CHAPTER 1

INTRODUCTION

Smart agriculture is a newly introduced concept. Majority of farmers and agricultural experts are new to this concept. Smart agriculture involves the use of smart technologies such as automated machines, sensors, actuators, drones and security cameras to control and operate agricultural lands and animals. The motive is to increase the quality and quantity of agricultural goods at the same time keeping in mind the cost and energy usage. Digital technologies like the Internet of Things (IoT) are reshaping agriculture. When it comes to farming, what is IoT? The IoT connects "dumb" devices. IoT is all about data. Data is becoming a valuable resource for our world. Farmers may become more intelligent and safe by using data from gadgets to adapt to changing conditions more readily and farm more efficiently. To free up resources, farmers can use the ability to monitor agricultural conditions and infrastructure from afar. Many sectors and industries have adopted IoT to reduce errors and improve performance in manufacturing, energy, health care, and communication. Farm devices can collect and deliver data remotely to their owners using IoT.

Farmers can save time and money using IoT to keep tabs on-farm operations and efficiency, make more informed decisions about boosting productivity, and respond more quickly to changing conditions. In this case, it is putting data ahead of the farmer's intuition. A trough's water supply, the amount of fertilizer to use on a crop, and which ewe to check when lambing are all things a farmer could know about.

Smart agriculture is necessary since 70% of the farming time is spent monitoring and analysing crop status rather than performing actual field labour. Given the industry's size, it needs various technology and precise solutions to ensure sustainability while reducing environmental damage. Sensors and communication technologies have provided farmers with a remote sight of their fields, allowing them to watch what is happening without leaving home. Wireless sensors make monitoring crops in real-time with greater precision and, more importantly, detecting the early stages of undesirable conditions easier. This is why “smart agriculture uses innovative equipment and kits from seeding to crop harvesting, storage, and transportation. The operation is smart and cost-effective due to its accurate monitoring capabilities and prompts reporting using a variety of sensors. Various autonomous tractors, harvesters, robotic weeders, drones, and satellites supplement agriculture equipment. Sensors can be instantly deployed, started collecting data, and made available for further online study. By enabling precise data collection at each area, sensor technology allows crop and site-specific agriculture”. IoT and its apps are only scratching the surface of what they can do and have yet to impact people’s lives significantly, and everyone can see this. However, given the recent rise in IoT technology in agricultural applications, we can expect it to play a significant role. Figure 1 summarizes the key factors driving agricultural technology.

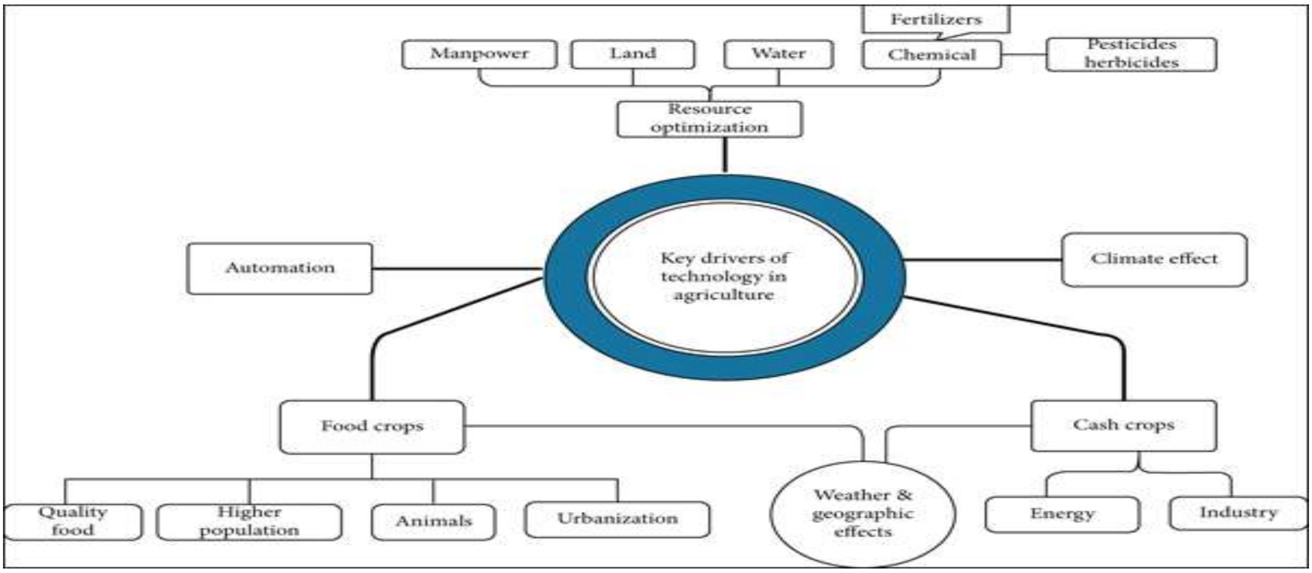


Figure 1

Technology’s key drivers in the agriculture industry

What is a smart farm?

A farm which is managed using smart technologies and modern forms of communication is termed as a smart farm.

The several of technologies farmers use in smart farms are:

Sensors for soil, water, moisture and humidity control

Software to diagnose plant and animal disease, to learn and treat the disease.

The smart farms are completely operated by automated tools and robotics in such a manner that the farmer does not even have to step on the field. The cost of manual labour reduces due to smart farming. IoT integrates and connects the entire farm to improve quality and quantity of crops and other produce.

CHAPTER 2

Objective

IoT smart agriculture products are designed to help monitor crop fields using sensors and by automating irrigation systems. As a result, farmers and associated brands can easily monitor the field conditions from anywhere without any hassle.

CHAPTER 3

Review of Literature

IoT is revolutionizing agriculture by bringing together various approaches, such as accuracy and conservative farming, to help farmers overcome obstacles in the field. Discussed using IoT, cloud computing, mobile computing, and smart agriculture to develop a “phononet” system, an open system of wireless sensors that share information and communicate. For many years, devices presently labelled as IoT have been deployed in agriculture. The Bosch technology corporation provides IoT-based data management strategies to monitor agricultural yield and diseases. A platform based on IoT developed by Intel helps agricultural solutions operate more efficiently by improving the interoperability of services. As part of the MIT Media Lab Open Agriculture Initiative, Google has shared its vision for a more sustainable food system. For efficient seed planting, “sensors and vision-based technology” help determine the distance and depth. An autonomous robot named Agribot is being developed to sow seeds using sensors and a vision-based. Technology and economic sustainability go hand in hand. A study was conducted in Pakistan to determine the commercial viability of a proposed crop insurance plan and assess the demand for crop insurance in various flood-prone rural districts of Khyber Pakhtunkhwa Province. Additional research revealed that farm households in the study area faced several barriers to adapting to climate variability, including a lack of labour, an insecure land tenure system, a lack of market access, poverty, a lack of governmental support, a lack of access to assets, a lack of water sources, a lack of credit sources, and a lack of knowledge and information. One study found a link between poverty reduction and natural and social capital for sustainable livelihood. The research provides empirical and quantitative evidence on poverty alleviation, and the conclusions will improve agricultural households’ sustainability. A study also uses natural and agricultural resources in North-western Pakistan to create a livelihood vulnerability index (LVI), LVI-IPCC, and livelihood effect index.

Further, several noncontact sensing methods for determining the seed flow rate are proposed in , “where the sensors were equipped with LEDs, infrared, visible light, laser-LED, and a radiation reception element”. The output voltage fluctuates depending on how the seeds move through the sensor and band of light rays and how the shades fall on the reception parts. Therefore, the seed flow rate is calculated based on the signal information about the passing seeds. Researchers offer an expert system for evaluating the viability of agricultural land in a 2019 study by combining sensor networks with artificial intelligence systems such as neural networks and multilayer perceptron. The proposed method is intended to assist farmers in categorizing agricultural land for cultivation into the most suitable, suitable, somewhat suitable, and unsuitable categories. In a recent study, researchers used citrus fruits data labelled by a domain expert with four severity levels (high, medium, low, and healthy) to train a deep neural network (DNN) model to detect disease by severity. The model has a 98% likelihood of predicting low severity and a 98% chance of predicting high seriousness. In a subsequent study, the author takes advantage of block chain’s potential benefits, combines it with SDN, and provides justification for worries about energy consumption and security [20]. In the most recent survey, authors applied the same block chain technology integration technology to different platforms. LDA was used to anticipate block chain research trends. The researchers have predicted 17 scientific trends that deserve more attention. According to the literature, LDA approaches anticipate smart agriculture research trends. The researcher created a novel routing protocol for IoT networks with a cluster topology using a block chain-based architecture for the SDN controller. The research concepts of the existing state of the art and its differentiation from the current state are represented in Table 2.

CHAPTER 4

Topic Modelling

Data mining is an emerging field to extract data from unstructured formats. Topic modelling is a powerful technique in text mining in natural language processing to explore the relationship between the data and collected documents. This technique is used by various researchers in their native fields, like medical, semantic analysis, and engineering, to conclude the relationship between the documents and topics. Techniques like latent Dirichlet allocation (LDA), nonnegative matrix factorization (NMF), latent semantic analysis (LSA), parallel latent Dirichlet allocation (PLDA), and Pachinko allocation model (PAM) were used in the topic modelling; among all, LDA is intensively used by researchers. The topic modelling technique is similar to the dimensionality reduction technique used for numerical data. A bag of words (BOW) is created from the dictionary of words, and topic modelling extracts the required features from this BOW. The words contained in the corpus are viewed as a significant feature in NLP.

NLP considers each word as a feature to train the model. This technique helps us find the right content instead of analysing the accurate data. LDA is used to attain a relationship among the documents in the collected dataset, and results are represented statistically and graphically. To develop LDA, variational exception maximization (VEM) algorithm [25] is used to estimate the similarities from the corpus. Usually, the top few words are picked up from the BOW as this approach lacks semantics in the sentence. LDA follows the concept of probabilistic distribution, so each document in the corpus portrays the probabilistic distribution of topics, and each extracted topic depicts the probabilistic distribution of words. It led to concluding a clear vision of the topic connection. LDA is applied to retrieve critical information or analysis from unstructured data.

CHAPTER 5

Methodology

The stepwise procedure of whatever tasks have been completed is affectingly explained, which picture quality defines our research methodology to predict the research trends of IoT agriculture. The methods used to conduct this review are depicted in Figure 2, in which three phases are involved. The first phase of research is data collection; in the second phase, collected data is pre-processed; finally, in the third phase, data is analysed, and results are depicted. NLP considers each word as a feature to train the model. This technique helps us find the right content instead of analysing the accurate data. LDA is used to attain a relationship among the documents in the collected dataset, and results are represented statistically and graphically. To develop LDA, variational exception maximization (VEM) algorithm [25] is used to estimate the similarities from the corpus. Usually, the top few words are picked up from the BOW as this approach lacks semantics in the sentence. LDA follows the concept of probabilistic distribution, so each document in the corpus portrays the probabilistic distribution of topics, and each extracted topic depicts the probabilistic distribution of words. It led to concluding a clear vision of the topic connection.

