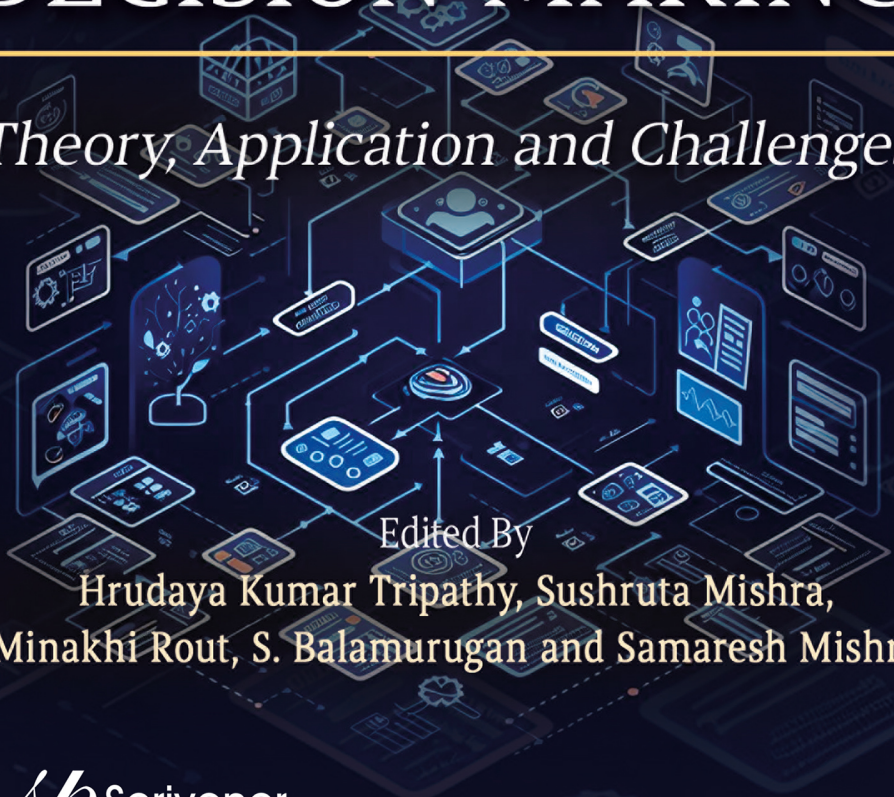
INDUSTRY 5.0 TRANSFORMATION APPLICATIONS

OPTIMIZED COMPUTATIONAL INTELLIGENCE DRIVEN DECISION-MAKING

Theory, Application and Challenges



Edited By
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Optimized Computational Intelligence Driven Decision-Making

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Industry 5.0 Transformation Applications

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Scope: The increase in technological advancements in the areas of artificial intelligence (AI), machine learning (ML) and data analytics has led to the next industrial revolution "Industry 5.0". The transformation to Industry 5.0 collaborates human intelligence with machines to customize efficient solutions. This book series aims to cover various subjects under promising application areas of Industry 5.0 such as smart manufacturing, green ecology, digital medicine, supply chain management, smart textiles, intelligent traffic, innovation ecosystem, cloud manufacturing, digital marketing, real-time productivity optimization, augmented reality and virtual reality, smart energy consumption, predictive maintenance, smart additive manufacturing, hyper customization and cyber physical cognitive systems. The book series will also cover titles supporting technologies for promoting potential applications of Industry 5.0, such as collaborative robots (Cobots), edge computing, Internet of Everything, big data analytics, digital twins, 6G and beyond, blockchain, quantum computing and hyper intelligent networks.

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Contents

Preface

Optimized Computational Intelligence (OCI) is a new, cutting-edge, and multidisciplinary research area that tackles the fundamental problems shared by modern informatics, biologically-inspired computation, software engineering, AI, cybernetics, cognitive science, medical science, systems science, philosophy, linguistics, economics, management science, and life sciences. OCI aims to apply modern computationally intelligent methods to generate optimum outcomes in various application domains. This book presents the latest technologies-driven material to explore optimized various computational intelligence domains.

