Volume 9, Issue 4, April – 2024 International Journal of Innovative Science and Research Technology
ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR175

Development and Construction of an Autonomous Firefighting Robot

S.Chandrasekhar[1]
Assistant Professor
Department of Mechanical Engineering, Gates Institute of Technology Gooty

C.PrasanthReddy[2]; T.UdayKumar[3]; V.Vinay KumarReddy[4]; P. Harsha Vardhan[5]; V. Soma Shekhar[6]
UG Students
Department of Mechanical Engineering, Gates Institute of Technology Gooty

Abstract:- Mechanical technology has ended up being fixing over which people groups shown their advantage. Mechanical technology has acquired prevalence because of progression of numerous innovations of registering and nanotechnologies. So we chose to put forth human existence more straightforward and diminish the attempts taken by them. Our audit is to make completely mechanized firefighting robot which manages the fire issues in family, research centers, limited scope enterprises. This robot follows the predefined way and plays out the different assignments. We can utilize this robot to play out those assignments that might be hurtful and hazardous to human. The Fire sensors prepared fixed in the rooms where there will be plausible of fire is to be happened. At the point when it detects fire the location of area got by robot and as needs be it will reach to the objective and stifle fire right away.

Keywords:- *Low-Cost Fire Fighting Robot, Wireless Communication, Remote Operation.*

I. INTRODUCTION

Firefighting robots represent a transformative advancement in emergency response technology, designed to mitigate the risks faced by firefighters and enhance their effectiveness in combating fires. These robots are equipped with a wide array of sensors, tools, and capabilities to navigate hazardous environments, detect fires, and execute firefighting operations autonomously or under remote human supervision. With the integration of artificial intelligence, robotics, and sensor technologies, firefighting robots offer a promising solution to address the challenges posed by complex and dangerous fire scenarios.

The word „robot" begins from the Czech word for constrained work, whose imaginary automated creations was similar as Dr. Frankenstein's beast animals made by substance and natural, as opposed to mechanical strategies, presented it. Be that as it may, the ongoing mechanical robots of mainstream society are not vastly different from the imaginary organic manifestations. Frameworks that process tactile contribution to the gadgets current circumstance and train the gadget to perform activities because of the circumstance in the assembling field, robot advancement has zeroed in on designing automated arms that perform fabricating processes. In the space business, advanced mechanics centers around the profoundly specific, one sort of planetary wanderers. Presently, mechanical rivalries are held occasionally both in public and global levels. Numerous robots intended for fire identification, fire quenching. Some of them are constrained by human. So assuming each time fire happened the robot for quenching the fire there is consistently a need of human to move robot to the spot where fire happened, from this we see that the cycle turns out to be so extended and tedious, so there is need to make the firefighting robot which expected to be self-controlled, likewise it have a both capacity of fire discovery as well as fire dousing. So here we will plan AVR based firefighting robot. We are utilizing Atmega16 microcontroller. For mechanical movement we are utilizing DC engine driven vehicle. The primary region of our venture is: Fire Sensor activity (IR Sensor), Microcontroller activity, Bluetooth activity, Robot development activity, Sprayer activity .Block outline execution is depicted in the subsequent segment. Equipment expected for project and its subtleties are additionally depicted after it.

II. LITERATURE REVIEW

U.Jyostna Sai Prasanna, M.V.D.Prasad (2013) was plan the fire discovery framework involving four fire sensors in the firefighting robot, and program the fire location and battling strategy utilizing sensor based technique. The firefighting robot is outfitted with four thermistors/fire sensors that consistently screen the temperature. In the event that the temperature increments past the foreordained limit esteem, signal sounds to suggest the event of fire mishap and an admonition message will be shipped off the separate staff in the business and to local fire station with the GSM module gave to it.

Swati A. Deshmukh (2015) was completely examined about the fire location framework involving sensors in the framework, and program the fire identification and battling system utilizing sensor based strategy.