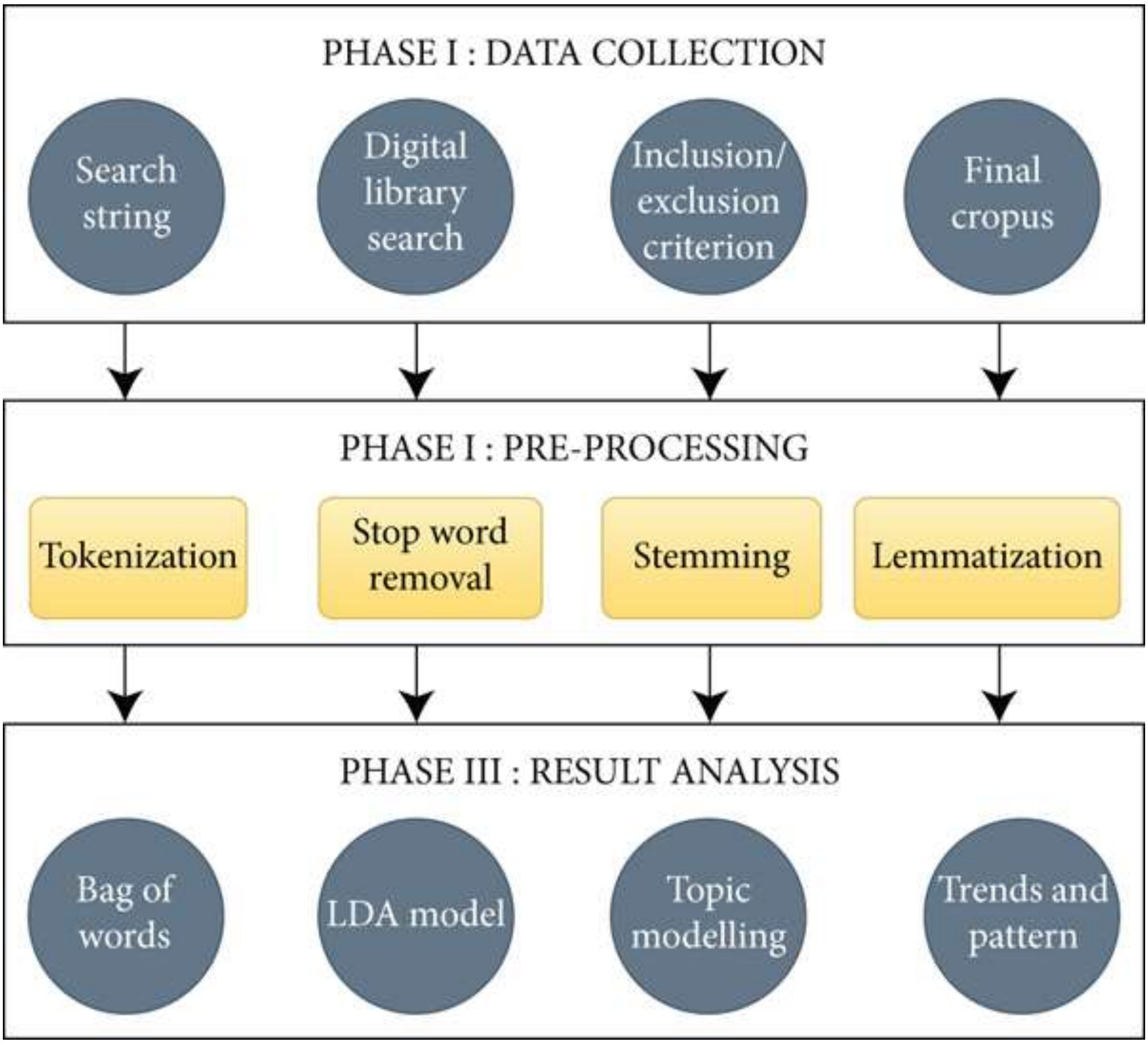


Figure 2

Proposed methodology.

CHAPTER 6

Corpus

The primary sources of data collection and formation of the research corpus were the various online digital libraries, journals, and conference proceedings available to users through Google Scholar. The search keywords for digital libraries have been selected based on topic selection. The research works of Sera et al. Have influenced them to experiment. The search phrases identified were “IoT agriculture”. Scopus is considered the most extensive database for published articles globally. The string is run on the Scopus platform, and 4803 articles were extracted from the Scopus database. The specific keywords in the publication’s title, abstract, and keywords were collected by searching for them in various databases.

Further processing required inclusion and exclusion criteria to finalize the corpus, so, for inclusion criteria, we considered the research papers published in English only. Then, the studies concerning IoT agriculture were only considered. Under the exclusion procedure, we excluded and removed those studies published in different native languages. In addition, studies having missing information like author, abstract, title, and year were excluded from the corpus. After applying the requirements, 4309 studies were considered for the current research. Figure 3 represents the year-wise growth in article publication in IoT agriculture. It is clear from Figure 3 that after 2015 there has been tremendous growth in publications.

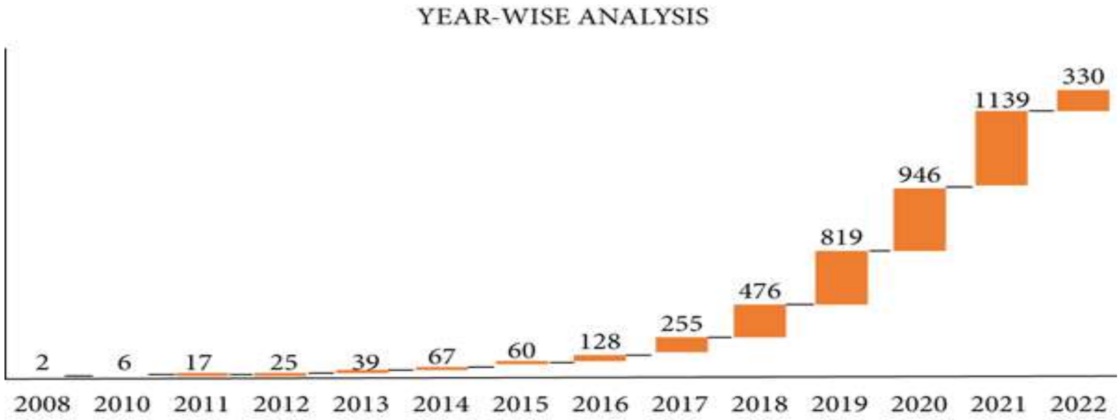


Figure 3

Year publication analysis.

This area of research is published in various reputed journals. Some top-rated journals or dominating journals in IoT agriculture are shown in Figure 4. Dominating journal analysis shows maximum participation from the Advances in Intelligent Systems and Computing, which has 134 articles having 0.031%, and this journal belongs to Springer, having H-Index 48 and 0.66 as its impact factor.

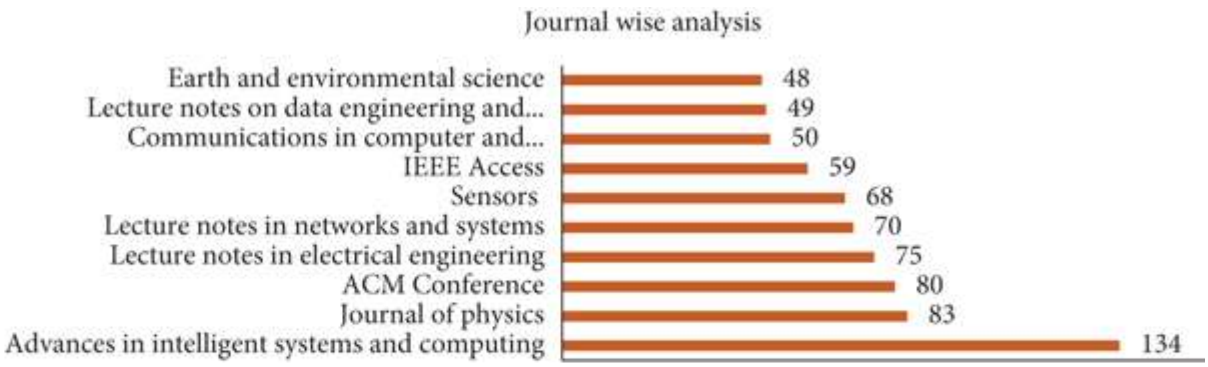


Figure 4

Dominating journals analysis.

CHAPTER 7

Pre-processing

It is a preliminary step that processes the dataset or the information collected. The objective of pre-processing is to discard the extraneous information inside the information. Pre-processing removes unwanted words and characters from the accumulated or collected corpus and improves the dataset's quality. As a result, the profile of further processing becomes more accurate and acceptable. In the collected corpus, the author used four types of data for LDA modelling: title of the paper, year of publication, journal of published article, abstract, and keywords of the documents. Further, abstract and keywords are combined under the same column. A sample of the loading corpus is shown in Table 3.

Table 3

Sample of loading dataset

The first step to performing on the uploaded corpus is to token the words so that all the abstracts per title are tokenized into tokens. The generated tokens are then transformed into lowercase letters for each document. In tokenization, the focus is on removing the punctuation marks, single characters, and other special characters like ";", ",", ".", "/", "\", "brackets", "!". Further, any equation or formula used in the abstract was removed. Also, the numerical values were eradicated to get a full-fledge textual token. Finally, after tokenization, the words which have no meaning are removed. The stop words are the commonly used words such as "the", "if", "but", "a", or "an". These words take up space in our corpus and consume valuable processing time. Thus, it becomes crucial to remove these stop removals, and here in our experimentation, we have used Natural Language Toolkit (NLTK). This toolkit has stop words stored in more than sixteen languages. Here, the English-language stop words in the NLTK library and other phrases used to build the corpus were removed from the corpus.

Further, stemming is reducing a word to its word stem. Stemming is essential in natural language understanding and natural language processing, endeavouring to extract the root or core word that is usually appended with the English suffixes and prefixes. It erases all the extraneous parts in the word and sources out the accurate, meaningful word. For example, use is the core word that can be extracted by stemming the word useless, useful, and uses. To prepare an adequate corpus, words stem from their original form using the Snowball stemmer algorithm, and the resulting base keywords are stored in the cleansed corpus. Finally, the words which were previously stemmed need to be lemmatized. Lemmatization is when the context is considered, and stemmed words are converted into more meaningful base words or lemmas. This phase targets removing inflected words and outputs the dictionary form of a word.

