

DRUG FREE SOCIETY WITH IoT AND AWS

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Electronics and Communication Engineering

by

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SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **ADITYA SAILESH T (39130011)** and **ABDUL RAHMAN S (39130004)** who carried out the project entitled **"DRUG FREE SOCIETY WITH IoT AND AWS"** under our supervision from November 2022 to April 2023.

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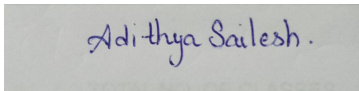
We **ADITYA SAILESH T (39130011)** and **ABDUL RAHMAN S (39130004)** hereby declare that the Project Report entitled “**DRUG FREE SOCIETY WITH IoT AND AWS**” done by us under the guidance of **Ms. J. PREMALATHA** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering.

DATE: 19.4.2023

PLACE: CHENNAI

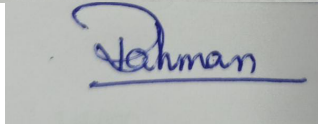
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ABSTRACT

The usage of drugs has a mammoth impact on the globe. It causes psychological changes in human behavior which results in discomfort of the society. Specifically, Indoor air pollution is receiving widespread attention as it can endanger people's health. Concentrations from dabbing and vaporizing cannabis can create levels of indoor air pollution similar to those seen in extreme air pollution events like wildfires and severe industrial pollution. Exposure at these concentrations can cause cardiovascular and respiratory diseases. The distinctive and pervasive odor from cannabis can trigger complaints from neighboring business and may violate local odor ordinances, as well as put others at risk. This creates a dusty environment with high particulate loads that must be addressed by adequate filters. In order to eradicate that from the root level a concept named as, Drug free society with Internet of Things (IoT) and AMAZON WEB SERVICES (AWS) has been introduced. It is specifically designed to abolish "Marijuana" the most commonly used psychoactive drug. The device acts as an air quality monitor which sense the smoke/ Tetrahydrocannabinol (THC) particles in air as well as send that information along with a proof to AWS which plays an important role as a part of cloud storage. The system uses Metal Oxide (MQ)135 and particulate matter (PM) 2.5 sensor for monitoring air quality as it detects most harmful gases and can measure their amount accurately. The IoT system is used for sensing the atmospheric gases with the help of embedded sensors in the device. There are so many existing projects with this base idea. They all are comes under the common category of "Air quality monitor". Their purpose is similar to our proposed project and they have more number of success ratio since their construction is very simple and neat. Their outcome is also limited to monitor certain gases. Commonly, smoke and dust particles. The existing methods won't deal with new tech concepts. They tend to follow the same commercial pattern of an air quality monitoring system.

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LIST OF ABBREVIATIONS

IoT	-	Internet of Things
AWS	-	Amazon web services
THC	-	Tetrahydrocannabinol
MQ	-	Metal oxide
PM	-	Particulate matter
OLI	-	Operational Land Imager
LSD	-	Lysergic acid diethylamide
CBD	-	Cannabidiol
VOC	-	Volatile organic compounds
COPD	-	Chronic obstructive pulmonary disease
CO ₂	-	Carbon dioxide
NH ₃	-	Ammonia
NO _x	-	Nitrogen oxide
LPG	-	Liquid petroleum gas
PPM	-	Parts per million
LCD	-	Liquid crystal display
AP-HRA	-	Air pollution health risk assessment
CRF	-	Concentration response function
LEDS	-	Low emission development strategies
NAMA	-	National Appropriate Mitigation Action

CHAPTER 1

INTRODUCTION

A drug is any chemical substance that causes a change in an organism's physiology or psychology when consumed. In English, the noun "drug" is thought to originate from Old French "drogue", meaning "dry (barrels)", referring to medicinal plants preserved as dry matter in barrels. Consumption of drugs can be via inhalation, injection, smoking, ingestion, absorption via a patch on the skin, suppository or dissolution under the tongue. Especially, Psychoactive drugs are chemical substances that affect the function of the central nervous system, altering perception, mood or consciousness.

These psychoactive drugs have been proven useful in treating a wide range of medical conditions including mental disorders around the world [1]. The most widely used drugs in the world include caffeine, nicotine and alcohol, which are also considered recreational drugs, since they are used for pleasure rather than medicinal purposes. All drugs can have potential side effects. Abuse of several psychoactive drugs can cause addiction and/or physical dependence.

Recreational drug use is the use of a drug (legal, controlled, or illegal) with the primary intention of altering the state of consciousness through alteration of the central nervous system in order to create positive emotions and feelings. The hallucinogen LSD is a psychoactive drug commonly used as a recreational drug. In this module we will be discussing about the most common and effective drug which is named as cannabis or weed.

Cannabis, also known as marijuana among other names, is a psychoactive drug from the Cannabis plant. Native to Central and South Asia, the cannabis plant has been used as a drug for both recreational and entheogenic purposes and in various traditional medicines for centuries. Tetrahydrocannabinol (THC) is the main psychoactive component of cannabis, which is one of the 483 known compounds in other cannabinoids, including cannabidiol (CBD).

Cannabis has various mental and physical effects, which include euphoria, altered states of mind and sense of time, difficulty in concentrating, impaired short-term memory loss and impaired body movement (balance and fine psychomotor control).

Cannabis is mostly used recreationally or as a medicinal drug, although it may also be used for spiritual purposes. Acute negative effects may include anxiety and panic, impaired attention and memory, an increased risk of psychotic symptoms, the inability to think clearly, and an increased risk of accidents.

Cannabis impairs a person's driving ability, and THC was the illicit drug most frequently found in the blood of drivers who have been involved in vehicle crashes. Those with THC in their system are from three to seven times more likely to be the cause of the accident than those who had not used either cannabis or alcohol, although its role is not necessarily causal because THC stays in the bloodstream for days to weeks after intoxication.

Legalization has increased the rates at which children are exposed to cannabis, particularly from edibles [2]. While the toxicity and lethality of THC in children is not known, they are at risk for encephalopathy, hypotension, respiratory depression severe enough to require ventilation, somnolence and coma [3]. The gateway hypothesis states that cannabis use increases the probability of trying "harder" drugs.

The hypothesis has been hotly debated as it is regarded by some as the primary rationale for the United States prohibition on cannabis use. Cannabis research is challenging since the plant is illegal in most countries.

There are also other difficulties in researching the effects of cannabis [4]. Many people who smoke cannabis also smoke tobacco. This causes confounding factors, where questions arise as to whether the tobacco, the cannabis, or both that have caused cancer. In case if the weed population is kept increasing it will lead to drug society.

CHAPTER 2

LITERATURE SURVEY

2.1 INFERENCES FROM LITERATURE SURVEY

Title	Changing trends in the air pollution–related disease burden from 1990 to 2019 and its predicted level in 25 years
Authors	Aaron J Cohen , Michael Brauer , Richard Burnett , H Ross Anderson, Joseph Frostad, Kara Estep, Kalpana Balakrishnan
Published Year	2017
Efficiency	• The article analyzes data from the Global Burden of Diseases Study 2015 to estimate the global burden of disease attributable to ambient air pollution over 25 years. The study estimates that ambient air pollution was responsible for 4.2 million deaths and 103 million disability-adjusted life-years (DALYs) in 2015. The authors also report an increase in the global burden of disease attributable to ambient air pollution from 1990 to 2015, with a 24.8% increase in deaths and a 27.3% increase in DALYs. The article discusses the limitations of the study, including the reliance on modeling techniques and the uncertainty of the estimations. However, the authors argue that their findings highlight the need for stronger public health policies to address the impact of air pollution on human health. Overall, the article provides a valuable contribution to the understanding of the global burden of disease attributable to ambient air pollution, emphasizing the urgent need for effective policies to reduce exposure and mitigate its impact on public health.

Drawbacks	• Underestimation: The estimates provided in the study may have underreported the actual burden of disease attributable to ambient air pollution, as they rely on models and assumptions that may not accurately capture the true extent of exposure and health impacts. • Data Quality: The quality and availability of data on air pollution and its health effects varies widely across the globe, and the study may have been constrained by limitations in data quality or availability. • Methodological Issues: The methods used to estimate the burden of disease attributable to ambient air pollution may be subject to methodological limitations or biases, leading to uncertainty in the estimates and difficulty in comparing between different regions and over time. • Regional Variations: The health impacts of air pollution can vary depending on local factors such as climate, geography, and population demographics. The estimates may not fully capture these regional variations and may not be generalizable to all settings. • Limited Scope: The study focuses on ambient air pollution, but other sources of air pollution such as indoor air pollution or occupational exposures may also contribute to the burden of disease. The estimated burden of disease attributable to air pollution may therefore be incomplete.