Saravanan P (2015) examined about the Plan and Execution of this task is mostly founded on control of Semi-Independent versatile robot (SA-BOT). The framework controls four DC Equipped engines which is fueled by the Atmega2560 and controlled independently by Route framework which contains incorporated ultrasonic and infra-red sensors. The bot is equipped with remote camera which

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR175

catches the video and sends it to the base station. The fire location framework contains LDR and temperature sensor, in the event that there is a fire, the sensors identifies it and the bot will be moved to the source and starts dousing it. The Dousing Framework includes a BLDC engine with water holder. The SABOT can likewise be worked physically for outrageous circumstances. We have given a GUI support through which the bot can controlled from the base station**.**

III. HARDWARE SPECIFICATIONS

- ATmega16 microcontroller.
- Bluetooth Receiver.
- L293D IC.
- Robot chassis.
- Motors.
- Buzzer.
- PIR Sensor.
- Fire sensor.
- LPG Sensor.
- Water pump.

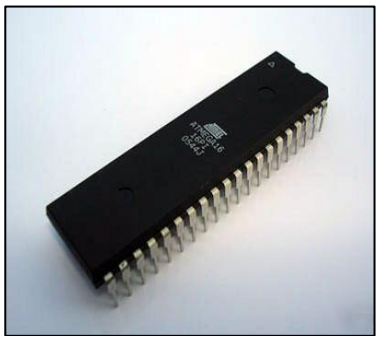
Fig 1 ATmega16 Microcontroller

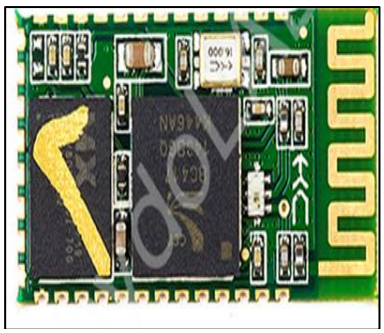
Fig 2 Bluetooth Receiver

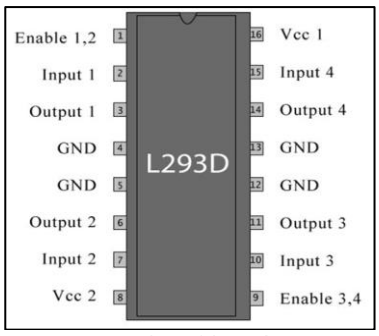

Fig 3 L293D IC


Fig 4 Motor


Fig 5 Buzzer


Fig 6 Robot Chassis

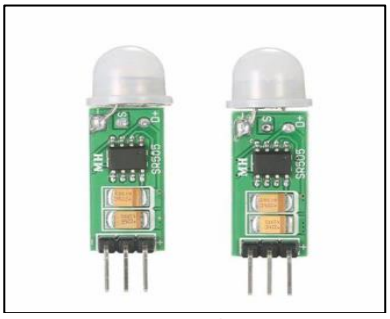
Fig 7 PIR Sensor

Fig 8 Fire Sensor

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR175

Fig 9 LPG Sensor

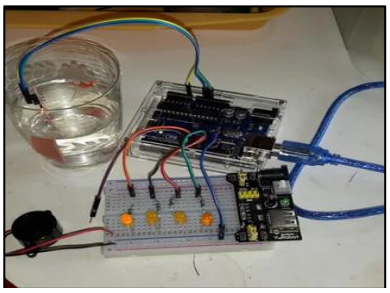

Fig 10 Water Pump

➢ *ATmega16 Microcontroller:*

The ATmega16 microcontroller as the smart brain of the firefighting robot. It's like the robot's decision-maker and coordinator. This tiny chip is responsible for taking in information from sensors, like detecting fires or obstacles, and then deciding what actions the robot should take. For instance, when it senses a fire, it tells the motors to move the robot towards it. It's like the captain of the team, directing everyone to tackle the fire and keep everyone safe. Without the ATmega16, the robot wouldn't know how to respond to emergencies, so it's essential for making sure the firefighting robot does its job effectively.

➢ *Bluetooth Receiver:*

The Bluetooth receiver for the firefighting robot as its ears. Just like how we use our ears to listen and follow instructions, the Bluetooth receiver allows the robot to receive commands wirelessly. It's like having a remote control for the robot. So, when a firefighter wants the robot to move closer to a fire or change its direction, they can send those commands using a smart phone or another Bluetooth-enabled device. The receiver then picks up those commands and tells the robot what to do. It's a simple but crucial part of the robot's communication system, helping it to respond quickly and effectively to the firefighter's instructions.