CHAPTER 8

SYSTEM ANALYSIS

8.1 Latent Dirichlet Allocation :

Latent Dirichlet allocation (LDA) is the most popular technique in NLP, so data is fed to the LDA model after pre-processing. Before sending data, bigrams and trigrams are removed from the corpus. Two words that occur together are named bigrams, like human resources, and the three words frequently occurring together in the document are termed trigrams, like human resource management. The LDA model is implemented in python language, where the genism library has been used to remove such phrases. Genism's phrases model can build and identify these bigrams, trigrams, quad grams, or even -grams; thus, we can remove and improve the data cleansing process. It is also part of pre-processing, so after completing this stage, data is sent to the LDA model for further analysis. LDA topic modelling is based on three input parameters, one of which is a list of topics, and the other is hyper parameters. Before the distribution of a document's topic content is the magnitude of the Dirichlet. This parameter is regarded as several "pseudo words" equally distributed across the document's topics, regardless of how the document's other words are assigned to topics. Is per-word-weight of Dirichlet prior over topic-word distributions? The value for this experiment is taken as, where is the desired number of topics, and the has been fixed as 0.01 for all topic solutions. For identifying two, five, and ten topic solutions, as suggested by, the number of iterations considered is 1000. Thus, initializing these parameters becomes a concern as the values can define the distribution of high-quality topic results. The bag of words (BOW) extracted is initially processed in LDA topic modelling, where the most frequently and least frequently occurring are removed so the corpus can become absolute. This study removes a word frequency of more than 5000 from BOW. The top 20 frequently occurring words from the corpus with their frequency are shown in Figure 5, as it is clear from the graph that the most occurring keyword is the system, use, sensors, internet, agriculture, and many more.

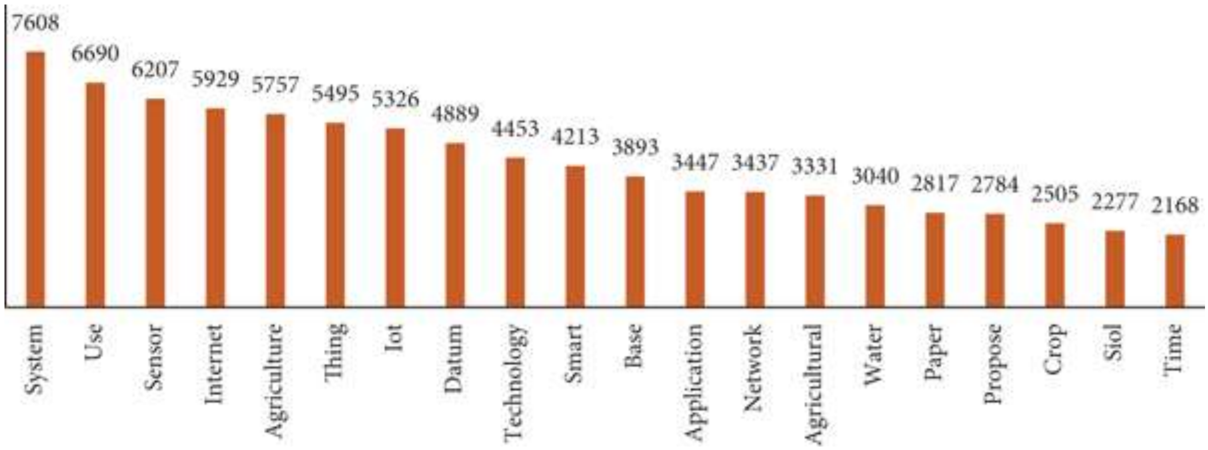


Figure 5

Top 20 words from corpus with frequency

Hyper parameters are optimized using Python's mallet library, a JAVA-based NLP package. Then, the mallet package extracts the desired topics by training the model using BOW. Unfortunately, no official or proven measure exists to find the optimal number of solutions. Still, some observational parameters are given by Cao and Arun, which helps the researcher decide the optimal number of keys. Furthermore, the choice of the topic solution has been influenced by the heuristics and findings of the studies, finally, -mean clustering algorithms are used to find the optimal number of topics from the BOW.

Topic Labelling

Once the topics have been extracted with the help of the LDA model, each topic is labelled manually based on the key terms of each topic. As a result, there are 4309

CHAPTER 9

Result Analysis

9.1 Parameters of Topic Solutions:

The loadings for two, five, and ten topic solutions have been acquired by deploying the LDA model and are presented in Table 1. The selection of two, five, and ten topic solutions is based on a coherence score and is influenced by the previous studies. The coherence score plays an essential role in finding the semantic similarity between the key terms in the topic, and ideally, a 0.3 to 0.6 coherence value is considered a good score. In this study, coherence values achieved are good; for two topic solutions, 0.62; for five topics, 0.58; and for ten topic solutions, 0.52 coherence value is reached. Therefore, five topic solutions are considered optimal based on coherence value. The dominance of each topic solution is also supported by the corresponding count of articles it covers. Table 4 summarizes the count of year-wise publications corresponding to each topic solution.

Table 4

Year-wise publication analysis for 2, 5, and 10 topic solutions.

The initial choice of two topics will broadly depict the core research areas that have been widely covered by the researchers in the compiled research literature. Further, in five topic solutions, the researchers have explored the research areas. Therefore, we have depicted in detail the research areas studied in five topic solutions. Further in the hierarchy, the five topic solutions have widened into ten topic solutions, with new areas emerging as the research trends in GHRM.

9.2 Topic Labelling :

The core research zones explored and discovered based on the two topic solutions are depicted in topics T-2.1 and T-2.2. Let us discuss how this labelling has been performed. While implementing LDA on two topic solutions, the keywords and their loading has been extracted. The extraction results of LDA depict the high-loading articles per topic and the high-loading terms or keywords per topic. The labelling process is based on the high-loading keywords that have been collected. Thus, in the table, the labelling per topic solution corresponds to the terms extracted under the heads T-2.1, T-2.2, and so on; it goes for five and ten topic solutions.

9.3 Core Research Area :

The two topic solutions present an abstract view of the literature dataset and divides it into "Security and Privacy in Smart Agriculture" (T-2.1) and "Monitoring and Control System in Agriculture" (T-2.2). These two significant labels depict the research areas the researchers have extensively explored.

T-2.1: Security and Privacy in Smart Agriculture. Agriculture has shaped human civilizations since ancient times. Rapid information and communication growth affects agriculture's structure and operation (ICT). Despite advances, hazards may be significant, so smart farming must grasp security and privacy challenges before contemplating cyber-attacks. Smart farming uses devices, protocols, and computer ideas to modernize agriculture. Digital farming changes everything and creates effective, efficient, sustainable, and open systems. Mobile devices, precision agronomy, remote sensing, big data, cloud analytics, cyber security, and intelligent systems simplify agricultural technology integration. Incompatibility, heterogeneity, equipment constraints, processing, and data security may threaten smart farming, but recent years have increased usage of ICTs in agriculture. Physical risks and concerns may impede agriculture's deployment, but agriculture 4.0 will be the new agriculture standard. Simultaneous research is also going on in the area to secure smart agriculture. Technology has added to environmental problems—list agriculture's physical threats by category. Population increase, urbanization, aging, and technical developments in food production all affect agriculture and farmers. Agriculture's most significant physical hazard is weather. External factors continually threaten agriculture. In recent decades, technology has reduced its influence. Agriculture apps need stable connections, IoT networks, and cloud computing. External factors continually threaten agriculture. In recent decades, technology has reduced its influence. Agriculture apps need stable connections, IoT networks, and cloud computing. The sensors can malfunction, causing erroneous readings and instructions that could cause a manufacturing failure. Temperature, humidity, obstructions, and human presence can impact Lora WAN, Zig bee, and other agro-wireless networks, causing data loss. Sensors and networking equipment are usually exposed.

T-2.2 Monitoring and Control System in Agriculture. New techniques, technology, and approaches have also helped in agriculture. 35% of the world's workforce works in this profession. Agriculture helps many economies to grow. It boosts industrialized nations' economies. India is the second largest country that deals in this profession. Every country has practiced agriculture since ancient times. Businesses and other areas must support agriculture's tech transformation. The future population rise is frightening. Mid-20th century population may have surpassed nine billion counts, so agriculture needs to be strengthened to meet the flooding needs. Agricultural engineering challenges include drainage, irrigation, crop scheduling, and bio-system optimization. The lack of agricultural technology to monitor and manage systems or machinery likely causes these problems. The report says control approaches increased seedling growth.

IoT helps in the process of modernizing the agriculture segment by gathering farming data. IoT-based agricultural monitoring system wirelessly communicates and disseminates the sensor data. Global agriculture uses 70% of available fresh water each year to irrigate 17% of the land. Growing food requirements and global warming reduce irrigated land, a challenge in plague agriculture. FAO predicts global food production must rise by 70% to meet population and urbanization needs. Modern agriculture uses robotics, automation, and computer systems to replace challenging human jobs, so expanding agriculture needs new technologies to be included. Future agricultural technology includes robotics and machine vision. In addition, population growth will increase the demand for resources and products. "Sustainability" is blended into social, economic, and technological problems to address environmental conservation and economic development, and information and control systems will be crucial.

CHAPTER 10

Five Topic Solutions: Research Areas

T-5.1: Intelligent Disease Detection Models. India's economy is mainly based on agriculture. Agriculture accounts for 16% of India's GDP and exports. More than 75% of India's population depends on agriculture. Healthy, high-quality agriculture is essential for economic prosperity. Detection of plant disease is critical at an early stage. Plants can become ill while growing. Early illness diagnosis is a challenge in agriculture. Researchers first demonstrated cutting-edge machine learning methods for identifying plant illnesses. Training parameters are used in modern systems but require powerful computers or lengthy training and prediction durations to work. Convolutional auto encoder (CAE) network prediction features have been reduced while preserving accuracy in this research. Thanks to technological advancements, the world's population of 7 billion people can be fed.

Changing climates, declining pollinators, and plant diseases threaten the ability to produce enough food. Plant diseases endanger the livelihoods of smallholder farmers who depend on healthy crops. Despite declining yields, smallholder farmers in developing economies provide more than 80% agricultural output. Methods for preventing disease already exist. Pesticides have been replaced with integrated pest management (IPM). Early diagnosis is essential for successful therapy. Agricultural extension organizations and local plant clinics have long supported disease detection thanks to their computer power, high-resolution displays, and broad accessory sets, such as HD cameras. Smartphone diagnostics are a first-of-its-kind technology. 5-6 billion mobile phones will be in use by 2020. More than two-thirds of the world's people now have access to mobile broadband, a 12-fold increase since 2007.