Description	Marijuana is the most commonly used federally illegal drug in the United States, 48.2 million people, or about 18% of Americans, used it at least once in 2019. Recent research estimated that approximately 3 in 10 people who use marijuana have marijuana use disorder. For people who begin using marijuana before age 18, the risk of developing marijuana use disorder is even greater [5]. Marijuana use directly affects the brain, specifically the parts of the brain responsible for memory, learning, attention, decision-making, coordination, emotion, and reaction time. Infants, children, and teens (who still have developing brains) are especially susceptible to the adverse effects of marijuana. Long-term or frequent marijuana use has been linked to increased risk of psychosis or schizophrenia in some users.
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2.2 OPEN PROBLEMS IN EXISTING SYSTEM

There are so many existing projects with this base idea. They all come under the common category of "Air quality monitor"[6]. Their purpose is similar to our proposed project and they have more number of success ratio since their construction is very simple and neat. Their outcome is also limited to monitor certain gases. Commonly, smoke and dust particles. The existing methods won't deal with new tech concepts [7]. They tend to follow the same commercial pattern of an air quality monitoring system. The other existing method is considered to be the "primitive method of an air monitor system". The air pollution situation is updated hourly or even daily. Hence, the air pollution maps built by the conventional air pollution monitoring systems are with extremely low spatial and temporal resolutions[8].

CHAPTER 3

AIM AND SCOPE OF THE PRESENT INVESTIGATION

3.1 FEASIBILITY STUDIES/RISK ANALYSIS OF THE PROJECT

The prediction and study of air pollution is a complex process due to the presence of controlling factors, different land use, and different sources for the elaboration of pollution. In this study, we applied the machine learning technique (Random Forest) with time series of particulate matter pollution records to predict and develop a particulate matter pollution susceptibility map. The applied method is to strict measures and to better manage particulate matter pollution in Ras Garib city, Egypt as a case study. Air pollution data for the period between 2018 and 2021 is collected using five air quality stations. Some of these stations are located near highly urbanized locations and could be dense with the current rates of development in the future. The random forest was applied to verify and visualize the relationships between the particulate matter and different independent variables. Spectral bands of Landsat OLI 8 imaginary and land cover/land use indices were used to prepare independent variables.

Analysis of the results reveals that the proper air quality distribution monitoring stations would provide a deep insight into the pollution distribution over the study site. Distance from the roads and the land surface temperature has a significant effect on the distribution of air quality distribution. The obtained probability and classification maps were assessed using the area under the receiver operating characteristic curve. The outcome prediction maps are reasonable and will be helpful for future air quality monitoring and improvements. Furthermore, the applied method of pollutant concentration prediction is able to improve decision-making and provide appropriate solutions. Environmental pollution problems interest is increasing recently, with the increase of industrialization, urbanization, and other human activities. Air pollution is considered to occur whenever an excessive quantity of pollutants is released into the environment. Thus, air pollution has a direct influence on human health due to the exposure to pollutants and particulates.

Air pollution is a major public health problem. A significant number of epidemiological studies have found a correlation between air quality and a wide variety of adverse health impacts emphasizing a considerable role of air pollution in the disease burden in the general population ranging from subclinical effects to premature death. Health risk assessment of air quality can play a key role at individual and global health promotion and disease prevention levels. The Air Pollution Health Risk Assessment (AP-HRA) forecasts the expected health effect of policies impacting air quality under the various policy, environmental and socio-economic circumstances, making it a key tool for guiding public policy decisions.

This paper presents the concept of AP-HRA and offers an outline for the proper conducting of AP-HRA for different scenarios, explaining in broad terms how the health hazards of air emissions and their origins are measured and how air pollution-related impacts are quantified. In this paper, seven widely used AP-HRA tools will be deeply explored, taking into account their spatial resolution, technological factors, pollutants addressed, geographical scale, quantified health effects, method of classification, and operational characteristics. preterm birth, and cognitive disorders.

Since air pollution is now one of the most significant health hazards, there is a sufficient scientific basis to justify developing approaches to incorporate epidemiological assessment into the health-related risk. Although the idea of has been around since the 1950s, the health-care system worldwide has not adopted them as quickly. It can play a critical role at both individuals, community, and global health promotion and disease prevention levels.

According to the estimate health impact to be expected from measures that affect air quality, in different socioeconomic, environmental and policy circumstances. It is, therefore, an important tool for informing public policy decisions". It synthesizes information on exposures to air emissions, health impacts, and community risk used for regulatory decision-making and public participation.

AP-HRAs help to understand health benefits, which will be an outcome due to improved air quality and has been used in many studies like the global burden of disease. Over the last decade, they have evolved from more qualitative approaches to quantitative tools. HRA tools assess the health risks of the major pollutants such as oxides of sulfur (SO_x) and oxides of nitrogen (NO_x), ground-level ozone (O₃), and particles (PM_{2.5}) on the population which is

exposed to these pollutants. They relate the change in the level of the air pollutant concentration to the expected mortality rates due to ischemic heart diseases, stroke, lung cancer, and respiratory infections, using Concentration Response Functions (CRFs) . Three main steps involved in developing the HRA tools include population exposure assessment, Health effect estimation related to air pollution, and calculation of the uncertainty of the analysis .

The HRA tools can facilitate policy decision-making by evaluating the associated costs and health benefits of climate change mitigation actions. The urgency of bold and timely Low Emission Development Strategies (LEDS) coupled with the health, environmental, and economic opportunities has been argued in China and Mongolia.

These tools help raise public awareness regarding the adverse health impact of low air quality and finally connect governing authorities with scientific research throughout the regulatory process .

The HRA tools have been widely used in evaluating air quality policies in the United States and the European Union . Many countries have developed their own Nationally Appropriate Mitigation Action (NAMA) based on using the HRA tools, taking into account the different air pollution reduction scenarios. The Internet of Things (IoT) is an important part of the new generation of information technology. The core and foundation of the Internet of Things is still the Internet.

The Internet of Things (IoT) collects various information such as sound, light, heat, electricity, mechanics, and chemistry through various information sensing devices, such as sensors, RFID, laser scanners, etc., and forms a huge network combined with the Internet [9] .

In order to test the effectiveness of this air pollution monitoring system in regional air monitoring, the project named as Drug Free Society With IoT and AWS is proposed [10].

3.2 SOFTWARE REQUIREMENTS SPECIFICATION DOCUMENT

The Intelligent air quality management system pilot consists of key technologies to develop a healthy indoor environment in the buildings that can automatically adjust its conditions to better temperature, air quality, humidity, etc. using the results analysed by the environmental data. As the indoor environments are affected by the outdoor pollutants as well as the indoor pollutants, Co-way will develop the IAQ (Indoor Air Quality) and the OAQ (Outdoor Air Quality) devices in order to gather environmental data related to the air quality. Basically, the IAQ and OAQ devices will be equipped with the telecommunication modules based on Wi-Fi and the various environmental sensors[11]. In addition, Co-way will operate on the indoor testbed to evaluate the intelligent air quality management system interconnecting with the air purifiers. ETRI will build a server platform to manage and analyse the environmental data measured from the IAQ and OAQ devices. ETRI will also develop some machine learning algorithms to detect and classify the user behaviours and the analysed results will be applied to air purifier to clean the indoor air quality in home and office buildings.

Technical development In this pilot, Co-way will contribute to the development of the IAQ/OAQ sensors for acquiring the environmental data and the adaptive control of air purifiers. ETRI will develop a data server to store the environmental data and efficiently access the data for further monitoring and analysis [12]. In addition to that, ETRI will analyse the data from the sensors to automatically find pleasant index and user activity patterns that lead to the adaptive control of air purifiers to improve the environmental conditions. The technical development of the pilot will be concentrated on the development of four technologies as shown in the following. The contributions of each partner will take into consideration the following technologies depending on their objectives:

- Development of IAQ/OAQ devices to measure environmental data (Co-way),
- Collection and management of environmental data (ETRI),
- Analysis of environmental data to extract pleasant index (ETRI), and
- Adaptive control of air purifier by using pleasant index and commercialization of the integrated product (Co-way).

3.3 SYSTEM USE CASE

On average, we spend around 90% of the time in indoor environments. Indoor Air Quality (IAQ) has been receiving increased attention from the environmental bodies, local authorities and citizens as it is becoming clearer that poor IAQ has public health implications. Therefore, monitoring of indoor environment becomes crucial to enhance IAQ and involving citizens in managing their indoor environments by raising awareness – a goal of a number of Citizen Science (CS) projects. In this work, we present a use case of IAQ monitoring in a European project with a focus on Smart Cities with citizen engagement and involvement. It is well known that the cost of Air Quality (AQ) monitoring stations, which are often stationary, and generally produce reliable, and high-quality data is a non-starter for CS projects as cost prohibits the scaling of deployment and citizen involvement. On the other hand, it is widely assumed that low-cost devices for AQ, although available in abundance, are often produce low-quality data, putting the credibility of basing any analysis on low-cost sensors.