➢ *L293D IC:*

In a firefighting robot, the L293D IC is like the control center for the motors. Imagine it as the brain that tells the robot's wheels or tracks how to move. With the L293D, the robot can go forward, backward, and turn left or right, making it really agile. It's like having a remote control for the robot's movement. This IC is super important because it lets the robot navigate through obstacles and reach the fire easily. So, if you think about it, the L293D is the key to making the firefighting robot move around effectively and put out fires efficiently.

➢ *Robot chassis:*

This is the body or frame of the robot. It holds all the parts together and gives the robot its structure.

➢ *Servo Motors:*

Make the robot move engines. They turn the wheels or tracks so the robot can go where it needs to. A servo engine is a sort of rotating actuator that considers exact control of precise position. It comprises of an engine combined with a sensor for position input, typically a potentiometer. The engine is constrained by sending a PWM (Heartbeat Width Balance) signal, which decides the ideal place of the engine shaft. Servo engines are usually utilized in different applications where exact control of rakish position is required, like advanced mechanics, remote-controlled vehicles, modern mechanization, and aviation systems. They are especially famous in specialist and instructive undertakings because of their convenience and moderateness.

➢ *Buzzer:*

It's like the robot's voice. It makes noise to alert people if there's danger, like a fire or gas leak.

➢ *PIR Sensor:*

Think of the PIR sensor as the "fire detector" of the firefighting robot. Just like how a smoke alarm senses smoke, the PIR sensor detects heat or movement. When there's a fire, the PIR sensor picks up the heat it produces and sends a signal to the robot's brain, telling it that there's a fire nearby. This helps the robot know where to go and what to do, like spraying water to put out the flames. So, in a simple way, the PIR sensor acts like the robot's eyes, helping it see and respond to fires quickly.

➢ *Fire Sensor:*

Think of the fire sensor as the "fire alarm" for the firefighting robot. Just like how a fire alarm detects smoke or heat, the fire sensor can detect the presence of fire. When the sensor senses flames or excessive heat, it sends a signal to the robot's control system, alerting it to the fire's location. This helps the robot quickly locate and respond to the fire, like spraying water to extinguish the flames. So, in a simple way, the fire sensor acts as the robot's early warning system, helping it detect fires and take action to put them out.

➢ *LPG Sensor:*

Imagine the LPG sensor as the "smell detector" for the firefighting robot. Just like how we can smell gas leaks, the LPG sensor can detect the presence of LPG (liquefied petroleum gas), which is often present in fires. When the sensor detects LPG in the air, it sends a signal to the robot's control system, indicating that there may be a fire nearby. This helps the robot locate the source of the fire more quickly and effectively. So, in a simple way, the LPG sensor acts like the robot's nose, helping it sniff out fires and respond to them promptly.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR175

➢ *Water Pump:*
The water pump is like a water gun for the robot. It helps the robot spray water to put out fires.