T-5.2: Data Security Challenges in Smart Agriculture. Technology, equipment, protocols, and computer paradigms are all used to enhance agricultural operations in smart agriculture. Big data, artificial intelligence, the cloud, and edge computing all store and analyse the data in various forms of storage and archiving. As a relatively new field, smart agriculture lacks adequate data security measures. Farming's future relies heavily on the availability and quality of data, which necessitates the need for security. To maintain security in smart agriculture, managing data compatibility, resource constraints, and massive data processing. Agricultural systems may not be well suited to traditional IoT security solutions, resulting in unique demands and possibilities. New agricultural projects have been developed to keep up with population increase and food production. The success of agriculture depends on productivity, era-specific restrictions, and the advancement of science and technology. A lot may go wrong regarding smart agriculture, which is still in its infancy. In the future, farmers will rely heavily on the availability and quality of data to help them; thus, developing secure and stable systems is critical. The growth of the agriculture generation is depicted in Figure 6, in which agriculture 1.0 started in 1784. In the 20^{th} century, agriculture 2.0 came into existence. In 1992 agriculture 3.0 was started, and in 2018 agriculture 4.0 if followed.

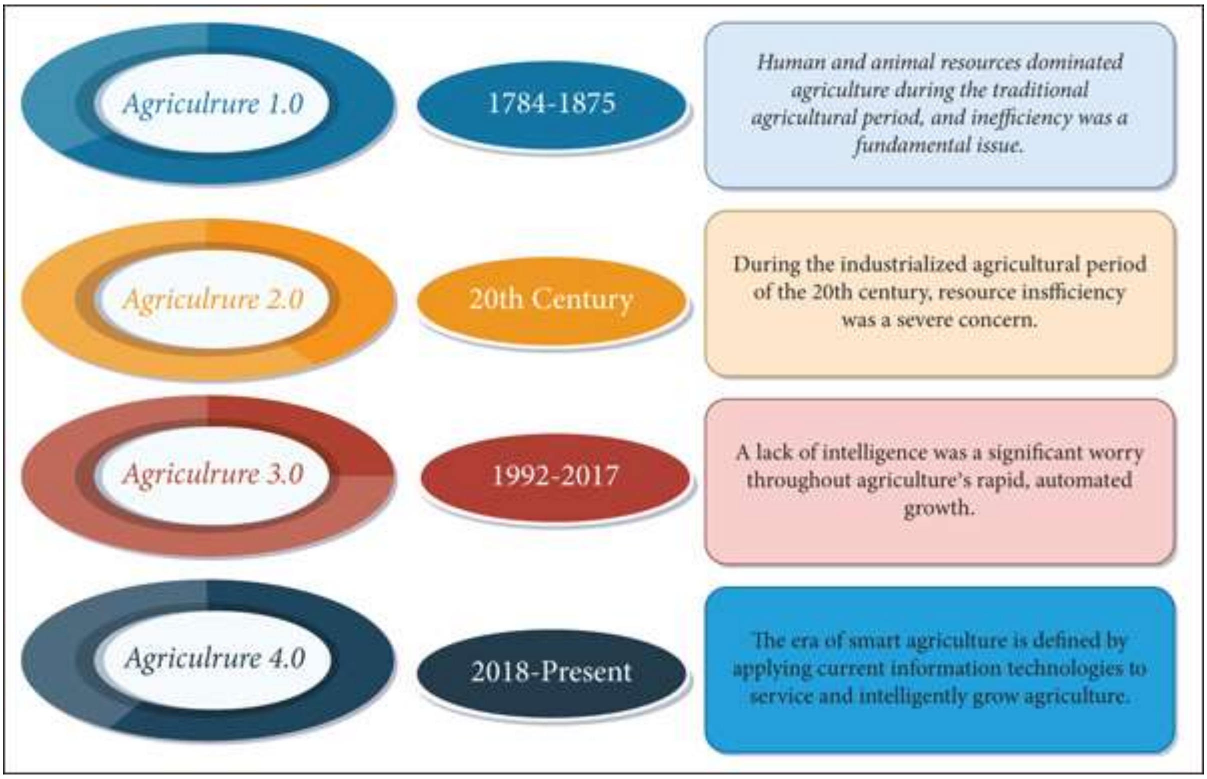


Figure 6

Agriculture generation.

Smart agriculture uses IT to increase information perception, quantitative decision-making, intelligent control, suitable investment, and personal service. In addition, current technology boosts agricultural yield and improves security and privacy. There are both advantages and disadvantages to using automation in smart agriculture. Computer-aided farming uses contemporary technology and procedures, so in the future, “digital agriculture” will be more productive, efficient, sustainable, inclusive, transparent, and resilient agriculture. Many different types of agricultural technology may be used in conjunction with one another to increase efficiency and productivity.

T-5.3: Smart Monitoring System in Agriculture. Rainfall and temperature fluctuations are very unpredictable. Climate-smart farming is becoming increasingly popular among Indian farmers. IoT enables smart agriculture. It saves water, fertilizer, and agricultural yields. IoT-enabled automated systems and wireless networks are expanding industries. Thus, research into integrated sensor technology and the usage of IoT networks in agriculture is reaching the level.

T-5.4: Production and Supply Chain Management in Agriculture. The growth of the supply chain and the movement of information are driven by the gathering of materials, the transformation of products, and the delivery to end-users. Information-driven, "connected supply chains" enable organizations to reduce inventory and expenditures; increase product value; extend resources; expedite time to market; and retain consumers, among other benefits. Supply chain performance determines how healthy activities are linked to maximizing customer value and profitability at each process stage—the end-user benefits from an efficient supply chain. Several agricultural supply chains in India are problematic owing to issues in the agriculture industry. Many factors affect the agro-food supply chain, including small and marginal farmers, disjointed supply chains, a lack of economies of scale, subpar processing, value addition, and fewer marketing options. Supply chain management is expanding into logistics by creating new divisions integrating manufacturing, procurement, transportation, and distribution. Information flow visibility has increased because of advancements in telecommunications, electronic data interfaces, and other technologies. Animals and plants are used in agriculture to produce products that benefit human health. For example, agribusiness produces textiles and paper. Throughout the supply chain, the needs of customers are met. Organizations in the agricultural supply chain, such as cooperatives, distribute produce, fruits, grains, pulses, and products derived from animals —a network of businesses that make goods and services for the end-user. There are several benefits to establishing a supply chain network, such as shifting risk and profit from one company to another. Quality is ensured by openness and accountability in the process. Quality is dependent on transparent processes and responsibilities at each stage of the process. The price and performance of transfer payments are crucial to the success of process chains.

T-5.5: Cost-Effective Communication System in Smart Agriculture. Low-cost solutions like crop rotation, green maturing, and mulching have cut cultivation expenses while saving soil and water. Legumes, weed control, and increased agricultural diversity are nonmonetary inputs. Climate change, global warming, saltwater intrusion, desertification, and a lack of arable land have increased worldwide worries about food safety and security. Connectivity-of-Things applications require steady internet. In the Mekong Delta and HCMC, climate change threatens food security. Drought and saltwater intrusion in the South and Central Highlands in early 2016 demonstrate the vulnerability and susceptibility of unsustainable agriculture. Agriculture may be more efficient and safer thanks to a new Farming system. Vietnam may become a smart and sustainable farm by modernizing, boosting productivity, and ensuring quality. Businesses in Vietnam have shared their know-how with companies in other countries. Another important factor to consider is the safety of the food being prepared. When deciding which meals are good for you and the environment, most people have no idea where to begin. Concerns about food safety have given rise to new ideas like “city farms” and “growing your veggies at home”. However, the economic sustainability of these models must be thoroughly explored. Researchers are currently focusing on developing an IoT-enabled agriculture system. Increased productivity, quality, and safety may be achieved via this method.

CHAPTER 11

Ten Topic Solutions: Research Trends

T-10.1: Greenhouse Monitoring System. Most Indians work in agriculture, contributing to the country's economy—agriculture benefits from technological advancements. However, pesticides are used to grow most fruits and vegetables since contemporary farming methods cannot keep up with demand. As a result, conventional farming practices contend with weather and disease. Although crop yields may be increased by altering agricultural practices because of urbanization and land scarcity, farming must be done in greenhouses. Temperature, humidity, light, water content, pH, and wetness are all shown via LEDs in the greenhouse. The goal is to create an intelligent greenhouse. Greenhouse temperature and humidity may be adjusted automatically using programmable modules and low-cost and high-efficiency options.

Soil water content, light intensity, temperature, and humidity may be adjusted. In greenhouse crop production, the appropriate growth conditions must be changed to achieve high yields, low costs, improved quality, and the lowest environmental impact. To attain these goals, proper heating and ventilation must be maintained. Using a greenhouse is more dependable, but it is also more difficult. Temperature and timing controls had previously improved crop quality. Many control devices and systems lack automation and efficiency in today's dynamic and competitive environment. A variety of complicated models depict the greenhouse effect. Costs increased, plans became more complex, and more control was required. The usage of computers in greenhouses has increased during the last decade. These components are necessary for a control system. Sophisticated microelectronic hybrid circuits boost sensor manufacturing. Advances in product quality and dependability enable commercial competitiveness. Each sensor's performance is determined by its calibration and sensing processes. It will be impossible to automate some jobs even in the far future. Several American businesses have yet to automate fully, maybe due to cost concerns.

T-10.2: Service-Based Industry for Smart Agriculture. Technical advancement has been driven by the widespread use of IT and its adaptability in satisfying various requirements. Service-based agriculture (SBA) is widely utilized in multiple industries. Farming systems that make it easier for farmers to do their work. A large-scale service smart agriculture systems link buses to a hotel, hospital, logistics centre, restaurant, grocery store, or traditional market. With SBA, material sales partners may easily share information about their products with one other fast. As a result of SBA, Indonesia will see an increase in its economy, as quoted in one study. Over time, the importance of information technology has grown. The production of farms has increased thanks to the adoption of contemporary technology. Many people are familiar with the predicament of Indonesian farmers. The significance of variables cannot be overstated. Farmers have a fear of technology. Farmers in Indonesia may be able to increase their abilities and produce food for the country's population by utilizing new technologies.

Brokers are often used to resell the produce of Indonesian farmers. Small-scale farmers in Indonesia were hurt by brokers who gambled on the price of agricultural goods. Prices for components are rising. Broker fraud inflated market values. Brokers save agricultural products, giving the impression that the market is oversupplied and driving up the price of food. When chili prices climb and there is a shortage, many brokers refuse to buy from growers. The growing cost of food in Indonesia might harm the country's economy. Farmers must be able to sell their products directly to consumers. The direct distribution offers farmers an easy way to market their products. Wholesalers buy agricultural goods from farmers at inexpensive rates. To get their goods to market, farmers must rent a vehicle.