To begin, the first chapter discusses the emergence of computational intelligence in smart sensory settings. Chapter 2 deals with the capabilities of advanced machine intelligence in educational domains. The third chapter addresses the issue of recognizing false data injection attacks with a machine learning approach in the industrial IoT sector.

Chapter 4 discusses the analysis of fake news by using modern intelligence-based approaches to prevent misinformation propagation. The fifth chapter addresses the challenges and issues of telemedicine by applying computational intelligence techniques. Chapter 6 demonstrates how to detect and predict crop suitability by deploying machine intelligence in smart sensory settings. The seventh chapter explains the significance of using advanced intelligence methods for smart, IoT-based regulation of road traffic. The eighth chapter presents a succinct analysis of text-based corpora using social network analysis.

Chapter 9 highlights the growing role of autonomous intelligent vehicles, the challenging issues related to them, and their futuristic trends. The tenth chapter discusses the impact of smart predictive analytics in healthcare within a modern urban society. Chapter 11 show how to use advanced predictive analytics to assess depression in the modern world. The twelfth chapter discusses current scenarios that demonstrate IoT-enabled healthcare standards with revolutionized guidelines.

Chapter 13 presents a detailed analysis of Parkinson's disease risk factors and explains how to apply machine learning in detection and treatment. Chapter 14 discusses the capability of computational intelligence to monitor climatic variations that are taking place in today's world. The final chapter presents a deep analysis on the relevance of using computational intelligence to address weather fluctuation.

We are deeply grateful to everyone who helped with this book and greatly appreciate the dedicated support and valuable assistance rendered by Martin Scrivener and the Scrivener Publishing team during its publication.

1

Emergence of Advanced Computational Intelligence Coupled with Smart Environment

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Abstract

In this paper we have tried to work out various models which may elevate the lifestyle of us humans by using the technology of present day IoT system concept making it possible to make things or our daily requirement smart or very easily available. As for the models, we have thoroughly studied and discussed how we would build smart homes using various sub disciplines such as building garbage monitoring systems and a system in which we detect any accident. We also went through the whole idea of the present day healthcare system and we built a model for a smart healthcare system and how we can build a weather monitoring system, an Air Pollution monitoring system. Considering the extra need for the noise surrounding the environment, we have proposed a model for Noise Pollution monitoring system. We have proposed a forest fire detection system model. We also have tried to bring the knowledge of advanced computational intelligence and artificial intelligence to our work as we believe the huge significance of advanced computational intelligence and AI inside the development of smart green terrain is a manner to attain clever green frugality.

***Keywords*:** Advanced computational intelligence, scalability, security, connectivity, analyzing and integration

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1.1 Introduction

The things which we can hardly imagine are encouraged and supported by new opportunities that the IoTs is reinventing. The Internet of Things is changing our physical world to grow. Through the Internet of Things, the devices that are connected through the internet are designed to become specific, customized, and intelligent to fully fill our unique and day-to-day necessity and requirements. The word smart stands for making Specific, Measurable, Achievable, Relevant and Time-bound objects and the word environment means the surroundings. A smart environment is therefore said to be the ability to acquire knowledge and apply it to modify the needs of its residents to improve their occurrence with that environment. By using various wireless technologies we can enhance the functional capabilities of smart devices. According to reports from Cisco, 50 billion objects and devices will be connected to the Internet 2020. More than 99% of things available in the world today still remain unconnected. According to a Navigant research report, the number of smart meters installed worldwide will increase to 1.1 billion by 2023. [3] Automotive News reports that worldwide the number of Internet-connected cars will increase from 23 million in 2013 to 152 million in 2024. [5] The significant growth such as forecasting shows that the Internet of Things will become a modern society to conceive a concept of a smart environment. For the integration of IoT devices along with the smart environments, several research efforts have been made with the smart environments. The possibilities of smart objects from the combination of IoT with a smart environment are expanded by allowing remote locations of the environment to be monitored by the users. Primarily based on the software requirements, IoT can be included into various smart environments. Work on intelligent IoT-based environments can generally be divided into the areas: smart cities, smart houses, and smart health. An IoT-based system consists of objects, sensor devices, and a computing and processing unit that can be located in the cloud, a decision-making and action-invoking system. IoT things and devices play a vital role in interaction and communication through data exchange. They respond to actual events in the physical world and also have the effect of triggering processes that trigger various actions and services with or without human intervention. With the enabling current era technologies like advanced computational intelligence, the world is becoming a supremely computerized environment. These enabling technologies are planned for a smart environment focusing on restful life to live in. The digital transformations experts collaborating with the application tests providers lead

