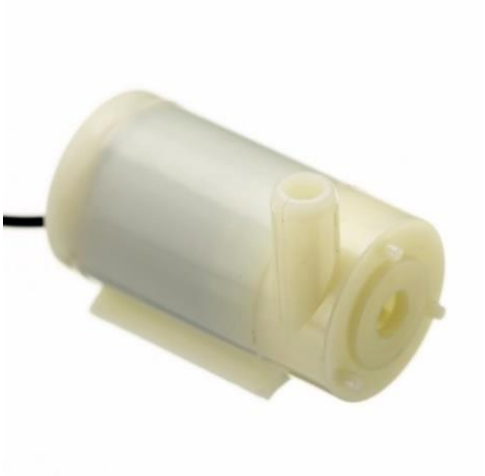

Figure 3.10: Pump Motor

Feature:

- Operating Current: 130 ~ 220mA
- Flow Rate: 80 ~ 120 L/H
- Maximum Lift: 40 ~ 110 mm
- Continuous Working Life: 500 hours
- Driving Mode: DC, Magnetic Driving
- Material: Engineering Plastic
- Outlet Outside Diameter: 7.5 mm
- Outlet Inside Diameter: 5 mm

3.6 Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

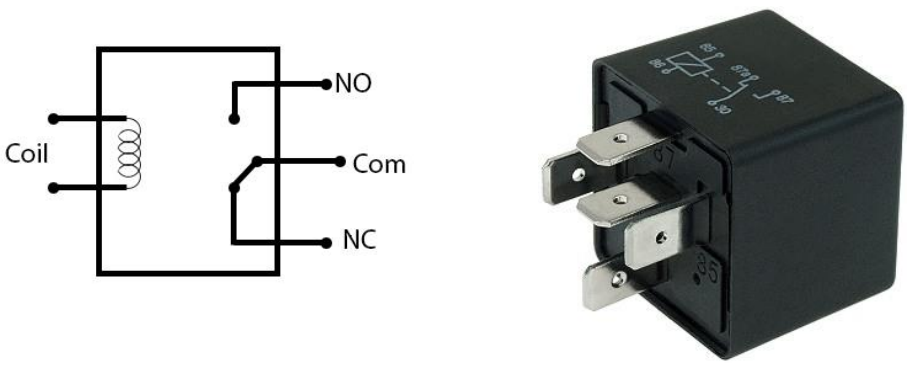

Figure 3.11: Relay

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with

calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

Magnetic latching relays require one pulse of coil power to move their contacts in one direction, and another, redirected pulse to move them back. Repeated pulses from the same input have no effect. Magnetic latching relays are useful in applications where interrupted power should not be able to transition the contacts.

Magnetic latching relays can have either single or dual coils. On a single coil device, the relay will operate in one direction when power is applied with one polarity, and will reset when the polarity is reversed. On a dual coil device, when polarized voltage is applied to the reset coil the contacts will transition. AC controlled magnetic latch relays have single coils that employ steering diodes to differentiate between operate and reset commands.The relay module is the one in the figure below.

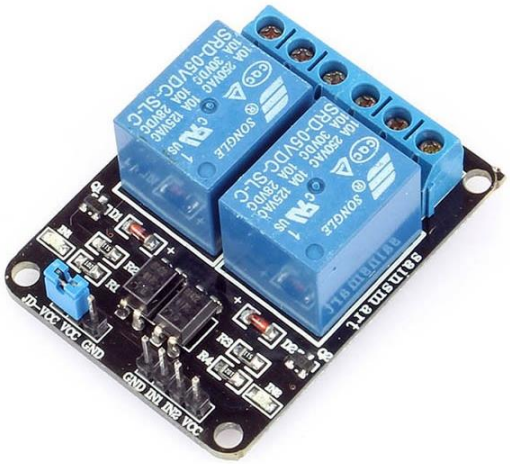

Figure 3.12: Relay Module.

This module has two channels (those blue cubes). There are other varieties with one, four and eight channels.

Main's voltage connections.