Commodities no longer impact farmers' earnings with a long processing time. Indonesians rely heavily on their smartphones to get information. Technology can help farmers become food wholesalers. Local markets and restaurants might be fed using this method by farmers. The Internet of Things (IoT) and cloud computing support agriculture's food supply and distribution systems. Nowadays, nanotechnology is also used in agriculture to improve yields and reduce waste.

T-10.3: Cloud-Based Smart Applications in Agriculture. Smart farming uses technology to increase production and improve product quality. For example, the Internet of Things-based smart agriculture automates crop inspections and watering. Database traffic and data cannot be handled by a cloud-based IoT-based system. As a result, there is less lag, the battery lasts longer, and the money and information are better managed.

In many cases, the edge for IoT may provide significant advantages, such as removing the need for interval and geometric communications efficiency. High interface automation in IoT activities may achieve reduced latency and faster processing. This simulator replicates the sting, edge, and fog of IoT. IoT-based edge computing is more immediate, cost-effective, and efficient than traditional computer systems. In cities, these strategies are ineffective. Rural locations are where they are most commonly used. Robots should be used in agriculture. The field is navigated using the GPS on the tractor. Agribusiness in the 21st century is anything but digital or computerized. Monitoring crops and animals with sensors, GPS-enabled tractors, image processing, and machine learning is possible. Edge computing reduces the amount of noise in the raw data it analyses which can be cleaned using data mining techniques.

On the other hand, Broadband networks are more cumbersome and difficult to standardize. After sensors are installed, data is automatically collected. We can identify if animals or birds are active, inactive, unwell, healthy, submissive, or dominant. We may alter their treatment, living circumstances, medicine, and food to suit their needs.

T-10.4: Energy-Efficient Smart Transmission System. An intelligent electrical infrastructure that satisfies society's sustainability and energy efficiency demands is called "smart infrastructure" Customers and utility providers will benefit from the smart grid's ability to monitor their energy use better and link the power grid with micro-networks. As a result, there is a danger to data security and privacy. Economic growth depends on the availability of electricity, which boosts productivity and sustains quality of life. Global economic development and electricity usage are depleting the world's energy resources. The smart grid's core assumption is to minimize resource depletion and promote economic growth through energy efficiency and management technologies. Demand management lowers transmission and distribution system stress and high-demand overhead lines. Several countries have used industrial and commercial demand response strategies to boost their economies. Direct load limiting often reduces peak demand. Direct load management may result in a decrease in customer satisfaction—direct load management. Consumers and utility companies benefit from reduced peak demand when loads are shifted. However, the electrical system's stability and dependability are compromised during periods of high energy demand. The smart grid and load modelling need to limit peak energy use.

Trouble ensues when demand exceeds supply. From 2019 to 2030, India's population and development demands are expected to grow by 50 percent. A transmission system that can endure interruptions and blackouts must meet these criteria. Grid operators must regularly monitor supply and demand to avoid power outages. To fix this problem, load shedding disconnects specific customers' electricity. Generators must be turned down to prevent blackouts if supply and demand are out of sync. Smart grids can identify problems early on and immediately resolve them. Sensors monitor the grid and manage the flow of current. These are computerized to increase productivity.

T-10.5: Smart Solutions for Modern Farming. Sustainable food production is in high demand as the world's population expands and weather patterns shift. Agriculture and development go forward as time goes by. Agricultural technology is advancing rapidly. These new technologies are pretty effective, but they must be constantly improved. Using information and communications technology, planting, watering, and harvesting are all enhanced. Many fields, including agriculture, benefit from technological advancements. The Internet of Things (IoT) in agriculture is referred to as "smart farming". Produce and livestock will be healthier thanks to IoT-enabled smart farming. Real-time information is provided through wearables and sensors in the field.

Shelter, clothing, and food have been top priorities for humanity since the dawn of civilization. There is a lot of modernity in the house and clothing. According to the UN Food and Agriculture Organization (FAO), humanity's food requirements will rise by 70% by 2050, according to the UN Food and Agriculture Organization (FAO). IoT can be used to solve problems in business and technology. Tractors are used to plant seeds and gather crops. You can use it for business or yourself. Farming is done with the help of tractors. Farmers can do other things when they use tractors that drive themselves. A Polish company called Agribot makes tractors that can work independently. When they pull weeds, their tractors have sensors that reduce the number of chemicals and pesticides exposed. Agro-IoT devices can meet the needs of farming in the future. Traditional agriculture must become more productive and less risky for the global economy to grow. IoT helps growth. Farmers can keep an eye on their land with the help of the Internet of Things. IoT applications include keeping an eye on climate change, managing water, keeping an eye on land, improving productivity, keeping an eye on farming, and keeping track of pesticides and herbicides .

T-10.6: Smart Irrigation System for Agriculture. The most difficult chore in agriculture is watering fields. Water systems consist of drips, nozzles, tubes, and sprinklers, among other things. As a whole, agriculture has a positive impact on economic activity. Watering by hand is required. Gardening and soil deterioration are both covered in rainfall. Agriculture's key objectives are the production of food and livestock. IoT is a network of interconnected devices that can exchange data. When water supplies are limited, automatic irrigation may be necessary.

According on the weather, irrigation might be done continuously or intermittently. As a result, there is less spillage. Almost all of the water comes from drip irrigation or sprinklers. With a wireless gadget, soil moisture and humidity may be monitored. In agriculture, controllers manage everything from power to intruder detection to pump switching. A pump is used to deliver water to the ground. Water is conserved when drippers are used. Drip irrigation and flood irrigation are both standard irrigation methods. Both all of the sensors, pumps, and controls work as expected. Manual watering may hurt or deplete crops and the environment. Automated irrigation systems can be used to address the difficulties. Farming may benefit from drip irrigation, which saves on water. Automatic irrigation systems for crop management have become widespread during rainstorms, landscaping, and soil erosion. Wi-Fi sensors are used to gauge the humidity and moisture content of the soil. In agriculture, controllers keep an eye on the electricity, keep an eye out for intruders, and manage the pumps. Saturating the soil is accomplished with the use of pumps. Using drippers saves water, therefore reducing the amount of water used. Floatation irrigation commonly utilizes electricity, sensors, pumps, and controls.

T-10.7: Block chain-Based Security System for Agriculture. There are nodes in a block chain, and each node has its own distributed ledger, allowing several nodes to read and amend a single ledger while preserving shared control. Each block chain node contains a distributed ledger that is safe and accessible to all participants. There are no middlemen to authenticate, track, store or synchronize transactions using block chain technology. According to several research studies, block chain has altered technology from centralized to decentralized and distributed networks, a shift that has been well documented. The block chain helps business networks. Business networks are composed of companies or individuals that trade assets. Products, materials, and equipment are examples of physical assets. A distributed ledger may be used to move assets across the network by anybody who is a member. The most recent ledger is available to all members. Consensus-based distributed ledgers and smart contracts foster network confidence. Assets and transactions are recorded in the distributed ledger. Transactions are possible with a distributed ledger. You cannot remove a transaction after it has been added. An encrypted ledger prevents tampering with transactions. With block chain, the distributed ledger is transformed into a reliable data source for the network. A distributed ledger of digital commerce is known as a block chain.

Each node of the network modifies distributed ledgers through cryptography. Components of a block chain include its block header, timestamp, nonce, and Merle root hash. Smart apps are being developed for rural agriculture. Agricultural modernization relies on ICT to automate processes and protect personal data. Data from many IoT devices may be sent to a central hub to analyse and manage autonomous farm activities. However, centralized intermediates are inherent in a single point of failure, data loss risk, and man-in-the-middle attacks. Thanks to smart contracts on the block chain, decentralized and safe agricultural automations are now possible.

T-10.8: Production-Based Smart System for Agriculture. It is possible to increase productivity and quality by using IoT-based agricultural convergence technologies.

Predicting demand, managing supply, and ensuring quality are benefits of precision agriculture. The expansion of the economy is mainly fuelled by agriculture. The government is responsible for protecting the land. Nothing has changed despite advances in science and technology. There is no shortage of green technologies. Farmers need to reduce the time they spend working and increase the precision they use their resources. Complex statistical methodologies are used by agriculturalists when analysing historical data and making economic predictions. Farm yields are improved via GPS, sensors, and big data. Real-time data from ICT-based decision support systems can take the role of farmers' knowledge and intuition. Improved decision-making reduces the amount of waste and increases efficiency. Images, GPS, science-based solutions, climate forecasts, technology, and environmental controls play a role in agriculture. As with the terms "smart meters" and "smart cities," "smart farming" refers to any M2M application. Technology advances to aid in harvest forecasting. However, predictions based on statistics are not always accurate. Harvest data and the agricultural environment should be correlated. IoT will provide agricultural data. Complex statistical methodologies are used by agriculturalists when analysing historical data and making economic predictions. Predicting crop yields is aided by the use of smart systems. In the end, statistical forecasts are not perfect; they are only a starting point. Make a connection between the agricultural environment and harvest data. Crop pattern data will be provided through IoT-based decision support. On IoT, agribusiness utilizes data mining, statistical forecasting, and IoT services.

T-10.9: Industry 4.0 in Agriculture. Global agriculture must undergo a paradigm shift in light of evolving environmental conditions, dietary preferences, and a scarcity of critical inputs. It is all about the latest advancements in agriculture. As a result of the adoption of Industry 4.0, businesses may expect to see advances in output, efficiency, and creativity. First, agriculture provides food for the world's population. Second, agriculture 4.0 decreases labour and environmental effects to increase agricultural profitability by reducing greenhouse gas emissions and water use. Third, agriculture is the primary source of income for half of India's population, India's veins and arteries. The fourth stage of industrial development is large-scale agriculture. Among the essential ICTs is the IoT. Flexibility is improved in "smart factories." People, equipment, and software work together to satisfy production demands, which are met through cutting-edge technology such as CPS/IoT/is and real-time interaction. The industry benefits from consolidation. However, future manufacturing and commerce will be harmed. This shift is made possible due to the Internet and information technology. Quality control encompasses all aspects of engineering, management, manufacturing, operations, and logistics. Costs, availability, use of resources, and market demand may all be automated. 'The implementation of Industry 4.0 will profoundly impact the agriculture and industrial sectors. All technologies like Big Data, AI, and IoT are part of Industry 4.0. IoT allows agricultural systems and equipment to connect with one another, making Industry 4.0 a game changer in agriculture. The fourth industrial revolution created networked tractors, farms, and manufacturing equipment. "Industry Revolutions 4.0" refers to three factors: Digitalization and its integration into simple economical and technical networks Digitalization of services and products (3) Market models that have been updated

As economic, economic and business models develop, humans become more distant from the centre of production and surveillance of crops. Industry 4.0 is being used by both developed and developing countries. India has a lot of untapped potential for agricultural growth. Robotics, IoT, and e-business are the three pillars of this revolution, aiming to deliver technology to every corner of the globe. T-10.10: Image-Based Classification Techniques in Intelligent Agriculture. Agriculture originated thirteen thousand years ago between the Tigris and Euphrates rivers north of Iraq. Gathered vegetation included wild wheat and others. Few people needed food. UN estimates that the world's population will reach 10 billion by 2050, impacting farmers. Desertification and urbanization wreak havoc on farmland. COVID-19 is a threat to food security and the nation's economy. To solve this problem, we need to use fewer people to generate more food. In certain parts of India, rainfall is the only irrigation water supply. However, crop destruction can occur in some places due to unpredictability in rainfall, which is a problem. Management of watersheds is critical. Many-variable hydrological modelling is required to predict rainfall and runoff in different basins accurately. Estimates of imperviousness necessitate a terrain categorization, which ultimately categorizes land use and cover. The image classification curve number is used in modelling. Satellite pictures are difficult to classify because of their high resolution and wide range of applications.