There is an increasing number of research efforts that look at how to ascertain data quality of such sensors so they could still be used reliably, often to provide indicative readings, and for analytics. In this work, we present data science-based techniques that we have utilised for selecting low-cost sensors based on their data quality indicators, and an integrated visualisation system that utilises structure data for IAQ to support multi-city trials in a CS project. The sensors are selected after analysing their consistency over a period by applying different approaches such as statistical analysis and graphical plots.

In recent years there has been a growing awareness about the negative health impacts caused by poor indoor air quality. Good air quality in buildings is vital for people who spend much of the day indoors. We spend an average of 90 % of our time indoors, more than 20 hours in enclosed spaces. Indoor air quality does affect our health and therefore, badly managed air quality can have economic and legal implications.

Pollutants can cause or contribute to short and long-term health problems, including asthma, respiratory tract infections and allergic reactions etc. Indoor air pollutants can cause discomfort, increase absenteeism and reduce productivity. Poor indoor air quality strains relationships among employees, family members, teachers and students. Indoor air quality

problems can result in litigation. Indoor air quality monitoring (IAQ) is carried out to assess the extent of pollution, ensure compliance with national or local legislation, evaluate pollution control options, and provide data for air quality modelling. It is particularly important in chemical plants, mines, and other facilities with potentially harmful concentrations of pollutants.

The central objective is to ensure that the location is safe for individuals. As the burden of air quality regulation shifts from publicly-funded monitoring to industry-funded monitoring, businesses have begun to invest more heavily in their own air quality monitoring equipment and processes. An indoor air quality monitor will report on the levels of common pollutants and other air conditions inside the home or office in real-time.

The culprit could be anything from excessive dust to high humidity to emissions from household cleaners or building materials. Some indoor air-quality monitors will also track outdoor air quality to provide context for the indoor readings. The measurements are then displayed on a screen on the device itself as well as in a companion app on the mobile device. Most IAQ monitors will alert users to unsafe levels via an indicator light and/or push notifications to the smartphone or tablet.

Wireless sensor networks (WSNs) are paying attention in the industry also in academia because of their significant relevance and associated security challenges. The utility of this network is to collect the data from the environment and fling it to the sink node. The present system consists of the five sensor nodes and one sink node. The chic sensor nodes are least-power gadgets outfitted with one or more sensors, microcontroller, a power supply and radio.

An array of different sensors can be allied to the mote to determine environment parameters. With the establishment of 'Solapur' as smart city it becomes pertinent to employ the WSN for monitoring AAQ protocols. The smart city projects in Solapur is obligatory to put up a superior air quality monitoring system in terms of rate, power competence, ability by using contemptible handy ambient sensors.

The use of IoT (Internet of Things) provides the remote monitoring of our system [13]. Internet of Things has a backbone of diverse technologies- Wireless Sensor Networks, Embedded Systems, Security Protocols and Architectures, network services, Internet and Search Engines and Cloud Computing. The internet of things (IoT) is a system of unified

computing gadgets, automatic and digital tackle, items, group that are provided with unique identifiers and the capability to convey data in excess of a network with no requiring user-to-user or user-to-computer dealings. Devices that work on IoT, distribute the sensor information; they amass by linking to an IoT gateway where data is sent to the cloud to be analyzed. The block diagram, Figure 1 represents the proposed system.

The use of open source IoT web server platform, to ensure an enduring storage as well as real time monitoring of air quality monitoring data makes the system more superior than the traditional data logger system. Use of flawless incorporation of smart mobile standards, WSN, and several other sensing technologies makes this system more scalable and smart [14]. Uses of XBee wireless protocol make the system least power consumable.

The IoT based air contamination monitoring system can be created via sensors and microcontrollers existing in the marketplace. The sink nodes are programmed to collect the data from the mote and transmit it to the cloud.

An algorithm is proposed to examine the data and hurl it to the smart phone app. Smartphone app will be developed for user to access the air quality information in real-time [15]. The IoT monitoring is scamper on the communication protocol. Internet of Things is now verdict reflective exploit in each and every area, plays an important role in this monitoring system too.

This system monitors the effluence source from anywhere via PC or mobile. The system shows the air pollution in ppm on webpage, accordingly continuous monitoring can be done. IoT makes almost all “smart” which ameliorate aspects of our existence with the supremacy of data collection and networks [16]. The thing in IoT can compared to be similar to a human being amid a diabetes supervise embed, an animal with tracking plans, etc.

Therefore, monitoring of indoor environment becomes crucial to enhance IAQ and involving citizens in managing their indoor environments by raising awareness – a goal of a number of Citizen Science (CS) projects. In this work, we present a use case of IAQ monitoring in a European project with a focus on Smart Cities with citizen engagement and involvement [17].

CHAPTER 4

EXPERIMENTAL OR MATERIALS AND METHODS; ALGORITHMS USED

4.1 SELECTED METHODOLOGY OR PROCESS MODEL

Our proposed project is built with more social consciousness and loaded with advance tech feature named as," AWS " (Amazon web services) [18] .Our methodology is far advanced and it is not limited to monitor certain gases alone. It is specifically designed to monitor "marijuana " emission in an indoor environment. The proposed idea is fresh and techie with the base pattern of an air quality monitoring system. This method is an absolute eco-friendly oriented proposal. This proposed methodology is quite advanced version than the existing method. The proposed methodology can detect more number of gases and even act as a drug detection sensor where the existing methods won't. We can get accurate information from the proposed methodology than the existing one .AWS is the current trend and it act as the cloud storage part of proposed methodology where there is no presence of AWS in any of the existing methods. The existing methodology can't be directly enter into the market field whereas this proposed method is completely tech loaded and can directly enter into the society.

All of the data collected by the MQ135 sensor and GPS module is stored in the cloud using AWS (Amazon Web Services). This allows for easy access to the data and makes it possible to analyze it using various tools and algorithms to identify trends and patterns related to drug use .The LCD display is used to show alerts to the user and other stakeholders, such as law enforcement agencies. For example, if marijuana smoke is detected, the LCD display could show an alert message like "Marijuana detected in this area."

In addition, the buzzer provides an audible alert when marijuana smoke is detected, which can be used to discourage drug use [19]. The GPS module allows the location of the device to be tracked, which can be useful for identifying areas where drug use is more prevalent.