➢ *Diagram*

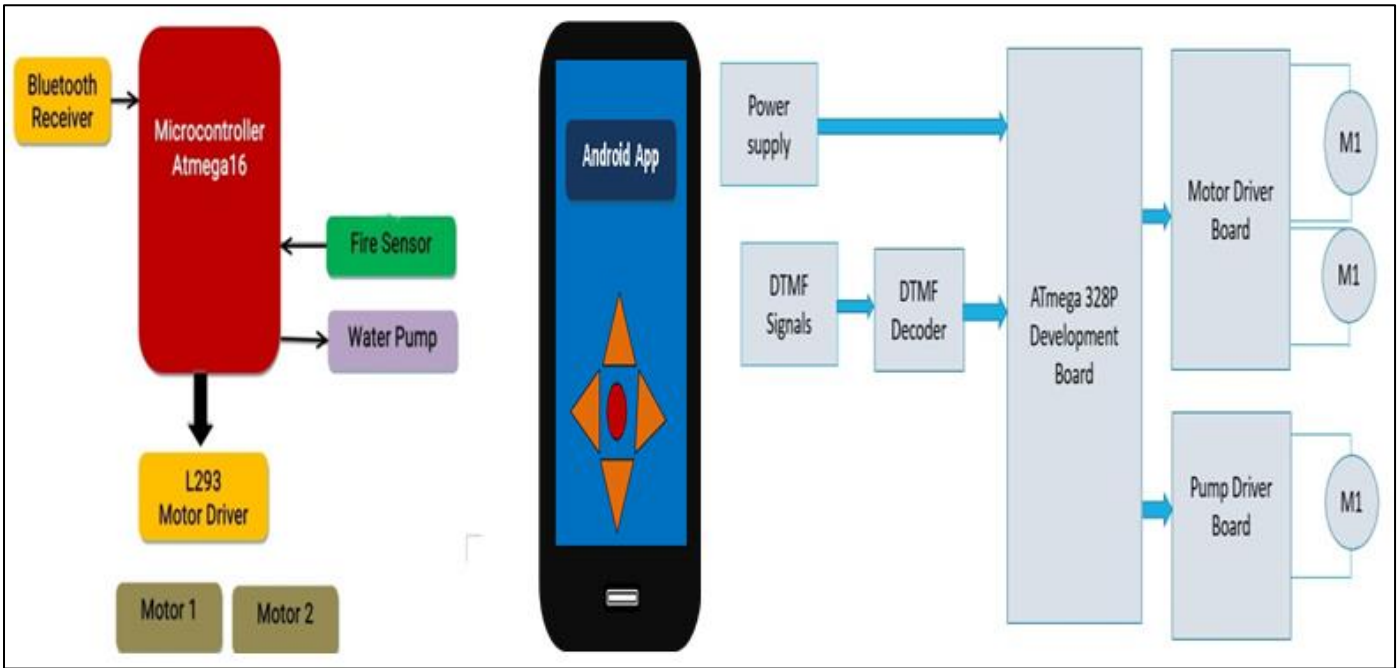

Fig 10 Diagram

➢ *Software used:*

- *AVR Studio for Programming Microcontroller*
- *DIP follow for PCB Planning*
- *Blue Control Android Application for Controlling.*

IV. WORKING& EXPERIMENTATION

- Robot will be controlled by android mobile phone via Bluetooth technology.
- Android mobile phone will be having a software running on it.
- Using this software any person can move the robot in any desired direction.

It will detect the fire. If there is any fire then it will start the water pump. A firefighting robot typically operates autonomously or semi-autonomously to detect, locate, and extinguish fires in hazardous environments. Here's a general overview of how a firefighting robot might work:

➢ *Detection:*
The robot may be equipped with various sensors to detect the presence of fire, such as infrared (IR) sensors, flame detectors, smoke detectors. These sensors continuously monitor the surroundings for signs of fire.

➢ *Localization:*
Once a fire is detected, the robot uses its sensors to determine the precise location of the fire. This information helps the robot navigate towards the fire source.

➢ *Navigation:*
The robot navigates towards the fire using either predefined paths or by dynamically planning its route based on the environment. It may use sensors such as ultrasonic sensors, LIDAR (Light Detection and Ranging), or cameras to detect obstacles and navigate around them.

➢ *Extinguishment:*
Upon reaching the fire, the robot employs various firefighting mechanisms to extinguish the flames. Common methods include spraying water or fire-retardant foam onto the fire using a water cannon or nozzle. The robot may also use a fan or other mechanisms to deprive the fire of oxygen and suppress it.

➢ *Monitoring:*
While extinguishing the fire, the robot continues to monitor the surrounding area for any signs of reignition or spreading of the fire. It may also relay real-time data and video feed to human operators or a central control station for monitoring and decision-making.

➢ *Safety Features:*
Firefighting robots are often equipped with safety features such as heat-resistant materials, automatic shutdown mechanisms in case of malfunction or overheating, and built-in fire suppression systems to protect themselves from damage during firefighting operations.

Overall, firefighting robots provide an effective and safe means of combating fires in hazardous environments where human intervention may be difficult or dangerous.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR175

They can operate autonomously in areas such as industrial facilities, warehouses, forests, and urban environments, assisting firefighters and improving overall firefighting capabilities.

➢ *Experimentation:*

Conduct experiments to evaluate the performance and capabilities of the firefighting robot in various fire scenarios, including:

- *Fire Detection:*

Test the robot's ability to detect fires of different sizes and intensities under varying environmental conditions.