in the progressed conclusion of the new innovative automation and the Internet of Things. The world in the near future will utilize the knowledge of such specialists for the remodeling of the various cities. The smart environment is characterized by complex systems which require balance between transparency and context awareness. The architecture of such a system responds to the demand space and the incorporation of modular and the design of such architecture are flexible and responsible for the right time production of appropriate services.

Main contribution of the paper:

- How energy and resource management techniques are building up the nation and how more swiftly it can be utilized
- Human computer interaction and building more sophisticated software and algorithms for a smart environment
- Predictive maintenance of the society with the proper system using new technologies

1.2 Background Works

In 2017, Kanishka Majumdar Devices for Integrated Circuit (DevIC), 23–24 March 2017, Kalyani, India. "Development Board", has exact attributes like the microcontrollers in the trade but has some additional features i.e., twice the figures of input and output pins adaptable with Arduino IDE also it is very cost efficient. [1] Soil & Surrounding Testing Module by K. P. Keyur and M. P. Sunil, "Internet of Things-IOT". A farmer can easily be benefited by this model as it is an automated analysis producer of soil moisture, pH, temperature, humidity, etc. It can advise regarding the sprout growth and the amount of further fertilizers needed. LCD screens will be of great use here. Sensors like moisture sensor, pH sensors, humidity sensors, etc., are used. [12] Water Pump ON/OFF via Phone Call by M. Fahim and A. Sillitti, "Anomaly detection, analysis and prediction techniques in IoT environment: A systematic literature review," IEEE Access. It provides an important feature of turning the water pump on or off by using a mere phone call option. It reduces a great deal of labor. [13] Solar Tracking System (Renewable Power Supply) by K. P. Keyur and M. P. Sunil, "Internet of Things-IOT". Solar tracker is built on the idea that solar can provide an alternative of renewable energy fit for the respective farmland. It acts as an automatic single axis solar tracker. Sensors such as the LDR are used here. [6] Electronic Scarecrow by H. Haddad Pajouh, A. Dehghantanha,

R. Khayami, and K.-K.-R. Choo. This model basically acts as a scarecrow which can be used to keep the harmful pests off the land. Sensors such as PIRs are being used here [11].

1.3 Integrated Smart Environment

The Internet of Things (IoT) is coming with new technologies to improve human capabilities in this modern world. These means or new technologies promise a high quality of life and professional efficiency; however, with each new advancement in IoT synthesis and human augmentation technologies coming, the challenges of the IoT go far beyond that. The integrated intelligent environment is designed with various applications such as intelligent home systems, intelligent health care, intelligent transportation, intelligent agricultural systems, intelligent electronic management system, intelligent weather monitoring system, intelligent education system, etc. IoT objects and things are connected with RFID tags and sensors that are already in various business applications of the smart environment. RFID tags that utilize intelligent barcodes to identify any item use high-frequency technology in which radio waves transmit data from the tag to a reader that acts as a translator to a computer program. In Figure 1.1, the data of an integrated smart environment are stored in cloud based applications consisting of sensors and connecting IoT devices. It makes it much easier to send and analyze the given data and predict outcomes [8].