4.2 ARCHITECTURE / OVERALL DESIGN OF PROPOSED SYSTEM

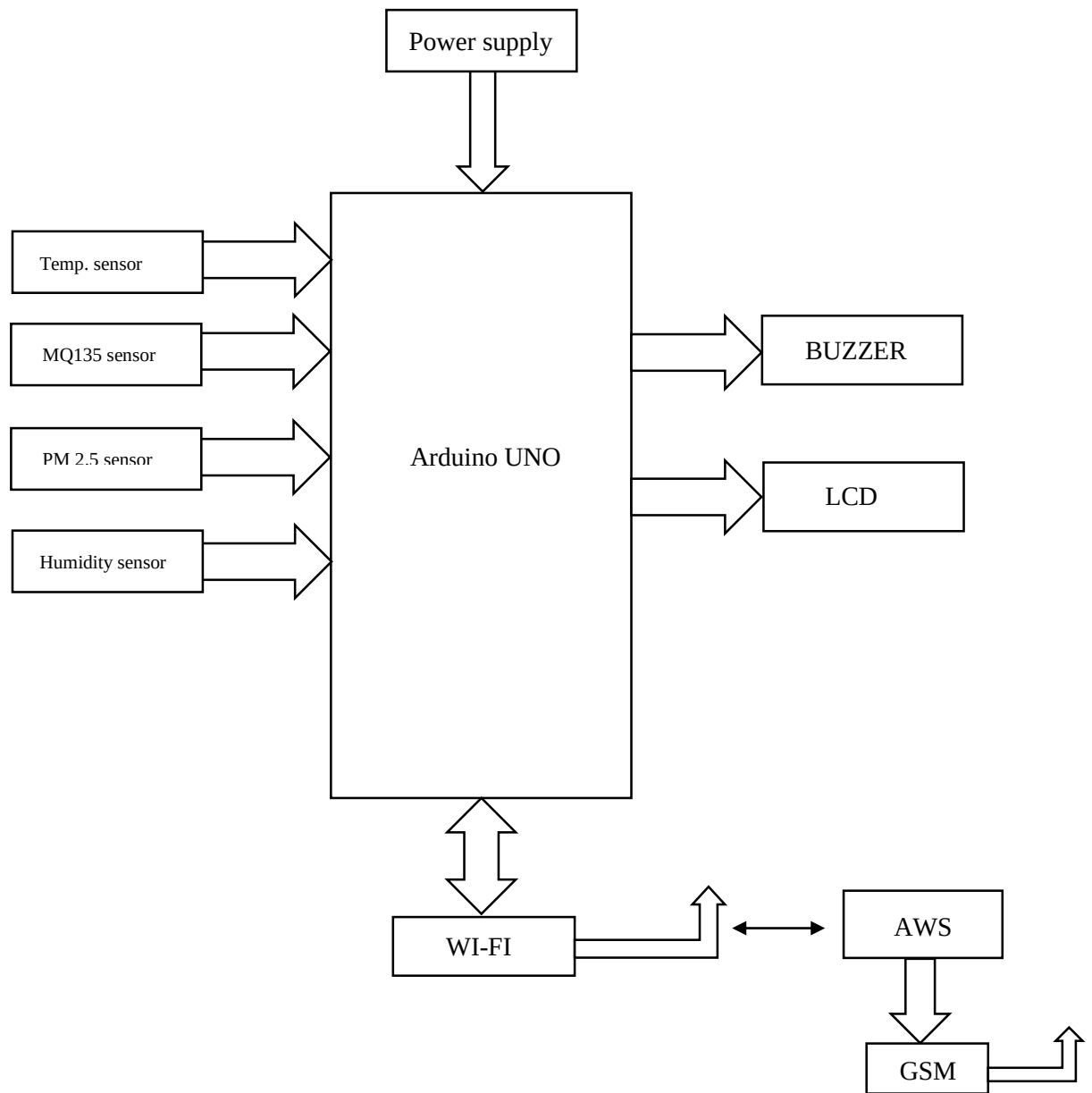


Fig 4.1: Architecture of proposed system

4.3 DESCRIPTION OF SOFTWARE FOR IMPLEMENTATION AND TESTING PLAN OF THE PROPOSED MODEL / SYSTEM

Amazon web service is an online platform that provides scalable and cost-effective cloud computing solutions (from Fig 4.1).

AWS is a broadly adopted cloud platform that offers several on-demand operations like compute power, database storage, content delivery, etc., to help corporates scale and grow. AWS has significantly more services, and more features within those services, than any other cloud provider—from infrastructure technologies like compute, storage, and databases—to emerging technologies, such as machine learning and artificial intelligence, data lakes and analytics, and Internet of Things. This makes it faster, easier, and more cost effective to move your existing applications to the cloud and build nearly anything you can imagine.

AWS also has the deepest functionality within those services. For example, AWS offers the widest variety of databases that are purpose-built for different types of applications so you can choose the right tool for the job to get the best cost and performance. AWS has the largest and most dynamic community, with millions of active customers and tens of thousands of partners globally. Customers across virtually every industry and of every size, including start ups, enterprises, and public sector organizations, are running every imaginable use case on AWS. The AWS Partner Network (APN) includes thousands of systems integrators who specialize in AWS services and tens of thousands of independent software vendors (ISVs) who adapt their technology to work on AWS [20].

AWS is architected to be the most flexible and secure cloud computing environment available today. Our core infrastructure is built to satisfy the security requirements for the military, global banks, and other high-sensitivity organizations. This is backed by a deep set of cloud security tools, with over 300 security, compliance, and governance services and features. AWS supports 98 security standards and compliance certifications, and all 117 AWS services that store customer data offer the ability to encrypt that data.

AWS has unmatched experience, maturity, reliability, security, and performance that you can depend upon for your most important applications. For over 16 years, AWS has been

delivering cloud services to millions of customers around the world running a wide variety of use cases. AWS has the most operational experience, at greater scale, of any cloud provider.

4.4 PROJECT MANAGEMENT PLAN

Information about past and current status (before any new pollution prevention measures are implemented) needs to be gathered from systematic monitoring or using a specific investigation [21]. Inclusion of historical data is often an advantage; it allows assessing the temporal variability and trends, and provides additional perspectives. The choice of method for the baseline assessment depends on available resources and tools. The baseline information should allow to assess levels of target pollutants in background areas (in areas not affected by major local sources), and in urban areas both under direct influence of sources (e.g., near roads, near industrial installations) and in the background (e.g., in areas somewhat removed from the main sources). This assessment should take into account temporal variations (e.g., seasonal variability), and should be performed using a predetermined plan. In addition to using monitoring data, many methods are available for such assessments, including passive sampling, or dispersion or statistical modelling [22].

Identifying measures and control options Once the current air quality has been assessed it may be necessary to identify actions and control options in order to reduce the pressure and impact on the environment. This part of the integrated AQMP may include but is not limited to: Establishment of detailed emission inventories as a basis for control options [23]. Specification of control options related to national, regional and municipal requirements: - source and emission standards, - pollutants specific to national, regional and local technology control requirements, health based needs for regulations and - economic incentives. Mobile source control requirements: - engine performance, - exhaust gas control and - fuel requirements. Specific priority area control requirements. Issue of legally enforceable operation permits. **Implementation** An implementation strategy is a plan to provide for the implementation, the maintenance, and the enforcement of desired environmental standards.

The following tasks may need to be undertaken: Implementation strategy developed into an implementation plan by the relevant stakeholder. The implementation plan may include: a) identification of sources and areas of impact and concern, b) quantification of emission and air

quality changes anticipated and c) emission limits and work practices which comprise the compliance strategy including how compliance will be determined in practice.

Implementation measures may include among other options: - source specific emission regulations, - product related regulations, - mobile source engine and fuel performance regulations, - mobile source exhaust gas and evaporation loss control and - public transportation alternatives.

Necessary institutional building, education and public awareness campaign. The implementation plan must be enforceable, measurable, and transparent, listing reporting requirements, compliance dates and schedules. Evaluation of changes and impact trends.

In order to evaluate implementation of the plan in a given area, it may be necessary to: establish expert institutions, perform training and provide instruments and tools. Evaluate the effect of measures and controls using measurements and models. Use different methods and tools in the evaluation such as: - source surveillance, - ambient air concentration monitoring downwind from the sources, - checking and updating control plans and modifying where necessary.

Evaluating short term, medium and long term reduction measures and the impact on air quality of these measures. Information to the public If an AQMP is to be developed and successfully implemented, it must also be based on input from stakeholders including industry, numerous groups and individuals [24].

Public consultation is an integral part of the AQMP development process, starting with informing the public and entering into a dialogue with stakeholders at the stage of initial assessment.

However, communication with stakeholders regarding methods and results achieved is necessary in all the AQMP steps. Engaging in a public consultation process should preferably be a policy of the regulatory body. Particulate matter and the AQMP process.

4.5 FINANCIAL REPORT ON ESTIMATED COSTING

TIER	COST RANGE	ANTICIPATED USER
Tier V (most sophisticated)	\$10-50k	Regulations (supplement existing monitoring)
Tier IV	\$5-10k	Regulations (supplement existing monitoring)
Tier III	\$2-5k	Community groups and regulators
Tier II	\$100-2k	Community groups
Tier I (more limited)	Less than \$100k	Citizens (education and personal health purpose)

Table 4.1 Financial report on estimated costing

4.6 TRANSITION / SOFTWARE TO OPERATIONS PLAN

The MQ-135 gas sensor is highly sensitive to ammonia, benzene and is ideal for monitoring smoke and other harmful gases. MQ-135 can detect a variety of harmful gases, compared with methods that use a variety of dedicated sensors to monitor the air pollution, the use of MQ-135 modules can effectively reduce the node volume, greatly reducing energy consumption, extending the life of the equipment, and it also has the characteristics of low manufacturing cost and low maintenance cost [25]. So MQ-135 module is suitable for monitoring air pollution in a wide range.

The Internet of Things (IoT) is an important part of the new generation of information technology. The core and foundation of the Internet of Things is still the Internet [26]. It is an extended network based on the Internet. Its users are no longer limited to people or computers. It is extended to exchange information and communication between any item.

The Internet of Things (IoT) collects various information such as sound, light, heat, electricity, mechanics, and chemistry through various information sensing devices, such as sensors, RFID, laser scanners, etc., and forms a huge network combined with the Internet. In order to test the effectiveness of this air pollution monitoring system in regional air monitoring, the project named as Drug Free Society With IoT and AWS is proposed.

Temperature / Humidity is detected and monitored in the system. MQ135 sensor is used for monitoring air quality and it detects most harmful gases. PM 2.5 sensor can measure the harmful particles in micro level accurately. In this IoT project we can prevent the effects of illegal drugs and we can obtain the proper results of the scenario.

The device transmits the data to AWS which would prevent the causes of marijuana. The system will show the air quality in PPM on the LCD as well as on web page of AWS (amazon web services). So that it can be monitored very easily.

CHAPTER 5

IMPLEMENTATIONS DETAILS

5.1 DEVELOPMENT AND DEPLOYMENT SETUP

The initial development stage of an air quality monitoring system is described as follows:

Without the addition of cloud storage. This is the basic setup of the system.