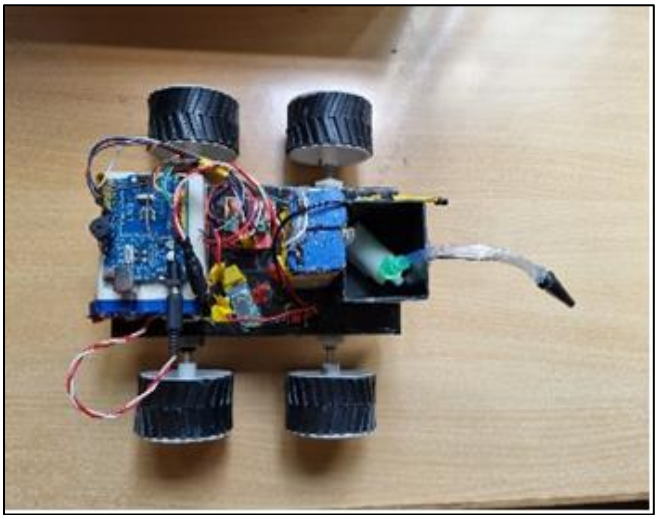

Fig 11 Development and Construction of an Autonomous Firefighting Robot

- *Navigation:*

Assess the robot's navigation capabilities in smoke-filled environments, cluttered spaces, and uneven terrain.

- *Fire Suppression:*

Evaluate the effectiveness of the robot's firefighting mechanisms in extinguishing fires and preventing their spread.

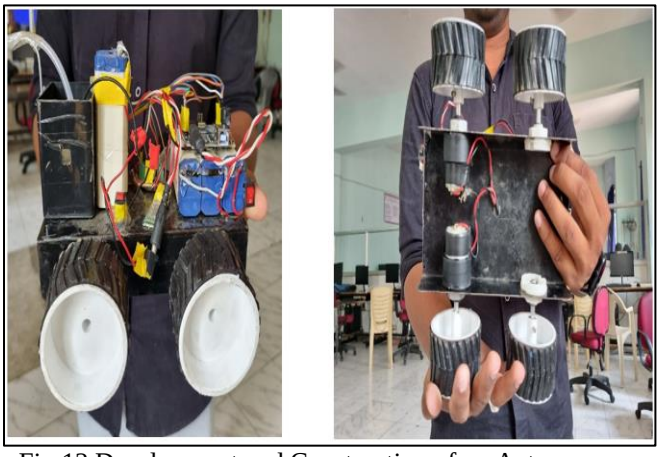

Fig 12 Development and Construction of an Autonomous Firefighting Robot

- Measure key performance metrics such as response time, detection accuracy, success rate in fire suppression, and reliability.
- Document experimental procedures, observations, and results to inform further refinements to the robot's design and functionality.
- Collaborate with firefighting professionals and experts to validate the robot's performance and gather feedback for iterative improvement.
- Publish research findings and contribute to the body of knowledge in the field of firefighting robotics through academic papers, conference presentations, and technical reports.

V. METHODOLOGY

➢ *Problem Definition and Requirements Analysis:*

- Characterize the goals and extent of the firefighting robot project.
- Recognize the particular necessities and difficulties the robot needs to address, like fire recognition, route in smoke-filled conditions, and viable fire concealment.

➢ *Research and Design Planning:*

- Conduct research on existing firefighting robot designs, technologies, and best practices.
- Develop a conceptual design for the firefighting robot, considering factors such as size, mobility, sensor integration, and firefighting mechanisms.

➢ *Component Selection and Procurement:*

- Select appropriate hardware components based on the design requirements and budget constraints.
- Procure components such as microcontrollers, sensors, actuators, and structural materials from reliable suppliers.

➢ *Prototyping and Assembly:*

- Build a prototype of the firefighting robot based on the conceptual design.
- Assemble the selected components onto the robot chassis, ensuring proper wiring, mounting, and structural integrity.

➢ *Software Development:*

- Develop the firmware and software algorithms required to control the robot's behavior.
- Program the microcontroller to interface with sensors, process sensor data, make decisions, and control actuators.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR175

➢ *Sensor Integration and Calibration:*

- Integrate sensors such as fire sensors, temperature sensors, gas sensors, and motion sensors onto the robot.
- Calibrate sensors to ensure accurate and reliable detection of fire, heat, smoke, and other relevant environmental parameters.