In relation to mains voltage, relays have 3 possible connections:

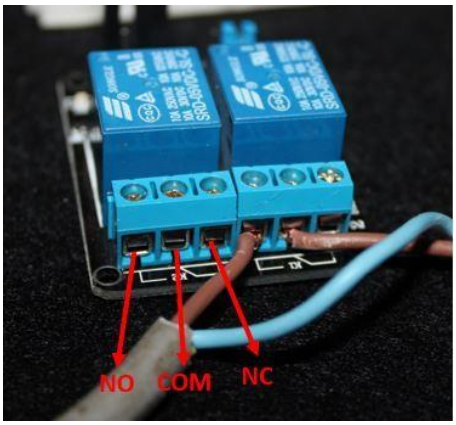

Figure. 3.13: Main's voltage connections.

COM: common pin

NO (Normally Open): there is no contact between the common pin and the normally open pin. So, when you trigger the relay, it connects to the COM pin and supply is provided to a load

NC (Normally Closed): there is contact between the common pin and the normally closed pin. There is always connection between the COM and NC pins, even when the relay is turned off. When you trigger the relay, the circuit is opened and there is no supply provided to a load.

Pin wiring

The connections between the relay module and the Arduino are really simple:

GND: goes to ground

IN1: controls the first relay (it will be connected to an Arduino digital pin)

IN2: controls the second relay (it should be connected to an Arduino digital pin if you are using this second relay. Otherwise, you don't need to connect it)

VCC: goes to 5V

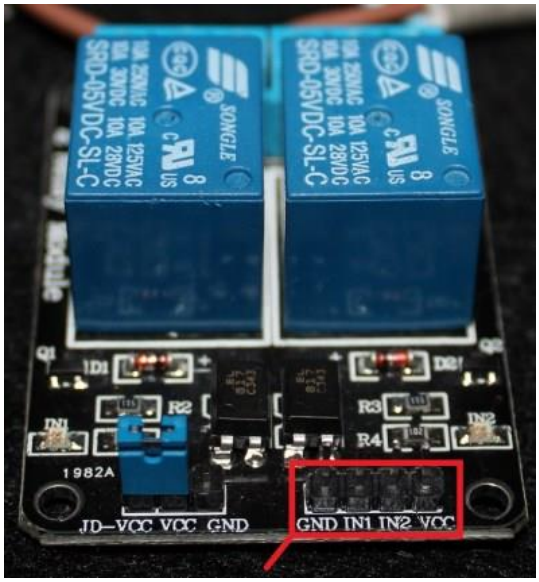

Figure 3.14: Main's voltage connections.

3.7 5V Regulator IC

Voltage sources in a circuit may have fluctuations resulting in not providing fixed voltage outputs. A voltage regulator IC maintains the output voltage at a constant value. 7805 IC, a member of 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC). The xx in 78xx indicates the output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add a heat sink.

7805 IC Rating

- Input voltage range 7V- 35V
- Current rating Ic = 1A
- Output voltage range VMax=5.2V ,VMin=4.8V

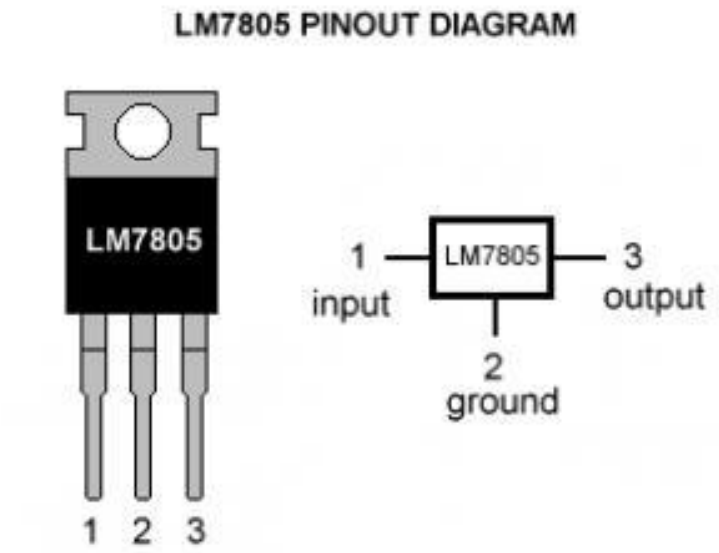

Figure 3.15 : 5V Regulator IC

3.8 Arduino IDE

The digital micro-controller unit named as Arduino Nano can be programmed with the Arduino software IDE. There is no any requirement for installing other software rather than Arduino. Firstly, Select "Arduino Nano from the Tools, Board menu (according to the micro-controller on our board). The IC used named as ATmega328 on the Arduino Nano comes pre burned with a boot loader that allows us to upload new code to it without the use of an external hardware programmer.Communication is using the original STK500 protocol (reference, C header files). We can also bypass the boot loader and programs the micro-controller through the ICSP (In Circuit Serial Programming) header. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available. The ATmega16U2/8U2 is loaded with a DFU boot loader, which can be activated by:

On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode.