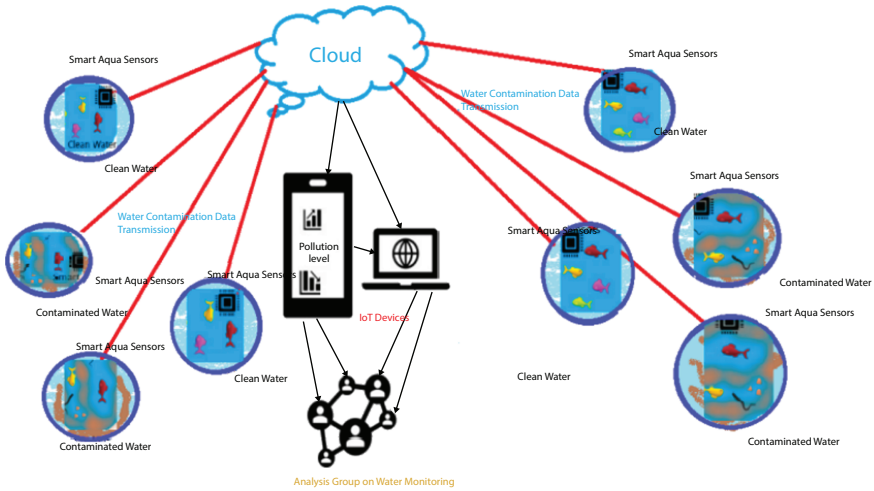

Figure 1.1 Integrated smart environment using cloud based application.

1.4 Proposed Models for Smart Intelligent Environment

Figure 1.2 denotes the sensors enabled smart environment for smart cities and homes along with smart healthcare service.

1.4.1 Smart Cities

Smart cities are technologically upgraded urban areas which use smart things, sensors, and electronic methods to collect various data and make life easier. The various functions performed by smart things can be traffic management, multi-city connectivity, pollution control, and smart lighting. The main purpose of smart cities is to make things easier and make us look at things with a new perspective. The Internet of Things makes an

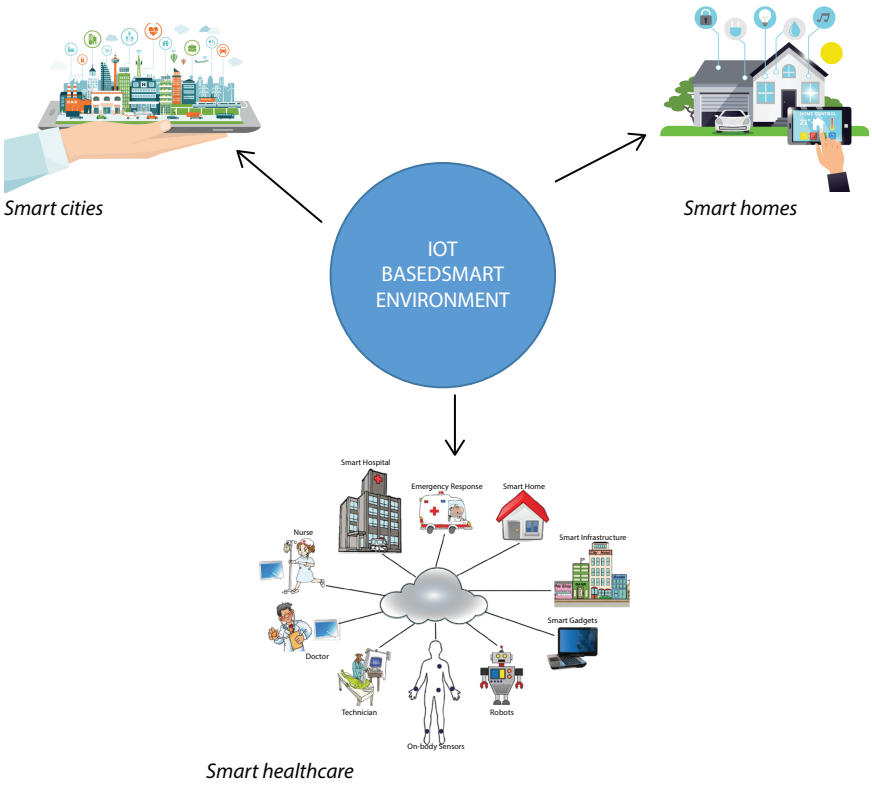

Figure 1.2 Smart environment based IoT system in smart cities, smart homes, and smart healthcare.