➢ *Navigation and Localization:*

- Implement algorithms for autonomous navigation and obstacle avoidance.
- Incorporate localization techniques such as GPS, inertial navigation, or SLAM (Simultaneous Localization and Mapping) to enable the robot to determine its position and navigate effectively in indoor and outdoor environments.

➢ *Fire Suppression Mechanisms:*

- Integrate firefighting mechanisms such as water pumps, extinguisher dispensers, or foam sprayers onto the robot.
- Develop control algorithms for activating and controlling firefighting mechanisms based on sensor inputs and environmental conditions.

➢ *Testing and Evaluation:*

- Conduct rigorous testing of the firefighting robot in simulated fire scenarios and real-world environments.
- Evaluate the robot's performance in terms of fire detection accuracy, navigation efficiency, fire suppression effectiveness, and overall reliability.

➢ *Iterative Improvement:*

- Analyze test results and identify areas for improvement in the robot's design, hardware, and software.
- Iteratively refine the robot's design and functionality based on feedback from testing and evaluation.

➢ *Applications*

- Smothering fire where probability of blast is more is utilized
- It utilized as home security application.
- It is utilized in server rooms in workplaces.
- It is helpful in misfortune region observing and salvage.

➢ *Sure, here are some Straightforward Applications of Firefighting Robots:*

- **Indoor Fires:** Enter burning buildings to locate and extinguish fires, especially in areas too dangerous for humans.
- **Wildfires:** Deploy in forests and remote areas to suppress wildfires by spraying water or fire-retardant substances.
- **Hazards:** Navigate through industrial settings to manage fires involving hazardous materials.
- **Search and Rescue:** Assist in finding and rescuing people trapped in hazardous environments during fires.
- **Hazardous Material Handling**: Transport and contain dangerous substances to minimize risks to human responders.
- **Remote Monitoring:** Patrol areas prone to fires, detect early signs of fires, and provide real-time data to firefighters.
- **Training Simulations:** Provide realistic scenarios for firefighter training exercises to enhance skills and preparedness.
- **Post-Fire Cleanup:** Assist in assessing damage, identifying hotspots, and cleaning up debris after fires.
- **Aerial Support:** Utilize drones for aerial reconnaissance, firefighting, and delivering supplies to firefighters on the ground.
- **Collaborative Efforts:** Work alongside human firefighters to enhance response capabilities and improve overall firefighting outcomes.

➢ *Advantages*

- Robot can stifle the fire without hurting people being.
- Robot can go to hazardous spots where individual can not go.
- Less reason for mishap cases. In any event, Working is done programmed mode as well as manual mode.
- Human prerequisite is less.
- Support cost is less.
- Effectively repairable.
- Further developed security.
- Assurance of property from misfortune.
- Basic in development.
- Simple to screen.
- Little in size.
- **Safety:** Robots keep firefighters out of harm's way
- **24/7 Availability:** They can work round the clock without fatigue.
- **Remote Operation:** Operated from a safe distance by human controllers.
- **Precision:** Perform firefighting tasks accurately and efficiently.
- **Data Gathering:** Collect real-time information for informed decision-making.
- **Cost-Effectiveness:** Save money in the long run by reducing property damage.
- **Versatility:** Can be adapted for various firefighting tasks.
- **Collaboration:** Work alongside human firefighters to improve efficiency.
- **Adaptability:** Operate in extreme conditions where humans may struggle.
- **Public Confidence:** Showcase commitment to safety and innovation.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR175

➢ *WinAVR*

There are multiple ways that you can compose, incorporate, and download a program to the ATmega16 microcontroller. There are a wide range of word processors, compilers, and utilities accessible for the vast majority various dialects (C, Essential, low level computing construct, and so on.). A portion of these are for nothing, and some require a permitting expense to utilize them. In this class, we will utilize a freeware bundle of programming devices named WinAVR (articulated, "at whatever point"). WinAVR has been introduced on the PCs in the Mechatronics Research facility, yet you are emphatically urged to download it and introduce it on your own PC, so you can work with your microcontroller beyond the lab. Guidelines for introducing WinAVR are given in Supplement A toward the finish of this report.