The Arduino Nano is one of the latest digital micro-controller units and has a number of facilities for communicating with a computer, another Arduino, or other micro-controllers. The ATmega328 provides UART TTL at (5V) with serial communication, which is

available on digital pins 0 -(RX) for receive the data and pin no.1 (TX) for transmit the data. An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an .in file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board.

The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial Communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Nano's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus. Arduino programs are written in C or C++ and the program code written for Arduino is called sketch. The Arduino IDE uses the GNU tool chain and AVR Lab to compile programs, and for uploading the programs it uses argued. As the Arduino platform uses Atmel micro-controllers, Atmel's development environment, AVR Studio or the newer Atmel Studio, may also be used to develop software for the Arduino.

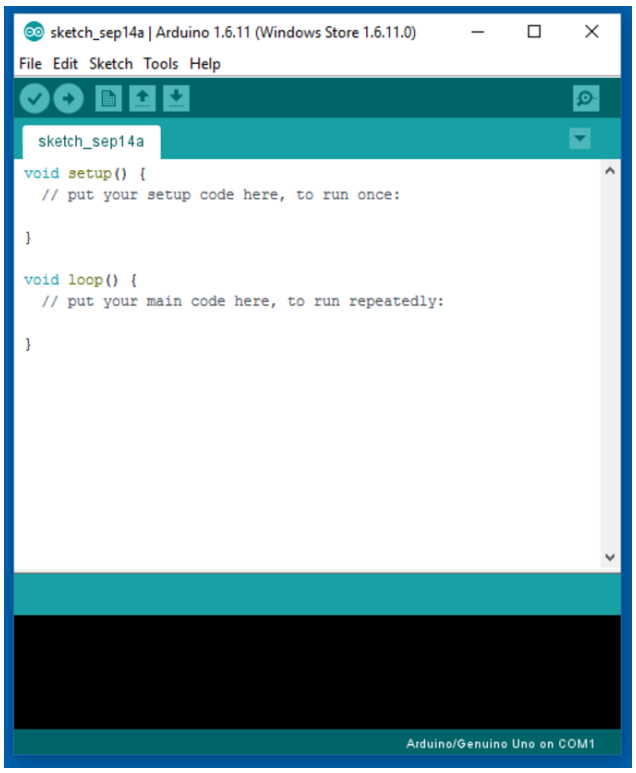

Figure 3.16: Arduino Software Interface IDE

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.

Writing Sketches

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and pen the serial monitor.

Sketchbook

The Arduino Software (IDE) uses the concept of a sketchbook: a standard place to store your programs (or sketches). The sketches in your sketchbook can be opened from the File > Sketchbook menu or from the Open button on the toolbar. The first time you run the Arduino software, it will automatically create a directory for your sketchbook. You can view or change the location of the sketchbook location from with the Preferences dialog.Beginning with version 1.0, files are saved with a .ino file extension. Previous versions use the .pde extension. You may still open .pde named files in version 1.0 and later, the software will automatically rename the extension to .ino.

Tabs, Multiple Files, and Compilation

Allows you to manage sketches with more than one file (each of which appears in its own tab). These can be normal Arduino code files (no visible extension), C files (.c extension), C++ files (.cpp),or header files (.h)**Uploading**Before uploading your sketch, you need to select the correct items from the Tools > Board and Tools > Port menus. The boards are described below. On the Mac, the serial port is probably something like /dev/tty.usbmodem241 (for an Uno or Mega2560 or Leonardo) or /dev/tty.usbserial-1B1 (for a Duemilanove or earlier USB board), or /dev/tty.USA19QW1b1P1.1 (for a serial board connected with a Keyspan USB-to-Serial adapter). On Windows, it's probably