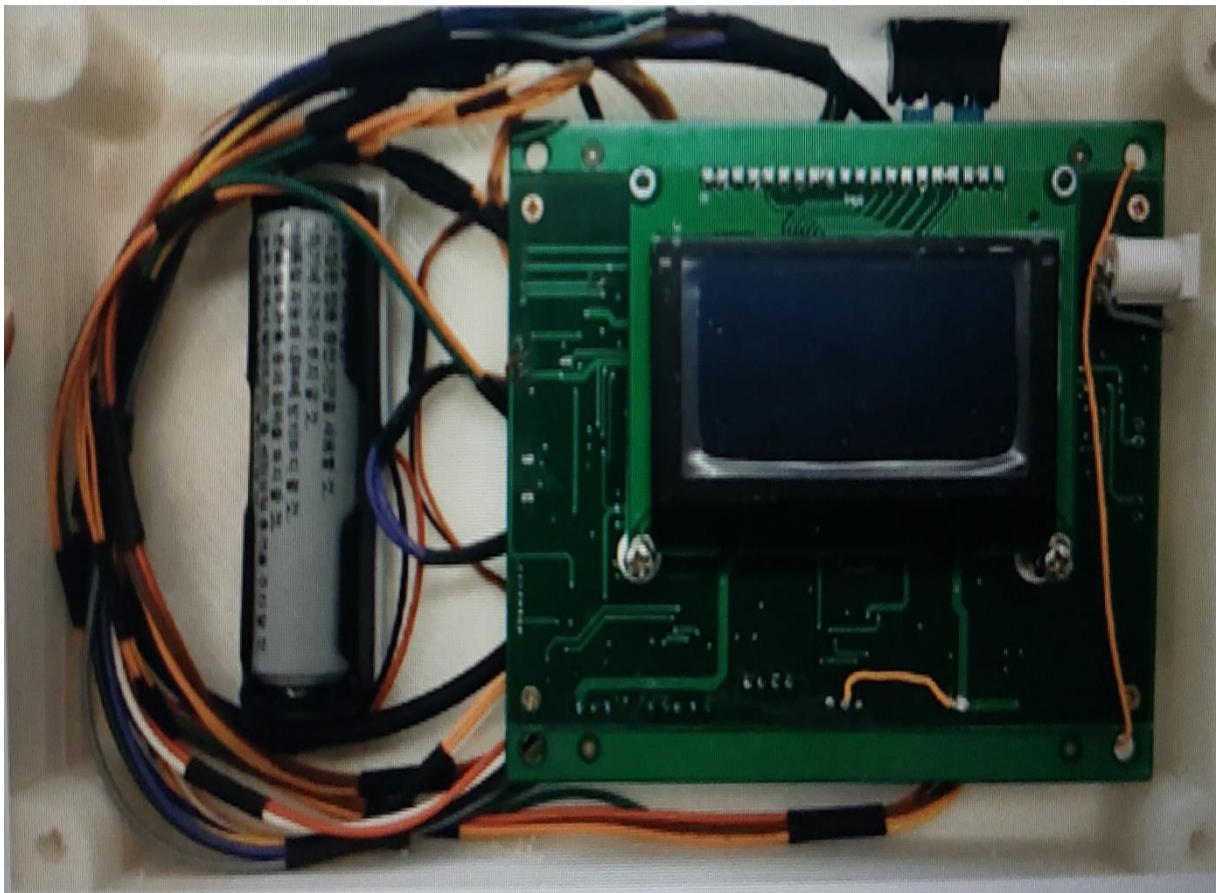


Fig 5.1 : Air quality monitoring system and sensors

The deployment stage of an air quality monitoring system is represented as block diagram format (given below).

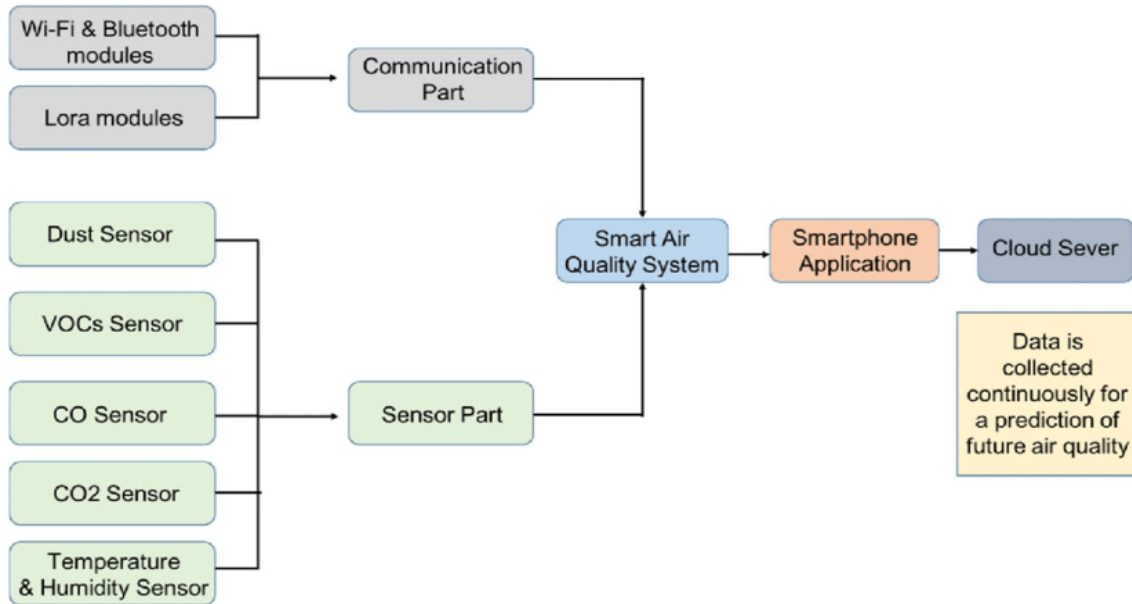


Fig 5.2 : Block diagram of air quality monitoring system

In addition, the buzzer provides an audible alert when marijuana smoke is detected, which can be used to discourage drug use. The GPS module allows the location of the device to be tracked, which can be useful for identifying areas where drug use is more prevalent (referred from Fig 5.1)

When the MQ135 sensor detects marijuana smoke, the ESP32 module triggers the buzzer to sound an alarm, indicating that marijuana smoke has been detected. The buzzer can be programmed to produce different sounds, depending on the level of marijuana smoke detected. For example, a low-level detection may trigger a short, soft beep, while a high-level detection may trigger a continuous, loud alarm.

The use of a buzzer is an effective way to alert individuals to the presence of marijuana smoke. It provides an audible warning that can be easily heard by people nearby, even if they are not looking at the LCD display (referred from Fig 5.2).

5.2 ALGORITHMS

There are various air quality monitoring systems which are used in different regions of India that collect sensor data for monitoring levels of PM10, PM2.5, SO2, NO2, CO, CO2, NH3 etc. The existing system network has a limited scope as the values are recorded at a very long interval. Due to this real time action is not possible. In the existing system analysis of recorded values is not done. Predictive analysis based on the past reported values is missing in the systems deployed. The project uses ESP32 as a microcontroller. It uses multiple sensors for monitoring air quality. MQ5 and MQ135 gas sensors are used along with Sound Sensor and DHT sensor. MQ5 sensor provides smoke sensing while MQ135 is used for overall Air Quality Index Monitoring. The sound sensor used here detects levels of sound while DHT sensor provides values of temperature and humidity.

All the sensors will log their values to Thing Speak Server [27]. The data from Thing Speak server can then be converted to CSV file. This CSV file is used as a dataset for Machine Learning. Machine Learning algorithms such as Random Forest and Logistic Regression are used in this system for analysis and prediction purpose. Air pollution is one of the vital factors that affects the quality of people's life in the urban environment. Existing monitoring systems play an important role in many smart city developments in urban areas for monitoring and governing air quality and the main pollutant concentrations.

Using such information, we could revisit the concepts like when, where the emission decreases and why the dangerous exposures of atmospheric pollution have been over-estimated from urban areas. The system proposed here works as expected. It collects data after a regular interval of time which is used for analysis purpose. Future work may include addition of more gas sensors to get additional parameters. Size of the dataset can be increased which means more data can be collected for more accurate predictions. Other models apart from Random Forest and Logistic Regression can be used to validate the system.

5.3 TESTING

First of all we will connect the ESP8266 with the Arduino. ESP8266 runs on 3.3V and if you will give it 5V from the Arduino then it won't work properly and it may get damage. Connect the VCC and the CH_PD to the 3.3V pin of Arduino. The RX pin of ESP8266 works on 3.3V and it will not communicate with the Arduino when we will connect it directly to the Arduino. So, we will have to make a voltage divider for it which will convert the 5V into 3.3V. This can be done by connecting three resistors in series like we did in the circuit. Connect the TX pin of the ESP8266 to the pin 10 of the Arduino and the RX pin of the esp8266 to the pin 9 of Arduino through the resistors.