WinAVR comprises of a set-up of executable, open source programming improvement devices for the Atmel AVR series of RISC chip facilitated on the Windows stage. It incorporates the GNU GCC compiler for C and C++, which is at times alluded to as avr-gcc. Customarily, the microcontroller in implanted frameworks was modified straightforwardly utilizing low level computing construct. Low level computing construct utilizes just the essential guidance set for a specific microcontroller. While this can deliver quick, effective code, it is restricted in that each processor type has its own guidance set. In this manner it's anything but a down to earth language to learn except if you are doing an undertaking that is committed to a particular microcontroller or has a genuine requirement for exact timing as well as memory use. The C language, then again, is ordinarily utilized in industry and can be applied over various stages. By realizing this one language, you will actually want to program practically any microcontroller, given that you have a compiler that can make an interpretation of C code into low level computing construct for your regulator. The Gnu-C compiler is an open-source, freeware, C compiler that frames the reason for compilers that produce code for the vast majority different microcontrollers and different working frameworks, like Windows and UNIX.

➢ *Procedure*

Presently, you'll start constructing your most memorable venture. For this first undertaking, you will utilize a model program accommodated you that shows how to print messages to the sequential port. Attempt to recollect these means, since you should go through them in resulting labs. The more comfortable you are with these means, the quicker the labs will go from here on out.

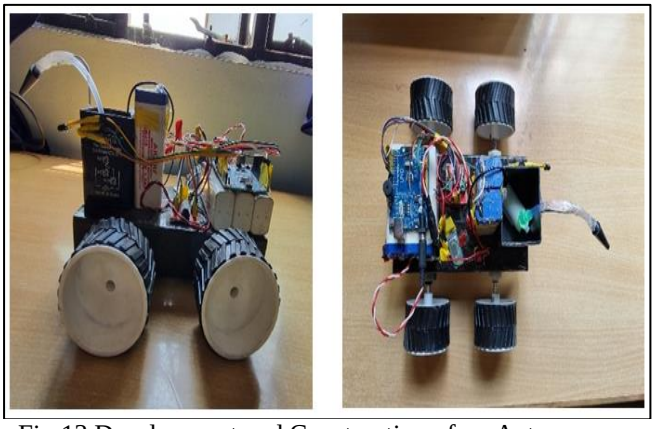

Fig 13 Development and Construction of an Autonomous Firefighting Robot

You will utilize a freeware program from Atmel called AVR Studio to sort out every one of the records expected to gather a program to run on the microcontroller. The following couple of steps will lead you through the most common way of setting up a document structure, which will contain the required files. Note that the PCs in the Mechatronics lab as of now have AVR Studio and WinAVR introduced on them. To deal with a microcontroller outside the lab, you should introduce this product on your own PC. See Reference section A toward the finish of this record for directions.

Open AVR Studio by double tapping its symbol on your work area or choosing it in the Beginning Menu. Select Undertaking - > New Venture starting from the drop menus or New Task from the spring up window if one opens when you send off AVR Studio. You ought to consider the new task window to be displayed in Figure.

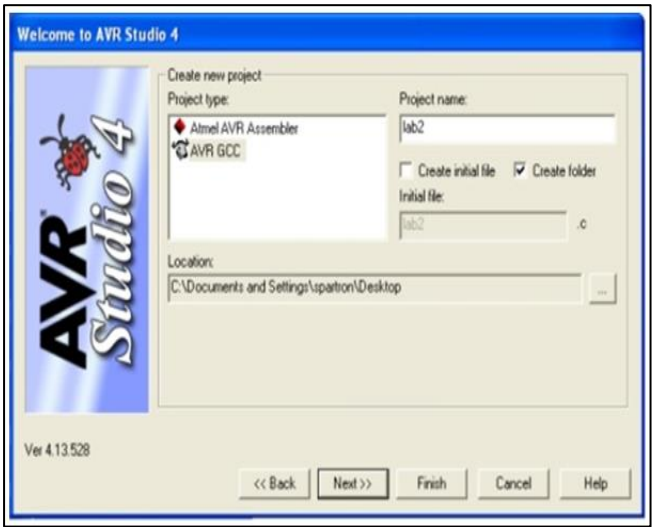

Fig 14 AVR Studio New Under Taking Window

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR175

- *Note the Settings Utilized for this Lab and where your Envelope will be Made. In the New Undertaking Spring up Window:*

Select AVR GCC and type an illustrative name into the Task name field (like (FirstAVRproject).Since you will utilize gave source codes uncheck the Make beginning record box. Check the Make envelope box. Peruse to guarantee that the Place (where your undertaking will be saved) as of now exists, so you know about where you are saving documents. Make certain to ultimately duplicate your task documents onto a USB drive or email your source records to yourself, on the grounds that any documents left on the lab PCs might be changed or erased out of the blue.