COM1 or COM2 (for a serial board) or COM4, COM5, COM7, or higher (for a USB board) - to find out, you look for USB serial device in the ports section of the Windows Device Manager. On Linux, it should be /dev/ttyACMx , /dev/ttyUSBx or similar. Once you've selected the correct serial port and board, press the upload button in the toolbar or select the Upload item from the Sketch menu. Current Arduino boards will reset automatically and begin the upload. With older boards (pre-Diecimila) that lack auto-reset, you'll need to press the reset button on the board just before starting the upload. On most boards, you'll see the RX and TX LEDs blink as the sketch is uploaded. The Arduino Software (IDE) will display a message when the upload is complete, or show an error.When you upload a sketch, you're using the Arduino boot loader, a small program that has been loaded on to the micro-controller on your board. It allows you to upload code without using any additional hardware. The boot loader is active for a few seconds when the board resets; then it starts whichever sketch was most recently uploaded to the micro-controller. The boot loader will blink the on-board (pin 13) LED when it starts (i.e. when the board resets).

Libraries

Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch > Import Library menu. This will insert one or more #include statements at the top of the sketch and compile the library with your sketch. Because libraries are uploaded to the board with your sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its #include statements from the top of your code.There is a list of libraries in the reference. Some libraries are included with the Arduino software. Others can be downloaded from a variety of sources or through the Library Manager. Starting with version 1.0.5 of the IDE, you do can import a library from a zip file and use it in an open sketch. See these instructions for installing a third-party library.

Third-Party Hardware

Support for third-party hardware can be added to the hardware directory of your sketchbook directory. Platforms installed there may include board definitions (which appear in the board menu), core libraries, bootloaders, and programmer definitions. To install, create the hardware directory, then unzip the third-party platform into its own sub-directory. (Don't use "arduino" as the sub-directory name or you'll override the built-in Arduino platform.) To uninstall, simply delete its directory.

For details on creating packages for third-party hardware, see the Arduino IDE 1.5 3rd party Hardware specification.

Serial Monitor

This displays serial sent from the Arduino or Genuino board over USB or serial connector. To send data to the board, enter text and click on the "send" button or press enter. Choose the baud rate from the drop-down menu that matches the rate passed to Serial.begin in your sketch. Note that on Windows, Mac or Linux the board will reset (it will rerun your sketch) when you connect with the serial monitor. Please note that the Serial Monitor does not process control characters; if your sketch needs a complete management of the serial communication with control characters, you can use an external terminal program and connect it to the COM port assigned to your Arduino board.

3.9EasyEDA

EasyEDA is a web-based EDA tool suite that enables hardware engineers to design, simulate, share-publicly and privately-and discuss schematics, simulations and printed circuit boards. Other features include the creation of a bill of materials, Gerber files and pick and place files and documentary outputs in PDF, PNG and SVG formats.EasyEDA allows the creation and editing of schematic diagrams, SPICE simulation of mixed analogue and digital circuits and the creation and editing of printed circuit board layouts and, optionally, the manufacture of printed circuit boards.

Subscription-free membership is offered for public plus a limited number of private projects. The number of private projects can be increased by contributing high quality public projects, schematic symbols, and PCB footprints and/or by paying a monthly subscription.Registered users can download Gerber files from the tool free of charge; but for a fee, EasyEDA offers a PCB fabrication service. This service is also able to accept Gerber file inputs from third party tools.