impact on various things such as every daily reliable life activity and also to any human's complex emotions. The Internet of things makes benefits for each day to us and the environment. Smart city can device itself as an assistant for anyone's daily schedule telling him/her to get up, make coffee or have dinner and go up to remind the person for dinner. It can detect the health condition if there is a problem or any underlying disease.

1.4.1.1 Garbage Monitoring System

Our proposed model gives an answer to the various hygiene problems we face in our daily life. Our model basically includes three subjects: 1. Smart trash, 2. Correlate, 3. Notify.

In Figure 1.3, the basic structure of our proposed model is shown. We have used different types of sensors with connecting them together to an LCD display for a better understanding of the situation. The basket contains a sensor and an ultrasonic sensor. The sensor we connected will bring in the information about the level of waste. With the help of Arduino the Wi-Fi which is fitted inside the bin will inform the authority when the bin overflows. We will receive a notification from the web server via coding through inside the Arduino. The collected details are then displayed on the LCD in the corresponding area in control [10].

1.4.1.2 Accident Sensing System

This proposed model informs us about the events or possibilities of accidents caused by concussion of a gas vehicle. This project contains three subjects: 1. Accident sensing, 2. Correlate, 3. Notify.

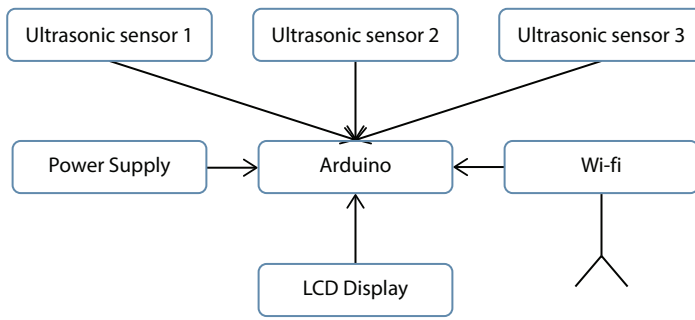

Figure 1.3 Block diagram of garbage monitoring system.

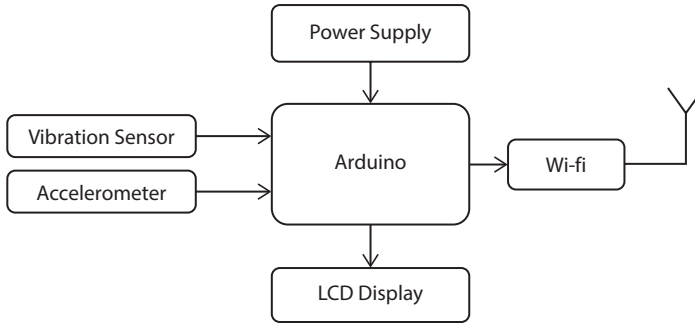

Figure 1.4 Proposed accident detection system model.

In Figure 1.4, the basic structure of the proposed Accident Sensing System is shown. The model will require power supply for the different utilities such as the sensors and we can have a clear visualization of the situation through the LCD display. This model contains two sensors, an accelerometer, and a vibration sensor. These sensors have some ability to alert a person to a possible occurrence. Wi-Fi located inside the module informs the appropriate person about the accident via Arduino. The coding programmed inside the Arduino helps the web server in sending the respective notification. The individual in charge will take action on the accident. If the casualty is not solved, the Arduino located on the module will generate constant information about the possibilities of an accident to the associated individual until the problem is solved. A crash sensing system is considered to be an economical and better way to maintain a safe environment without vehicle collision accidents [16].