Nevertheless, images are a common practice in agriculture and water management. There are a plethora of tools and methods for classifying images. ANN and SVM are used for image classification. Techniques used to organize pictures traditionally are time-consuming and prone to human error.

CHAPTER 12

Threats to Validity

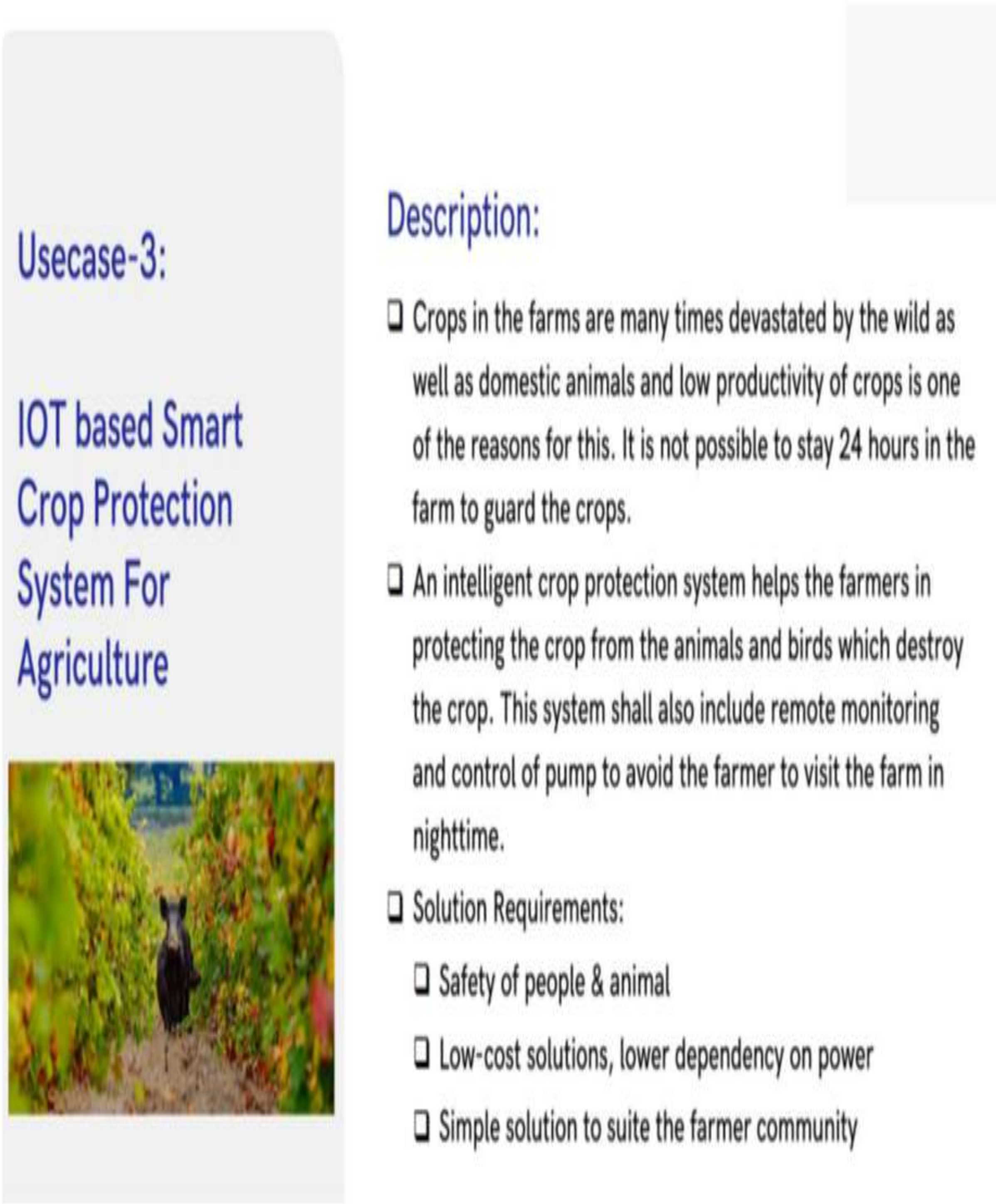
This analysis is based on LDA topic modelling and has bounded to the limitations of this topic modelling technique. A sufficient article count has been achieved, yet the risk of missing out is a concern. The bibliographic material has also been inferred. The search string insufficiency has been eradicated appropriately due to the limitations of selected search terms, synonyms, string formulation, and search engines' variedness resulting in imperfect retrieval of literature corpus. Labelling topics is a significant concern due to subjectivity and bias. According to the author, a deep discussion has been conducted to determine the label best to overcome this limitation. Then, based on critical terms, labels have been formulated to draw the best topic labels for researchers and practitioners.

CHAPTER 13

BRAINSTORM

AGRICULTURE BRAINSTORM

Literature survey :



Usecase-3:

IOT based Smart Crop Protection System For Agriculture

Social Impact

Improve the productivity, Save lives of farmers

Business Model/Impact

Community based solution by FAO's
Solution through contract farming

Recommended Technology Stack

Computer Vision API's, GSM Modules, ESP8266, IBM Watson IoT Platform, Android Application

Existing Solutions

https://www.agrivi.com/blog/top-five-strategies-to-protect-crops-from-wild-animals/

References

https://article.murata.com/en-eu/article/measures-against-wildlife-damage-through-iot
https://www.fao.org/3/cb2447en/cb2447en.pdf

CHAPTER 14

PROBLEM STATEMENT

14.1 Land Tenure System:

The land tenure system practiced in India is suffering from lot of defects. Insecurity of tenancy was a big problem for the tenants, particularly during the pre-independence period. Although the land tenure system has been improving during the post-independence period after the introduction of various land reforms measures but the problem of insecurity of tenancy and eviction still prevails to some extent due to the presence of absentee landlords and became transfer of land in various states of the country.

14.2 Inequality in Land Distribution:

The distribution of agricultural land in India has not been fairly distributed. Rather there is a considerable degree of concentration of land holding among the rich landlords, farmers and money lenders throughout the country. But the vast majority of small farmers own a very small and uneconomic size of holdings, resulting to higher cost per units. Moreover, a huge number of landless cultivators has been cultivating on the land owned by the absentee landlords, leading to lack of incentives on the part of these cultivators.

14.3 Cropping Pattern:

The cropping pattern which shows the proportion of the area under different crops at a definite point of time is an important indicator of development and diversification of the sector. Food crops and non-food or cash crops arc the two types of crops produced by the agricultural sector of the country.

14.4 Instability and Fluctuations:

Indian agriculture is continuously subjected to instability arising out of fluctuations in weather and gamble of monsoon. As a result, the production of food-grains and other crops fluctuates widely leading to continuous fluctuation

Of prices of agricultural crops. This has created the element of instability in the agricultural operation of the country.

14.5 Poor Farming Techniques and Agricultural Practices:

The farmers in India have been adopting orthodox and inefficient method and technique of cultivation. It is only in recent years that the Indian farmers have started to adopt improved implements like steel ploughs, seed drills, barrows, hoes etc. to a limited extent only. Most of the farmers were relying on centuries old. Wooden plough and other implements. Such adoption of traditional methods is responsible for low agricultural productivity in the country.

14.6 Instability in Agricultural Prices:

Fluctuation in the prices of agricultural products poses a big threat to Indian agriculture. For the interest of the farmers, the Government should announce the policy of agricultural price support so as to contain a reasonable income from agricultural practices along with providing incentives for its expansion. Stabilization of prices is not only important for the growers but also for the consumers, exporters, agro-based industries etc.

14.7 Agricultural Indebtedness:

One of the greatest problems of Indian agriculture is its growing indebtedness. The rural people are borrowing a heavy amount of loan regularly for meeting their requirements needed for production, consumption and also for meeting their social commitments.