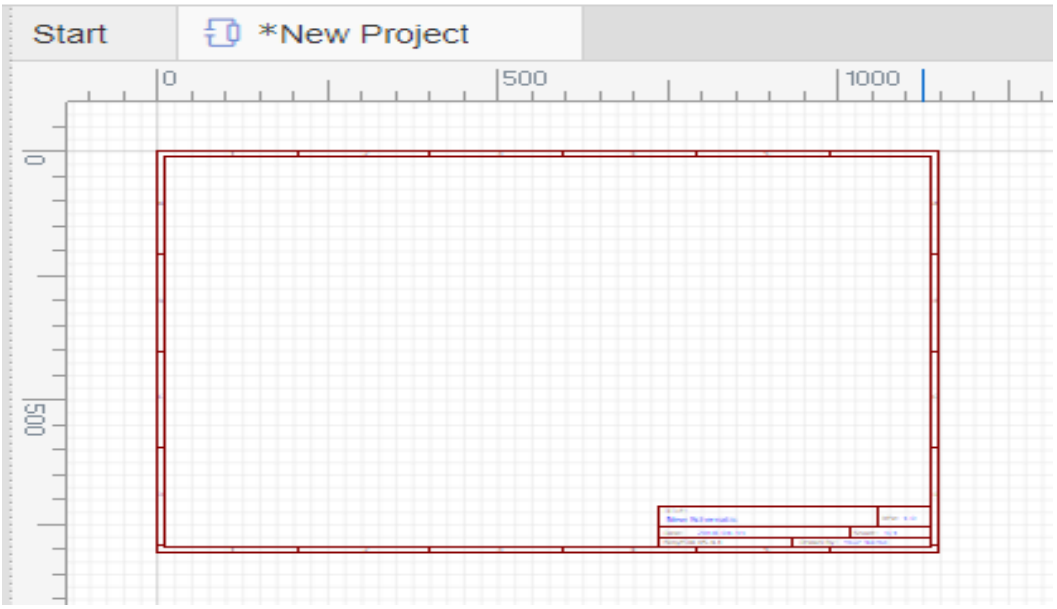

Figure 3.17: EasyEDA Software Interface

CHAPTER 4
METHODOLOGY

4.1 Working Principle

Connecting with the controller here is AC 220 volts coming to the circuit by converting to 5volts DC via SMPS. Which is safe for our project equipment. This project we use Arduino Nanomicro-controller for controlling this project. Here also use a Temperature sensor, Pump Motor, Engine Box used a Light.The system will work if our project is connected to power and switched on. At this moment,temperature rises above 35 degrees, then a Pump Motor will be turned on through the micro-controller relay.If the temperature inside the Engine Box is less than 25 degrees then a Pump Motor will be turned off. A temperature sensor has been installed here to measure the temperature. This will help the temperature of the engine to return to normal. This is the main purpose of our project.

4.2 Block Diagram

The block diagram here is representing the whole circuit and the components of the project. Here we have used standardized symbols and lines.

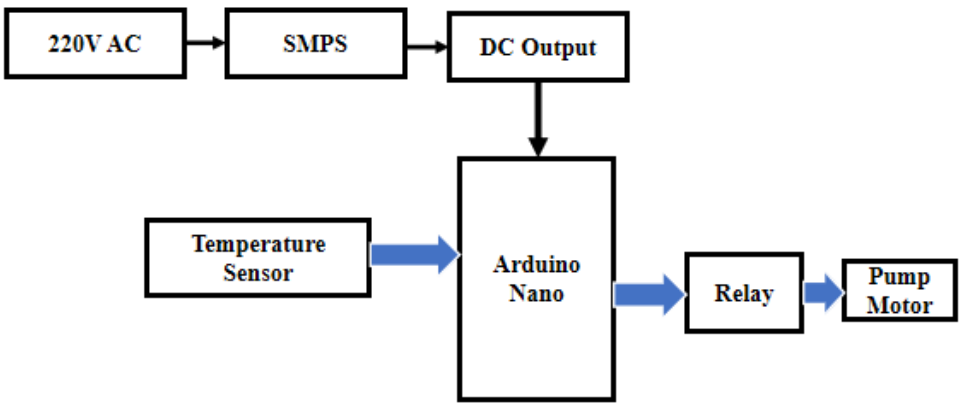

Figure 4.1: Block Diagram of Our Project

4.3 Schematic Diagram

The schematic diagram here is representing the electrical circuit and the components of the project. Here we have used standardized symbols and lines.