- Click the Following >> button
- Select AVR Test system in the Troubleshoot stage field.
- Select ATmega16 (not ATmega16A) in the Gadget field.(scroll down, it is there)
- Click the Completion button
- Arrange your task settings utilizing the Venture - > Design Choices drop down menu as displayed in Figure.
- Change the Recurrence box to 8000000.(8 million without the commas. Note that assuming you get a blunder with respect to F_CPU indistinct, it is on the grounds that you failed to remember this step.)
- Change the Enhancement box to - O2.
- Click on the Incorporate Catalogs button viewed as on the left side.
- Click on the New Envelope symbol (upper right corner) and utilize the peruse circle "… " to add your task organizer you made in Sync #3 (shows up as .\ )Snap alright

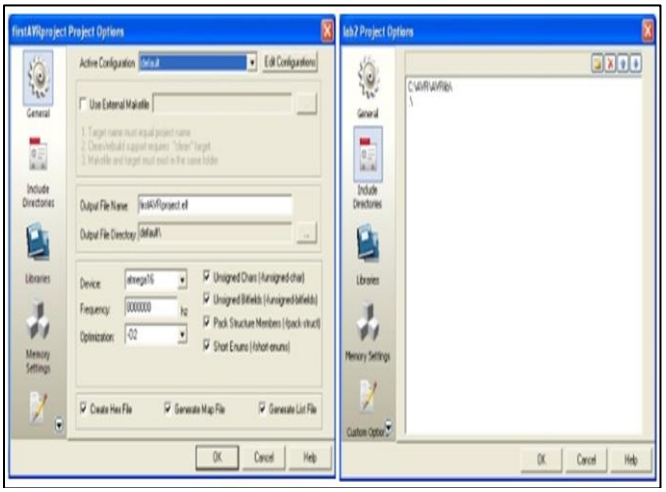

Fig 15 Project Design Choices

Any time you make a task utilizing AVR Studio, you ought to set the Recurrence and Enhancement as displayed above to one side. You likewise need to incorporate the registry that you have your source code in (denoted.\) by going to the Incorporate Catalogs choice, adding it as another envelope, and perusing to where it is on the PC as displayed above to one side. Assuming you use code from some other undertaking catalog or library, you should incorporate the area of where their registries dwell. In the model above, AVRlib was likewise included. You needn't bother with AVR lib for this lab.

VI. CONCLUSION

Fire causes enormous harm and loss of human existence and property. In this paper we have planned a putting out fires robot which to be controlled utilizing microcontroller ARDUINO Uno. Result of the sensors is given to microcontroller board and likewise robot is worked effectively.

REFERENCES

[1]. Kristi Kosasih, E. Merry Sartika, M. Jimmy Hasugian, danMuliady, “The Intelligent Fire Fighting Tank Robot”, Electrical Engineering Journal Vol. 1, No. 1, October 2010.
[2]. B. L. Theraja, A. K. Theraja, “A textbook of Electrical Technology” Volume 2.
[3]. Ashfaq Hussain, “Electric Machines”.
[4]. E. Krasnov and D. Bagaev, "Conceptual analysis of firefighting robots' control systems", 2012 IV International Conference “Problems of Cybernetics and Informatics” (PCI), pp. 1-3, 2012
[5]. T. L. Chien, H. Guo, K. L. Su and S. V. Shiau, "Develop a Multiple Interface Based Fire Fighting Robot", 2007 IEEE International Conference on Mechatronics, pp. 1-6, 2007.
[6]. H. Amano, "Present status and problems of firefighting robots", Proceedings of the 41st SICE Annual Conference. SICE 2002, vol. 2, pp. 880-885, 2002.
[7]. K. L. Su, "Automatic Fire Detection System Using Adaptive Fusion Algorithm for Fire Fighting Robot", 2006 IEEE International Conference on Systems, pp. 966-971, 2006.