1.4.2 Smart Healthcare

The Smart Healthcare system is mainly focused on the vision to provide the best healthcare to all the people across the globe. This system is done in a more than gentle and economical way. Henceforth, if you want to boost the efficiency of the healthcare system and patient care system one should focus on improving the healthcare monitoring equipment. In monitoring patients, medical fields are facing generally two problems; firstly the need that is to be present at the patient's bedside for providing the health care and caregiving, and secondly, the patients are attached to large machines and confined to a bed. The problem of providing flexible and friendly patient care, the solution was given to develop bio instrumentation and telecommunication technologies. With the help of these technologies it

has become possible to design home vital signs monitoring systems to display, collect, record and transfer physical data from the body of humans to any further location. There are many reasons that motivate doing work like making healthcare accessible to all public who do not have ingress to healthcare providers and for going hospitals there is no availability of public transportations; giving care to those patients who require more time to heal and more care; avoiding in the delay of delivering the medical kit to patients for health care providers, specifically in the event of accidents or emergencies; and reducing manual patient data entry, allowing healthcare staff to effectively monitor their patients [18].

In Figure 1.5, we show how in a smart healthcare system we can use many different types of sensors and using new technologies we can infer data and collectively enhance the diagnosis of many people at the same time. Our proposed model is an automated system which senses the patient's heart rate, blood pressure or the body temperature. The features can be expanded to predict the patient's possible chronic disease or other health parameters and other various symptoms. In Level 1, the various data we collect from the IoT devices will be gathered, organized, and stored on a server. Various sensors are acquired here, for example, sensors for BP, heart rate, body motion, etc. Since the output maximum times are given as an analog output, we first have to convert the analog values into digital form using a converter IC so that raspberry pi can use it. Further, the raspberry pi with the help of its Linux OS installed, converts the data to a python code which will update the database at specific or required time periods. At Level 2, with the help of filtering, classifying, and categorizing the helpful data is obtained from the stored data. This relevant data is solely about the

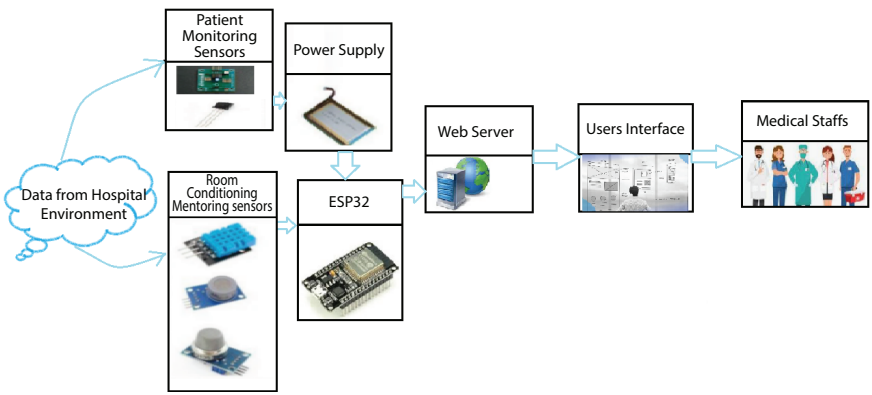

Figure 1.5 Block diagram from proposed model.

patient's real-time health information and his/her symptoms. This information will further help in predicting or diagnosing the patient. This helps the system be more self-sufficient and efficient. In phase 3, analysis/prediction is performed, techniques of data mining are utilized to understand the problem, its nature and type. i.e., the disease characteristics. Artificial Intelligence can be integrated to make the system more proficient [9].

1.4.3 Smart Homes

Nowadays, smart homes are considered some of the important applications for IoT based environments. A crucial feature involving smart homes is automation. What the goal we try to achieve here is to reduce human efforts as much as possible. At the present time, remote control systems are of great importance. The important advantage we get for using IoT in smart homes is the remote control of every device in the home. Home automation architecture can differ depending on the protocols and hardware utilized by the very system. Further following, the main services fetched out in the field of home automation are analyzed and, based on the analysis, a comparison of IoT architectures is made. There are certain advantages of using wireless technologies which cannot be established using traditional wired networks. We often call a smart home a home automation system, which uses the brand new technology to make household activities easier.