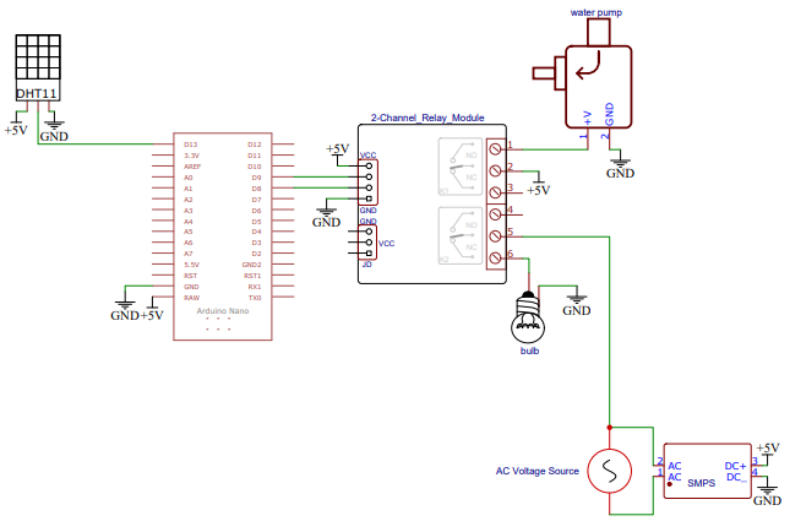

Figure 4.2: Schematic Diagram of Project

4.4 Final Project View

Here we have shown the final project overview with appropriate marking.

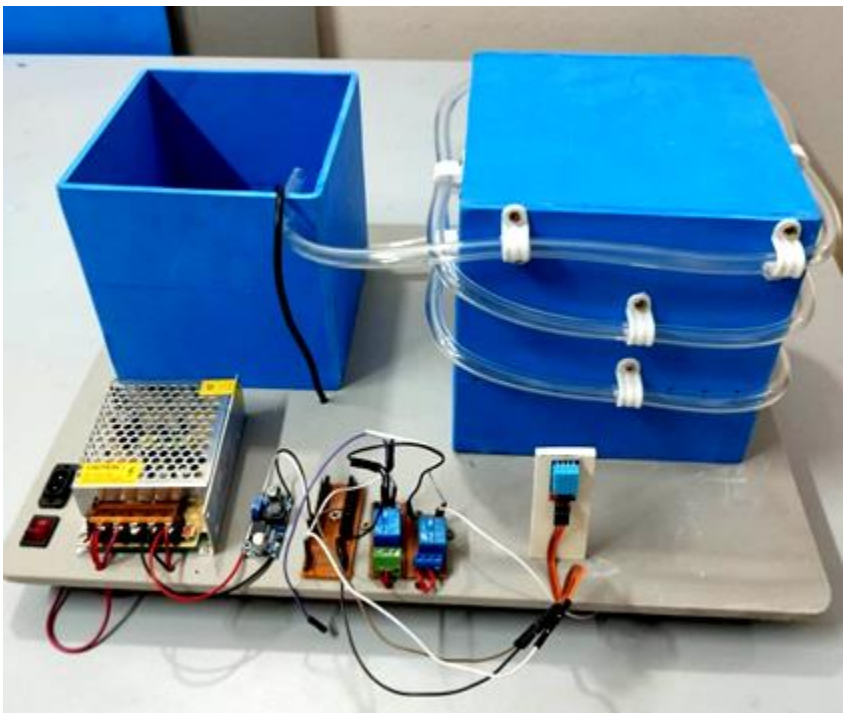

Figure 4.3: Final Project Vi

CHAPTER 5
RESULT AND DISCUSSION

5.1 Result

After making our project we observe it very careful. It works as we desire. Our project give output perfectly and all equipment are work perfectly. We check how much it works and we get perfect output from this project.

- Firstly, when we press switch on then the project will be run,
- After that temperature rises above 35 degrees, then a Pump Motor will be turned on through the micro-controller relay.
- Then when the temperature inside the Engine Box is less than 25 degrees then a Pump Motor will be turned off.
- Then the temperature sensor has been installed here to measure the temperature. This will help the temperature of the engine to return to normal.

5.2 Discussion

Engine cooling is crucial for maintaining the optimal operating temperature of the engine. Excessive heat can lead to various issues such as reduced efficiency, increased wear and tear, and potential engine damage. A well-designed cooling system helps dissipate heat efficiently, ensuring the engine operates within the desired temperature range.The efficiency of a cooling system depends on several factors, including the radiator's size, airflow through the radiator, coolant flow rate, and the effectiveness of heat transfer. Designing an efficient cooling system requires careful consideration of these factors to ensure adequate cooling capacity under different operating conditions.

5.3 Advantages

There are Some advantages of our Project because of its accuracy. The advantages are pointed out below:

- Temperature Regulation: The primary advantage of a water cooling system is its ability to regulate the engine's temperature effectively.