ESP8266 Wi-Fi module gives your projects access to Wi-Fi or internet. It is a very cheap device and make your projects very powerful. It can communicate with any microcontroller and it is the most leading devices in the IOT platform. Learn more about using ESP8266 with Arduino [here](#).

Then we will connect the MQ135 sensor with the Arduino. Connect the VCC and the ground pin of the sensor to the 5V and ground of the Arduino and the Analog pin of sensor to the A0 of the Arduino. Connect a buzzer to the pin 8 of the Arduino which will start to beep when the condition becomes true.

In last, we will connect LCD with the Arduino. The connections of the LCD are as follows

Connect pin 1 (VEE) to the ground.

Connect pin 2 (VDD or VCC) to the 5V.

Connect pin 3 (V0) to the middle pin of the 10K potentiometer and connect the other two ends of the potentiometer to the VCC and the GND. The potentiometer is used to control the screen contrast of the LCD. Potentiometer of values other than 10K will work too.

Connect pin 4 (RS) to the pin 12 of the Arduino.

Connect pin 5 (Read/Write) to the ground of Arduino. This pin is not often used so we will connect it to the ground.

Connect pin 6 (E) to the pin 11 of the Arduino. The RS and E pin are the control pins which are used to send data and characters.

The following four pins are data pins which are used to communicate with the Arduino.

Connect pin 11 (D4) to pin 5 of Arduino.

Connect pin 12 (D5) to pin 4 of Arduino.

Connect pin 13 (D6) to pin 3 of Arduino.

Connect pin 14 (D7) to pin 2 of Arduino.

Connect pin 15 to the VCC through the 220ohm resistor.

The resistor will be used to set the back light brightness. Larger values will make the back light much more darker.

The MQ135 sensor can sense NH₃, NO_x, alcohol, Benzene, smoke, CO₂ and some other gases, so it is perfect gas sensor for our Air Quality Monitoring Project. When we will connect it to Arduino then it will sense the gases, and we will get the Pollution level in PPM (parts per million). MQ135 gas sensor gives the output in form of voltage levels and we need to convert it into PPM. So for converting the output in PPM, here we have used a library for MQ135 sensor, it is explained in detail in “Code Explanation” section below.

When the value will be less than 1000 PPM, then the LCD and webpage will display “Fresh Air”. Whenever the value will increase 1000 PPM, then the buzzer will start beeping and the LCD and webpage will display “Poor Air, Open Windows”. If it will increase 2000 then the buzzer will keep beeping and the LCD and webpage will display “Danger! Move to fresh Air”.

CHAPTER 6

RESULTS AND DISCUSSION

The topic of a "drug-free society with IoT and AWS" aims to explore the use of technology to detect and prevent drug use, specifically using the MQ135 sensor to detect the smoke released by marijuana, an ESP32 module for processing the sensor data, a buzzer to provide an audible alert when marijuana gas is detected, a GPS module for tracking the location of the device, and an LCD display to show alerts. The MQ135 sensor is a gas sensor that can detect various gases such as Ammonia, CO2, and smoke.

In this case, it is being used to detect marijuana smoke. When the sensor detects marijuana smoke, the ESP32 module processes the data and triggers a buzzer to sound an alert. The GPS module is used to track the location of the device, allowing the authorities to pinpoint the location of where marijuana is being smoked.

All of the data collected by the MQ135 sensor and GPS module is stored in the cloud using AWS (Amazon Web Services). This allows for easy access to the data and makes it possible to analyze it using various tools and algorithms to identify trends and patterns related to drug use.

The LCD display is used to show alerts to the user and other stakeholders, such as law enforcement agencies. For example, if marijuana smoke is detected, the LCD display could show an alert message like "Marijuana detected in this area."

Overall, the use of IoT and AWS in a drug-free society has the potential to significantly improve drug prevention efforts by providing real-time data on drug use and facilitating rapid response to drug-related incidents. The use of technology in this way can help to promote a drug-free society by providing early detection and prevention of drug use. Additionally, the data collected can be used to inform policy

and educational initiatives.

When the MQ135 sensor detects smoke released by marijuana, it sends a signal to the ESP32 module, which is connected to the internet. The ESP32 module then sends the data to Amazon Web Services (AWS), where it is stored in a database. This data can be used for further analysis and to provide insights into drug use patterns.

In addition, the buzzer provides an audible alert when marijuana smoke is detected, which can be used to discourage drug use. The GPS module allows the location of the device to be tracked, which can be useful for identifying areas where drug use is more prevalent.

The buzzer used in this project is an electronic device that generates a loud sound when activated. In this project, the buzzer is connected to the ESP32 module, which receives the data from the MQ135 sensor. When the MQ135 sensor detects marijuana smoke, the ESP32 module triggers the buzzer to sound an alarm, indicating that marijuana smoke has been detected.

The buzzer can be programmed to produce different sounds, depending on the level of marijuana smoke detected. For example, a low-level detection may trigger a short, soft beep, while a high-level detection may trigger a continuous, loud alarm. The use of a buzzer is an effective way to alert individuals to the presence of marijuana smoke. It provides an audible warning that can be easily heard by people nearby, even if they are not looking at the LCD display or monitoring the device's location.

Additionally, the buzzer can be used in conjunction with other alert systems, such as text message or email notifications. This can ensure that individuals are alerted even if they are not physically near the device. Overall, the buzzer is a valuable component of the project, as it provides a reliable and effective method of alerting individuals to the presence of marijuana smoke.

The GPS (Global Positioning System) module used in this project is a device that receives signals from GPS satellites and calculates the device's location on Earth. The

GPS module is connected to the ESP32 module, which allows the device to transmit its location data to AWS for processing and analysis.

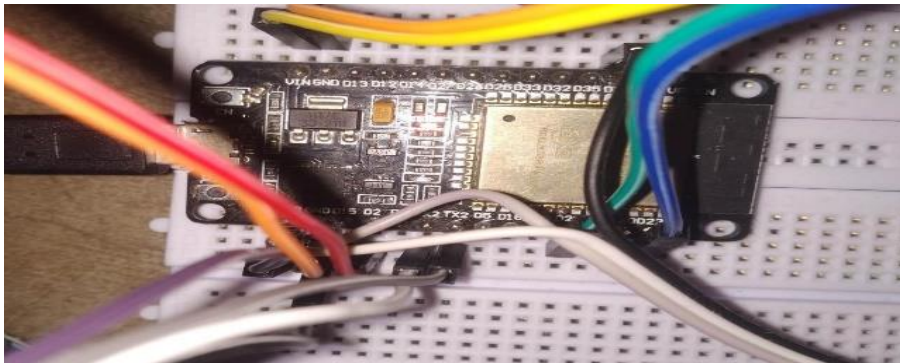


Fig 6.1 : Arduino board

In this project, the GPS module is used to provide the location of the device. This is important because it allows authorities to know the exact location of the device, and therefore the location of the marijuana smoke detection. This information can be used to pinpoint areas where drug activity is taking place, allowing authorities to take action and enforce the law. The GPS module can also be used to track the device's location over time, allowing authorities to monitor areas where drug activity is suspected. If the device detects a high level of marijuana smoke over a prolonged period, it may indicate the presence of a marijuana grow operation or drug den.

In addition to providing location information, the GPS module can be used to provide alerts to law enforcement or other authorities if necessary. For example, if the device detects a high level of marijuana smoke and is located in a school or other sensitive area, it can automatically send an alert to authorities, allowing them to respond quickly and effectively.

Overall, the use of a GPS module in this project is a valuable tool for law enforcement and drug prevention efforts. It allows authorities to quickly and accurately identify areas of drug activity and take action to ensure public safety. The ESP32 module is a microcontroller that is used in this project to interface with the MQ135 sensor and to transmit the sensor data to AWS (Amazon Web Services) for processing (referred from Fig 6.1). The ESP32 module is a powerful and versatile microcontroller that provides Wi-Fi and Bluetooth connectivity, making it ideal for IoT (Internet of Things)

In this project, the ESP32 module collects the data from the MQ135 sensor and transmits it to AWS for processing. This allows the data to be analyzed in real-time and alerts to be generated if necessary. The ESP32 module can be programmed to send data at regular intervals, allowing for continuous monitoring of the area for marijuana smoke.

The use of the ESP32 module also allows for remote control of the device. For example, the device can be remotely turned on or off using a mobile application or web interface. This allows for greater flexibility in the deployment and management of the device.

The ESP32 module is also capable of running custom software, allowing for the device's functionality to be easily customized and expanded. This means that additional sensors or alert systems can be added to the device, allowing for a more comprehensive drug detection system.