In Figure 1.6, we see how different sensors which are very justifiable to a home being secure and efficient connected to each other with the help of present technologies and thus providing a means of smart home. The proposed home automation system model includes a server, actuators,

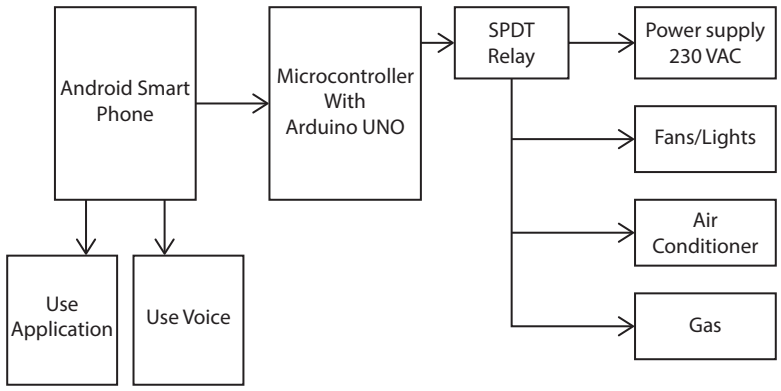

Figure 1.6 Block diagram from the proposed IoT based smart home system.

sensors and microcontrollers. The back end server will be set up to control and monitor the sensor devices. The proposed smart home system is going to be remotely controlled by wireless technology communication devices such as smartphones, cards, and other wireless devices remotely over the Internet. The room temperature could be remotely controlled, controlled, automatic fan on and off, automatic lights on and off, automatic gas leakage detected by sensors, air conditioning system, etc. are automatically controlled and controlled by the home automation system. Designed without the help of any human interaction with the home automation system monitor as well as gas leak control, fan on/off system, lights on/off system, room temperature, and humidity level control and monitoring through IoT communication device. The Node MCU is the primary need of this system and performs numerous procedures for the home appliance system. The Node MCU secures, interfaces with numerous sensors and collects real-time information for a home automation system. These contain two node MCUs. Node MCU (Node Micro Controller Unit) is an open source containing software and hardware that built a much cheaper system designed on a chip known as ESP8266. In particular, the home automation system remotely manages home appliances to make them convenient for people. This system includes for warning of any violation of safety assurance and violation of harmful events certainly will not happen in the home. A system linked to the Buzzer Alarm system can alert a person in the home with an acoustic signal to signal any problem. And there is also an alert SMS to the user's mobile phone or an email that can be sent to the affected user for home security alerts.

1.4.3.1 Weather Monitoring IoT-Based System

Nowadays, the technologies and innovations are focused to control and monitor the various devices wirelessly across the Internet, so in order to be a medium of communication between the communicating devices, the Internet comes into play. These technologies are mainly focused in managing and monitoring the various objects. In order to detect weather conditions, whether the prescribed parameter levels are exceeded and to collect the data for research purposes an effective monitoring system comes namely, weather monitoring system. Multiple instruments namely thermometers, barometers, wind vanes, rain gauges, etc. are used in weather stations inserted inside the weather monitoring system used to detect changes existing in the weather and the climatic conditions. Databases are used to store and the instruments that have been used, use simple analog calculations that are recorded later on physically. The radio stations and