- Efficient Heat Dissipation: Water cooling systems are highly efficient at dissipating heat compared to air cooling systems.
- Engine Longevity: By maintaining the engine within its optimal temperature range, a water cooling system contributes to the longevity of the engine.
- Maintenance cost is very less.
- Simple construction.

5.4Disadvantages

There are SomeDisadvantages of our Project because of its accuracy. The Disadvantages are pointed out below:

- High Initial Cost.
- Limited Efficiency at Low Speeds.
- Maintenance Requirements.

5.5 Applications

The application areas for Our Project in this modern and practical world are huge and some of these are given below:

- Passenger Cars
- Trucks and Commercial Vehicles
- Motorcycles
- Performance and Sports Cars.
- Industrial and Power Generation Equipment.

CHAPTER 6
CONCLUSION

6.1 Conclusion

In conclusion, automotive water cooling systems play a vital role in maintaining the optimal operating temperature of internal combustion engines. They offer several advantages, including effective heat dissipation, temperature regulation, consistent performance, and engine longevity. These systems are capable of handling the heat generated by engines of different sizes and power outputs, making them suitable for a wide range of applications such as passenger cars, trucks, motorcycles, off-road vehicles, performance cars, motorhomes, and industrial equipment.While water cooling systems have some potential disadvantages, such as complexity, maintenance requirements, and the risk of coolant leaks, these can be mitigated with proper maintenance and care. Overall, water cooling systems remain the preferred choice in automotive applications due to their superior cooling capabilities and the ability to handle demanding conditions.As technology continues to advance, we can expect further improvements in water cooling system design, efficiency, and integration with other vehicle systems. These advancements will contribute to more reliable and efficient engine cooling, enhancing overall vehicle performance and reliability.

6.2 Future Scope

As we have already discussed about the limitations of this system so definitely there's room for improvement and thus we have Some future scope of work available to us for this system. Some of these are listed below:

- Intelligent Cooling System Control: The integration of smart sensors, actuators, and control systems can enable more precise and adaptive control of the cooling system.
- Alternative Cooling Technologies: While water cooling systems are widely used, there is ongoing research into alternative cooling technologies.

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APPENDIX

Micro-controller Code:

```
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x3F, 16, 2);  // I2C address 0x3F, 16 column and 2 rows 27or3F

#include "DHT.h"
#define DHTPIN 4
#define DHTTYPE DHT11
int light=10;
int pump=11;
DHT dht(DHTPIN, DHTTYPE);
void setup()
{
  Serial.begin(9600);
  pinMode(light,OUTPUT);
  pinMode(pump,OUTPUT);

  dht.begin();     // initialize the sensor
  lcd.init();      // initialize the lcd
  lcd.backlight(); // open the backlight
}

void loop()
{
  delay(2000); // wait a few seconds between measurements

  float humi  = dht.readHumidity();    // read humidity
  float tempC = dht.readTemperature(); // read temperature
```

```
lcd.clear();
  // check if any reads failed
  if (isnan(humi) || isnan(tempC)) {
    lcd.setCursor(0, 0);
    lcd.print("Failed");
  } else {
    lcd.setCursor(0, 0);  // start to print at the first row
    lcd.print("Temp: ");
    lcd.print(tempC);     // print the temperature
    lcd.print((char)223); // print ° character
    lcd.print("C");
    Serial.print("temp");
    Serial.println(tempC);

    lcd.setCursor(0, 1);  // start to print at the second row
    lcd.print("Humi: ");
    lcd.print(humi);      // print the humidity
    lcd.print("%");
    Serial.print("humi");
    Serial.println(humi);
  }


  if(tempC>35 ){
    digitalWrite(pump,HIGH);
    digitalWrite(light,LOW);
     lcd.setCursor(0, 1);  // start to print at the second row
    lcd.print("Tempareture High ");
    }
```

```
  if(tempC>35 && tempC>33  ){
  digitalWrite(pump,HIGH);
  digitalWrite(light,LOW);
   lcd.setCursor(0, 1);  // start to print at the second row
  lcd.print("Tempareture High ");
  }
 if(tempC<33){
  digitalWrite(pump,LOW);
  digitalWrite(light,HIGH);
  }


}
```