Overall, the use of the ESP32 module in this project provides a powerful and versatile platform for interfacing with the MQ135 sensor and transmitting data to AWS for processing (referred from Fig 6.2). The module's Wi-Fi and Bluetooth connectivity, as well as its ability to run custom software, make it an ideal choice for IoT applications.



Fig 6.2 : ESP32 module

The MQ135 sensor is a type of gas sensor that is capable of detecting a variety of

gases, including carbon dioxide, ammonia, and nitrogen oxides. In this project, the MQ135 sensor is used to detect the smoke released by marijuana, which is a combination of various gases and particles.

The MQ135 sensor is able to detect the smoke released by marijuana because it is designed to specifically detect gases that are commonly found in the smoke produced by marijuana. This includes gases such as carbon monoxide, ammonia, and nitrogen oxides, which are all byproducts of the combustion of marijuana.

Unlike traditional smoke detectors, which are designed to detect smoke particles in the air, the MQ135 sensor is able to detect specific gases and particles that are released when marijuana is smoked.

This allows the device to accurately detect the presence of marijuana smoke, while ignoring other types of smoke that may be present in the environment. The use of the MQ135 sensor in this project is an effective way to detect the presence of marijuana smoke.

By specifically targeting the gases and particles associated with marijuana smoke, the sensor is able to provide reliable and accurate readings, allowing for effective monitoring and detection of drug activity.

The MQ135 sensor used in this project is capable of detecting a range of gases, including those released by marijuana smoke. However, in order to accurately detect the presence of marijuana smoke, the sensor must be properly calibrated and tuned.

To tune the MQ135 sensor for marijuana smoke detection, the sensor is first exposed to a known concentration of marijuana smoke. The sensor readings are then compared to the actual concentration of marijuana smoke, and the sensor is adjusted until it accurately detects the smoke.

The use of a buzzer is an effective way to alert individuals to the presence of marijuana smoke. It provides an audible warning that can be easily heard by people

nearby, even if they are not looking at the LCD display or monitoring the device's location.



Fig 6.3 : MQ135 sensor

This calibration process can be done using a variety of methods, including adjusting the sensor's gain, bias, and offset values, or by applying a calibration curve to the sensor readings.

Once the sensor is properly calibrated, it can accurately detect the presence of marijuana smoke within a certain range of concentrations.

In this project, the MQ135 sensor has been programmed to specifically detect when the accurate value is crossed, meaning when the sensor detects a concentration of marijuana smoke that exceeds a certain threshold (referred from Fig 6.3).

When this threshold is crossed, the sensor triggers an alert, which can be in the form of a sound or a message displayed on an LCD screen.

This information can be used to pinpoint areas where drug activity is taking place, allowing authorities to take action and enforce the law. The GPS module can also be used to track the device's location over time, allowing authorities to monitor areas where drug activity is suspected



Fig 6.4 : LCD display

The device transmits the data to AWS which would prevent the causes of marijuana. The system will show the air quality in PPM on the LCD as well as on web page of AWS(amazon web services). So that it can be monitored very easily (referred from Fig 6.4).

Temperature / Humidity is detected and monitored in the system. MQ135 sensor is used for monitoring air quality and it detects most harmful gases. PM 2.5sensor can measure the harmful particles in micro level accurately.

In this IoT project we can prevent the effects of illegal drugs and we can obtain the proper results of the scenario.

By tuning the MQ135 sensor to specifically detect marijuana smoke and setting an accurate threshold, the device can provide reliable and accurate detection of drug activity. This is important for law enforcement and drug prevention efforts, as it allows for effective monitoring and detection of drug use in public spaces.

Air quality data helps us understand the mortality rate of any location due to air pollution. We can also access and compare the short term and long term diseases/disorders which are a result of air pollution.

It is beneficial if people have asthma, allergies, or chronic obstructive pulmonary disease (COPD) conditions. If they have one of these health conditions, knowing the air quality in the area is essential for preventing or treating episodes.

This information can be used to pinpoint areas where drug activity is taking place, allowing authorities to take action and enforce the law. The GPS module can also be used to track the device's location over time, allowing authorities to monitor areas where drug activity is suspected. If the device detects a high level of marijuana smoke over a prolonged period, it may indicate the presence of a marijuana grow operation or drug den.

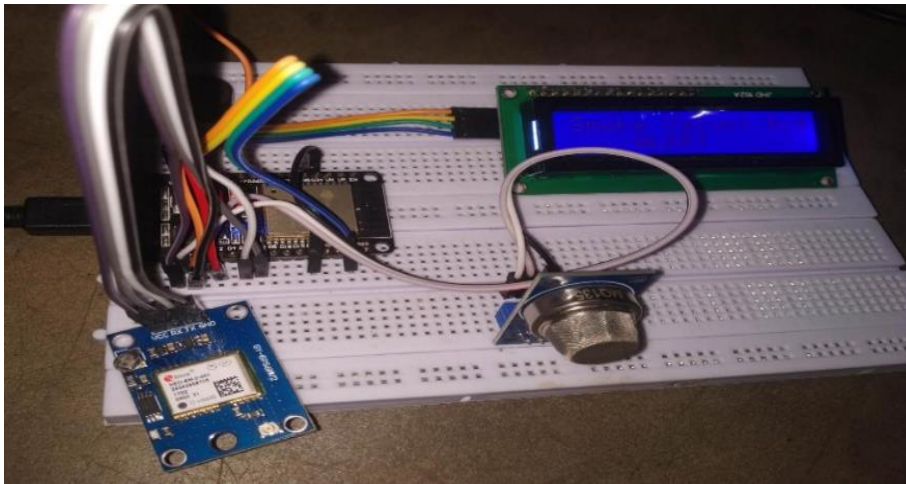


Fig 6.5 : Air quality monitor system

We have developed an Arduino based air pollution detector which is a very effective air pollution monitoring system. Based on the performance we can say that it is easy to use, and functionality is comparable to the expensive existing air pollution detectors. It is a microcontroller based portable system. It is efficient and user-friendly air quality monitoring system (referred from Fig 6.5).

There are various air quality monitoring systems which are used in different regions of India that collect sensor data for monitoring levels of PM10, PM2.5, SO2, NO2, CO, CO2, NH3 etc.

The existing system network has a limited scope as the values are recorded at a very long interval. Due to this real time action is not possible. In the existing system analysis of recorded values is not done. Predictive analysis based on the past reported values is missing in the systems deployed.

This allows the device to accurately detect the presence of marijuana smoke, while ignoring other types of smoke that may be present in the environment. The use of the MQ135 sensor in this project is an effective way to detect the presence of marijuana smoke.

This information can be used to pinpoint areas where drug activity is taking place, allowing authorities to take action and enforce the law. The GPS module can also be used to track the device's location over time, allowing authorities to monitor areas where drug activity is suspected. If the device detects a high level of marijuana smoke over a prolonged period, it may indicate the presence of a marijuana grow operation or drug den.

In addition to providing location information, the GPS module can be used to provide alerts to law enforcement or other authorities if necessary. The results of input and output parameters are as follows.

SERIAL NO.	COMPONENTS	INPUT PARAMETERS	OUTPUT PARAMETERS
1	Temperature sensor	2.7v - 5.5v	10mV/*C
2	MQ135 sensor	150mA	4.2V
3	PM2.5 sensor	5v	0~1000 ug/m3
4	Humidity sensor	5v	20 to 85% RH

Table 6.1 Results

CHAPTER 7

SUMMARY AND CONCLUSION

7.1 CONCLUSION

Arduino based air quality monitoring detector system design involves hardware and connection and finally the collection of data from the detector through code for the Arduino. To obtain real time air pollution data (in PPM), we have taken reading using our customized sensor-detector in different environmental pollutions. We have used cigarette smoke, coil burning smoke, vehicle smoke from street etc. The following values depicts for mosquito coil within 1 meter. From this data analysis we can conclude that for mosquito coil it is safe to be far from the coil while burning at least 2 or 3 meters.

We have developed an Arduino based air pollution detector which is a very effective air pollution monitoring system. Based on the performance we can say that it is easy to use, and functionality is comparable to the expensive existing air pollution detectors. It is a microcontroller based portable system. It is efficient and user-friendly air quality monitoring system.

This proposed methodology named as, " DRUG FREE SOCIETY WITH IoT AND AWS " is exclusively dedicatedly for the welfare of the society. The most important and efficient device which has the potential to save the society from the drug culture and its impacts. Especially, in monitoring the quality of air.

It has several benefits and purpose which will be the pillar of its success. The advantages include its easy installation, regular privacy updates, security of information and airquality monitoring.

The input devices such as PM2.5 sensor and MQ135 sensor plays an important role in monitoring the air quality. Whereas, the output device named as "AWS" displays the scenario briefly through its valid data. Even though there are more

competitors in the respective field this methodology can easily surpass them with its prime motto of "serving the society with good deeds" and enhances the brand of IoT and AWS. The whole purpose of this project is to bring a "DRUG FREE SOCIETY".