CHAPTER 15

IMPLEMENTATION

PROJECT DESIGN PHASE 1

15.1 Problem solution fit:

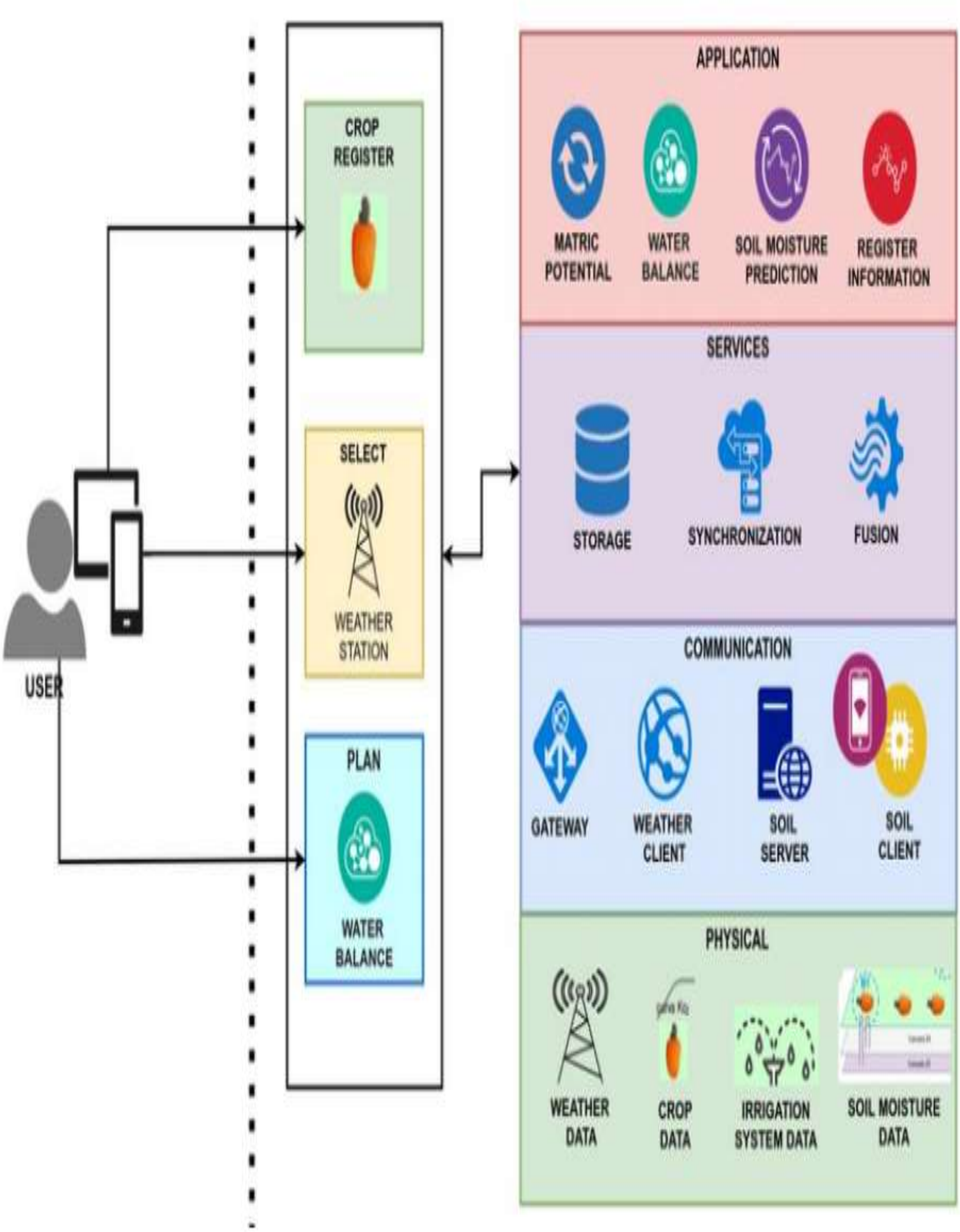
15.2

Proposed Solution:

Project team shall fill the following information in proposed solution.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Develop affordable app-based solution for Soil health monitoring and suggest which crop to be sown based on it. (Technology Bucket: IoT, AI, ML etc.)
2.	Idea / Solution description	Create app-based solution to detect soil parameters like moisture content, temperature, relative humidity, nutrient, Ph, CEC, and NPK etc. and provide crop suggestions to be produced based on soil parameters & environment values.
3.	Novelty / Uniqueness	Provide remedies & alerts on soil deficiencies like Watering for low Moisture level, Fertilizers for Nutrient deficiencies etc.
4.	Social Impact / Customer Satisfaction	Farmers can take immediate actions resulting better crop produces and farmers have better income. High Yield and prescriptive guidance.
5.	Business Model (Revenue Model)	GSM model
6.	Scalability of the Solution	soilarmor, minimizing soil disturbance, plant diversity, continual live plant/root, and livestock integration.

15.3.Solution architecture:



CHAPTER 16

SYSTEM TESTING

PROJECT DESIGN PHASE 2

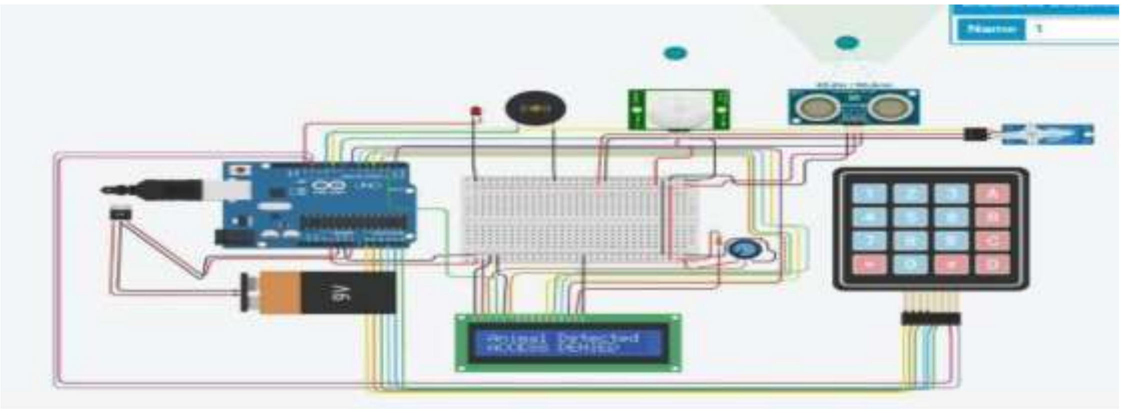
16.1 Customer journey map :

16.2 Data Flow Diagram & User Stories:

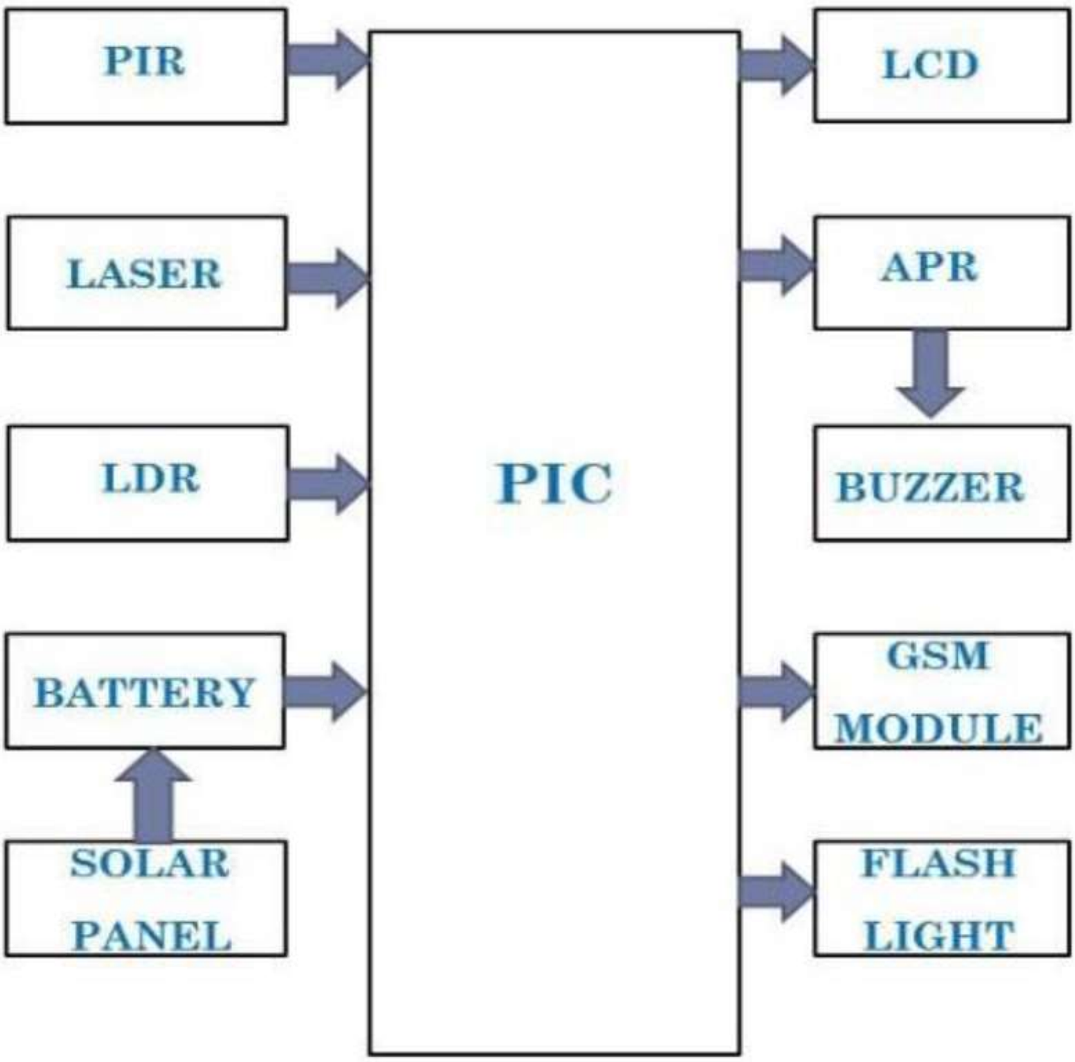
Data Flow Diagrams**:**

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.

Data Flow Architecture:



DATA FLOW DIAGRAM:



USER STORIES:

A systematic survey of 160 households in district was conducted to study the extent of crop raiding by wild animals. Almost all respondents (97.5%) reported crop damage by wild animals. Most crop damage was done by deer (91.1%). Farmers mostly used traditional nonlethal measures to secure their crops from wild animals. The most widely used measures were fencing (82.5%), guarding (75%), and scarecrows (71.9%). Farmers felt the need for the government to intervene- by providing permanent fencing materials (27.4%), legalizing killing (26.85%), introducing compensation schemes (18.3%) and investing in electrification of the field perimeters (17.7%).

16.3.SOLUTION REQUIREMENTS(FUNCTIONAL&NONFUNCTIONAL):

Functional requirements: Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Resource discovery	The specifications define the common services provided by the application service layer in IOT systems, referred to as common service functions. 'Discovery' is one of the defined CSFs which allows IOT entities to send discovery requests to search resources about applications and services.
FR-2	Resource management	The resources considered in Table 1 include battery-time, memory usage, and other data related to application performance to make quality of service reliable. Although some parts of this requirement rely on its implementation of the 'Application and Service Layer Management' and 'Device Management' could probably support these requirements.
FR-3	Data management	The 'Data Management and Repository' is responsible for providing data storage and management converting aggregated data into a specific format and preparing for further analytics such as semantic processing.
FR-4	Event management	The 'Subscription and Notification' can manage subscription to the resources hosted in the platform, and can provide notification containing the changes on the resources to the address where the subscriber wants to receive them. Accordingly, application and services can acquire all the information about the proper events in real-time.
	Code management	The 'Device Management' utilizes the already-existing technologies including broadband forum (BBF) TR-069, OMA-DM, LwM2M for managing device capabilities. Of course, code updating operations for IOT devices could be achieved with the help of management clients, servers, and adapters specifications.