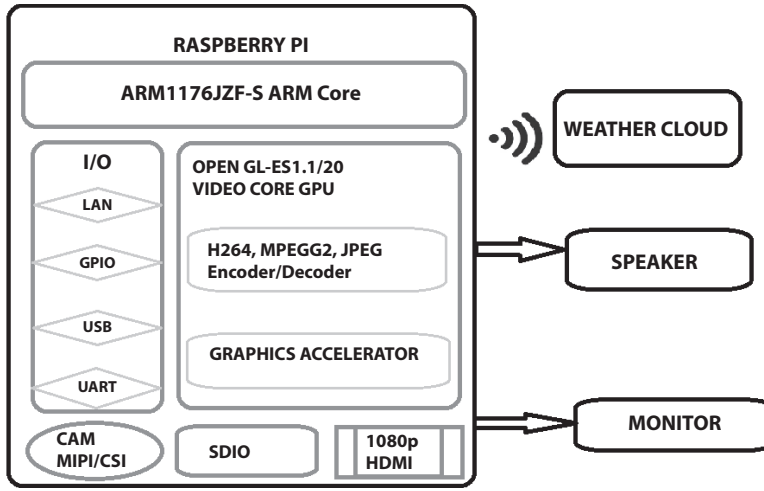

Figure 1.7 Block diagram of weather monitoring system using Raspberry Pi.

news stations collect this information lately and thus a weather report has been made. The data has been collected using a number of different connected sensors including humidity, pressure, temperature, and so forth and the statistics has been dispatched to cloud applications in order to supply them. The cloud applications then analyze and visualize the data that has been collected. These apps then send the weather alert to the users that have been logged in. The device named AirPi is used to detect air quality and weather and is able to record and upload the information on humidity, air pressure, light levels, temperature, UV levels, carbon monoxide, nitrogen dioxide, and smoke level on the Internet [2]. The proposed system is an advanced weather monitor solution that uses IoT to easily make actual time data available on a very wide scale. The changes made by the system deals with weather and climate are monitored as follows:

1. DHT11 sensors are used in monitoring humidity and temperature.
2. An anemometer measures wind speed and directions with LDR which keeps track of Light intensity.
3. GY8511 solar sensor measures UV radiation and MQ7 measures the Carbon monoxide in the air.
4. Hygrometer measures soil moisture.
5. Level sensors measure ultrasonic rainwater.
6. Raindrop sensor to detect rain or snow.

Mainly two devices namely, Dark Sky and Raspberry Pi are also used, which is an open source IoT source. Dark Sky is for storing and retrieving data. It is an open source Internet of Things (IoT) is an open source API using HTTP over the Internet or over a local network. We connect it using a Raspberry pi. In Figure 1.7 we use Raspberry Pi, which is an inexpensive mini sized credit card computer that fits into a computer monitor or TV and uses a standard keyboard and mouse.

1.4.3.2 Air Pollution Monitoring IoT-Based System

Air pollution contributes to a severe problem that adversely affects living organisms. It creates the major real concerns of the globe. Air pollution is a major global concern consisting of multinational companies, administration and broadcasting. Even some use of essential resources at an amount faster than nature's capacity to regenerate can cause pollution of plants, water and air. In addition to human activities, there are several irregular characteristic cycles that further lead to the release of dangerous things. In addition to artificial activities, nature's calamities can lead to air contamination. The Internet of Things (IoT) has become a primary conveying trends of recent times. Using this idea, it is foreseeable to secure innumerable intelligent embedded objects with low consumption among everyone and to the Internet. The ubiquitous existence of numerous wireless technologies for example, tags, RFID (Radio Frequency Identification), actuators, sensors, mobile phones form the foundation of the IoT concept. An IoT-based air pollution sensing and system design can detect dangerous gas discharge from industries and vehicles utilizing gas and weather sensors. Collected information can conceivably be analyzed to create informed conclusions regarding the pollution control application.

In Figure 1.8, we showcase what type of sensors our proposed system will use to detect the level of noise and pollution in the air. It has features of data transmission and perception so as to act to the benefit of the user.

The air pollution detection and forecasting design we proposed in this paper proposed a decent quick fix to the complication of air pollution. Utilization of some sensors makes sure that the monitoring accuracy is appropriate, also lessens monitoring costs, and fabricates the monitoring data in the monitoring area more organized and clean. The huge aggregate of field data given by the front-end sensor network builds big data analysis in the background application layer more directly and efficiently, and gives a factual and good decision-making foundation for emergency response after a pollution accident occurs.