7.2 FUTURE WORK

The sensors are controlled through Arduino which contains the micro controller and the driven data will be processed and analysed by microcontroller. And now the data will be updated live on internet by wi-fi module which sends the data to cloud through internet. User can monitor the data on their smart phone as well as on their laptop. When we start the device all the sensors will start interfacing with Arduino (At-mega 328). Now we need to send AT command in the serial port. Then the esp8266 will respond. Using hotspot, user can access internet browser on their smart phones or laptops. Web browser needs specific IP address. By providing IP address on browser, web page is displayed. Web page shows the monitoring results of the respected parameters also the parameters are shown in the LCD display.

This project can also be implemented using a Wi-Fi module that displays the AQI on a web server continuously. The server can be accessed by everyone, anytime and it can keep them informed about the air quality of a particular location. We can also connect multiple Arduino's and display the AQI of multiple areas and compare them to find which area is more polluted and which one is cleaner. We can also use the GSM module to send messages to users when the air quality goes above a particular limit i.e. the citizens can be alerted if the AQI goes above 300 and the air quality turns bad. This can keep them well prepared.

Additional sensors to measure temperature, pressure, humidity can be added. Since many air quality monitoring systems in Mumbai are not in operational condition, this project can be implemented for the benefit of the city. The project can also be implemented on a large scale by installing large LED screens across the city that displays the AQI and its corresponding category. I can also show warnings so that the citizens can take precautions when required.

7.3 RESEARCH ISSUES

The drawbacks of the conventional monitoring instruments are their large size, heavy weight and extraordinary expensiveness. These lead to sparse deployment of the monitoring stations. In order to be effective, the locations of the monitoring stations need careful placement because the air pollution situation in urban areas is highly related to human activities (e.g., construction activities) and location-dependent (e.g., the traffic choke-points have much worse air quality than average). Changes in urban arrangement, activities or regulation may affect both the species and the concentrations of air pollutants, which require relocating stations or adding new stations. These requirements are typically hard or even impossible to fulfill due to the cost inefficiency in acquisition and maintenance of the monitoring stations. Moreover, the conventional monitoring instruments involve long-term time-consuming average models. The air pollution situation is updated hourly or even daily. Hence, the air pollution maps built by the conventional air pollution monitoring systems are with extremely low spatial and temporal resolutions.

Researchers noted that the pollutant concentrations within a street may vary over a space with magnitude of few meters and over time with magnitude of few seconds. The conventional monitoring systems cannot detect this phenomenon because of their limited data availability and non-scalability characteristics. Furthermore, when road traffic is the major pollution source, which is always the case in urban areas, acute exposure to the public is prevalent. Evidences show that acute exposure to or short-term change of pollutants may trigger or worsen some health events or diseases.

In order to increase the spatiotemporal resolution of the air pollution information, researchers are pushing the air pollution monitoring systems to the limit by combining the low-cost portable ambient sensors and the Wireless Sensor Network (WSN) into one system which is known as The Next Generation Air Pollution Monitoring System (TNGAPMS). By utilizing the low-cost portable ambient sensors and the WSN, the air pollution information can be updated in minutes or even seconds. Also, the low-cost portable sensors enable the mobility and the feasibility in large-scale deployment of the sensor nodes. The spatial and temporal resolutions of the pollution information are

significantly increased in TNGAPMS. TNGAPMS fills the gap between the conventional monitoring systems and the air quality models because the air pollution information at locations without monitoring stations is accomplished by air quality models or estimations. TNGAPMS also helps researchers understand the distribution of the air pollutants more efficiently and accurately to improve the air quality models. The public users can even measure their personal exposures to pollutants using wearable sensor nodes.

Researchers anticipate that the real-time, high spatiotemporal (The spatial resolution of the air pollution information is in scale of tens to hundreds of square meters while the air pollution information of a specific location has reporting interval less than few minutes and is available to the users, including researchers, public users, and policy makers, with minimal or no delay.) air pollution information can help advise the public to take proper actions according to their individual health needs (e.g., asthmatics could choose an alternative healthier route to minimize the personal air pollution exposure), and raise public awareness about the air pollution that further leads to change of public “unclean” activities (e.g., driver with better driving habits can reduce pollutants’ emission).

Pollutants are emitted by human activities and natural sources. Hundreds of hazardous pollutants in our living environment have been identified. However, six of these pollutants are well studied and ubiquitous in our daily lives, including carbon monoxide (CO), nitrogen dioxide (NO₂), ground level ozone (O₃), sulfur dioxide (SO₂), particulate matter (PM) and lead (Pb). The health effects (see Table 2) and environmental effects caused by these pollutants can be found.

In order to guarantee the data accuracy and quality, these instruments use complex measurement methods and a lot of assisting tools including temperature controller (cooler and heater), relative humidity controller, air filter (for PM), and build-in calibrator. As consequences, these instruments are typically with high cost, high power consumption, large volume, and heavy weight. Thanks to technology advance, ambient sensors with low cost, small size and fast response time (in the order of seconds or minutes) is available recently. However, no low-cost portable ambient

sensor can achieve the same data accuracy and quality as conventional monitoring instruments.

7.4 IMPLEMENTATION ISSUES

Errors can range from simple syntax errors to more complex hardware issues. Hardware errors are not very common when using Arduino. These errors can be particularly frustrating, as they often require physical inspection of the hardware components to diagnose and fix. On the other hand, software issues are quite common. The Arduino bootloader is a vital piece of code that allows the microcontroller board to read the program that is present in its memory when the board is turned on or after reset. The bootloader also enables you to change the program by writing and uploading a new one. It waits for an instruction from the Arduino software.

In case you have a bootloader problem, your Arduino won't perform the above function, and neither will a new code upload to the board. The Arduino bootloader issue is one of the most common problems faced by beginner-level users.

Another common Arduino issue that beginners face frequently is the Arduino COM Port issue. The Arduino COM Port issue happens when you've selected the wrong COM port in the Arduino IDE while your microcontroller board is present at some other port.

If this happens, you won't be able to upload your program to the board. To avoid this issue, you need to get in the practice of checking your COM port when you connect the Arduino to computer.

An Arduino COM port issue can also lead you to one of the most common problems, which is the "not recognized" Arduino on your computer. You can see which COM port Arduino is present by checking the bottom right corner of the Arduino IDE screen.

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APPENDIX

A. SOURCE CODE

```
#include <Wire.h>#include <Adafruit_Sensor.h>
#include <Adafruit_BME280.h>
#include <Adafruit_MQTT.h>
#include <Adafruit_MQTT_Client.h>
#include <Adafruit_MQ135.h>
#include <WiFi.h>
#include <LiquidCrystal.h>
// Replace with your network credentials
const char* ssid = "your_SSID";
const char* password = "your_PASSWORD";
// Replace with your AWS IoT credentials
const char* mqtt_server = "your_MQTT_SERVER";
const int mqtt_port = 8883;
const char* mqtt_username = "your_MQTT_USERNAME";
const char* mqtt_password = "your_MQTT_PASSWORD";
Adafruit_MQTT_Client mqtt(&client, mqtt_server, mqtt_port, mqtt_username,
mqtt_password);
// Pin for LM35 temperature sensor
const int lm35Pin = A0;
// Create an instance of the MQ135 gas sensor
Adafruit_MQ135 gasSensor = Adafruit_MQ135();
// Create an instance of the BME280 temperature, pressure and humidity sensor
Adafruit_BME280 bme;
// Initialize the LCD
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
void setup() {
  // Connect to Wi-Fi
  WiFi.begin(ssid, password);
  while (WiFi.status() != WL_CONNECTED) {
    delay(1000);
    Serial.println("Connecting to WiFi...");
  }
  // Initialize the LCD
  lcd.begin(16, 2);
  lcd.print("Initializing...");
  // Initialize the BME280 sensor
  if (!bme.begin(0x76)) {
    Serial.println("Could not find a valid BME280 sensor, check wiring!");
    while (1);
  }
  // Connect to AWS IoT
  if (!mqtt.connected()) {
    if (mqtt.connect()) {
      Serial.println("Connected to AWS IoT");
    }
  }
}
```

```

    } else {
        Serial.println("MQTT connection failed");
        return;
    }
}
}

void loop() {
    // Read data from the MQ135 gas sensor
    float ppm = gasSensor.readPPM();
    Serial.print("Gas Concentration: ");
    Serial.println(ppm);
    // Read data from the LM35 temperature sensor
    int lm35Value = analogRead(lm35Pin);
    float temperatureLM35 = (lm35Value * 0.48828125);
    Serial.print("Temperature (LM35): ");
    // Read data from the BME280 sensor
    float temperatureBME = bme.readTemperature();
    float pressure = bme.readPressure() / 100.0F;
    float humidity = bme

```

B. SCREENSHOTS