Non - Functional requirements:

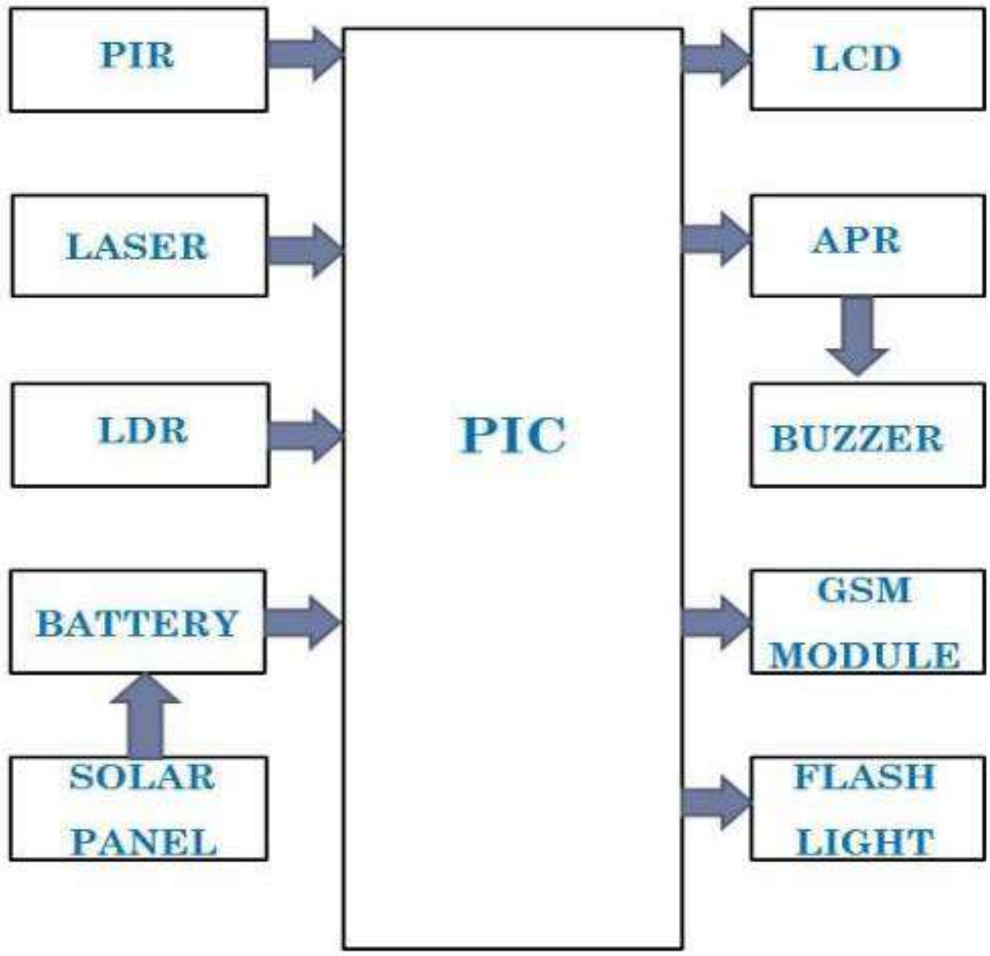
Following are the functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The 'Device Management' allows the application entities registered to an server platform to be easily maintained through existing device management technologies. Also, the Node.js-based implementation enables the middleware components to be updated or replaced accordingly without any high-level of technical expertise.
NFR-2	**Security**	Security is a very critical requirement in IOT solutions and defines its security framework including identification, authorization and authentication. Our middleware platform can be registered to the server (i.e., Mobius) as an application entity. It can attempt to access a list of authorized resources hosted by the server with its server-generated unique identifier and privileges, called access control policy. However, authentication and other security components such as certificates still remain incomplete.
NFR-3	**Reliability**	we have not yet realized capabilities related to Reliability, which allows platform-equipped devices to adapt themselves according to short-term or long-term changes in resource conditions, application scenarios, and surrounding environments, remaining our future work.
NFR-4	**Performance**	This requirement belongs to a part of intelligence for IOT devices, and the proposed IOT device platform provides no analytic tools on data or decision-making procedures depending on resource conditions, for example, recommending the most suitable (or currently available) one among multiple IOT devices offering the same service, which is one area of our future work.
NFR-5	**Availability**	Availability could be achieved by ensuring some level of fault-tolerance. The developed IOT platform does not deal with all fault tolerance issues that mainly occur in hardware interfaces. However, a watchdog function is able to detect the failure of middleware components interacting with hardware interfaces, and restart or reconnect if needed.
NFR-6	**Scalability**	An IOT platform needs to support rapidly growing numbers of IOT devices and keep a certain level of support. Although the scalability of an IOT platform is crucial, it highly depends on implementation and performance in IOT servers rather than connected devices. Accordingly, in support of a well-designed - based IOT server we can say that our middleware platform may deliver some level of appropriate for the given environment and applications.

Problem statement:

Technical Architecture: The Deliverable shall include the architectural diagram as below:

1. Block Diagram:



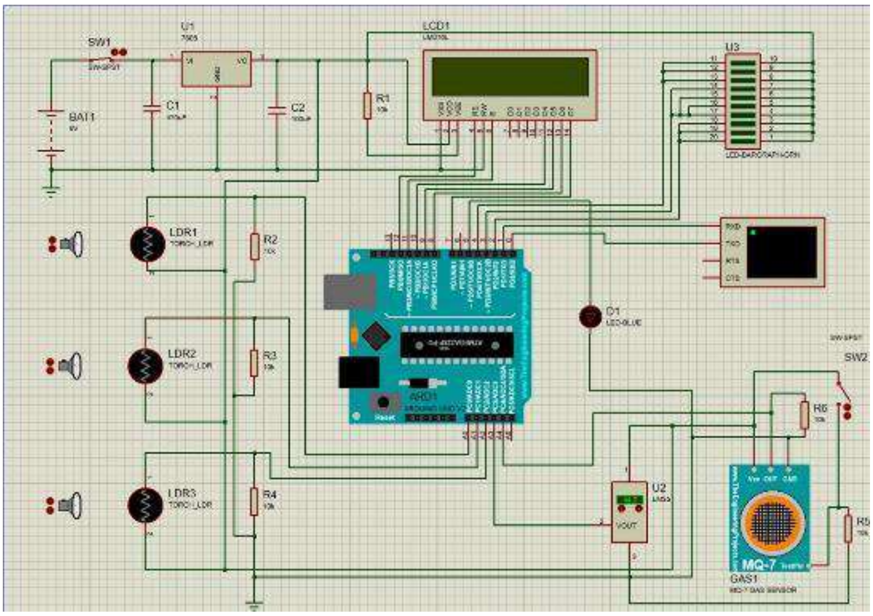
2. Experimentation Work :

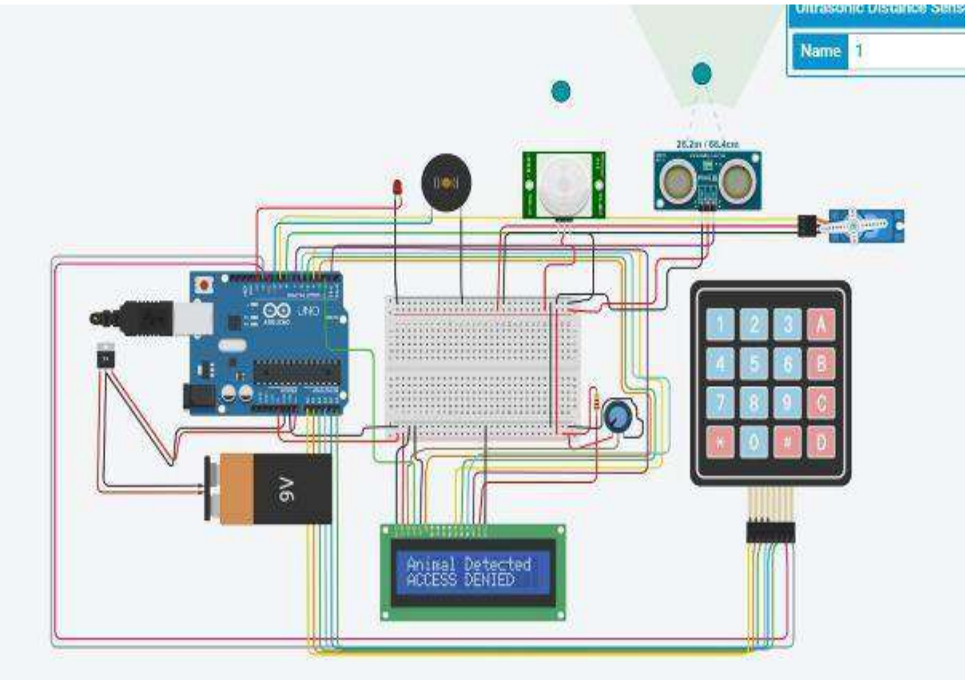
Tool used: Proetus 8

Platform used: Windows 10 64 bit

System Configuration: i5 7th gen

Results: Positive





Problem identification:

- PIC Microcontroller
- Buzzer
- Gsm model
- Passive infrared sensor (PIR)
- LCD display
- Laser diode

Arduino MEGA

Arduino/Genuino Mega is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button.

It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

You can tinker with your Mega without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Mega" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Mega board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Mega board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

PROGRAMMING

The Arduino/Genuino Mega can be programmed with the (Arduino Software (IDE)). Select "Arduino/Genuino Uno from the Tools > Board menu (according to the microcontroller on our board).

You can also bypass the boot-loader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header using Arduino ISP or similar; see these instructions for details.
The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available in the Arduino repository. The ATmega16U2/8U2 is loaded with a DFU boot-loader, which can be activated by:

• On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2.

Warnings

The Arduino/Genuino Mega has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Power

The Arduino/Genuino Mega board can be powered via the USB connection or with an external power supply. The power source is selected automatically.
External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and Vin pin headers of the POWER connector. The board can operate on an external supply from 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may become unstable.
If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

• Vin. The input voltage to the Arduino/Genuino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

• 5V.This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it.

• 3V3. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.

• GND. Ground pins.

• IOREF. This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.

Memory

The ATmega328 has 32 KB (with 0.5 KB occupied by the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

See the mapping between Arduino pins and ATmega328P ports. The mapping for the Atmega8, 168, and 328 is identical. Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(),digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. A maximum of 40mA is the value that

must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller.
In addition, some pins have specialized functions:

• Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

• PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.

• SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.

• LED: 13. There is a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

• TWI: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.

The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function. There are a couple of other pins on the board:
• AREF. Reference voltage for the analog inputs. Used with analogReference().

• Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

HUMIDITY SENSOR:

This DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high-performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness. Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The single-wire serial interface makes system integration quick and easy.

Technical Specifications:

• Relative humidity

• Resolution: 16Bit

• Repeatability: ±1% RH

• Accuracy: At 25? ±5% RH

• Interchangeability: fully interchangeable

• Hysteresis: <± 0.3% RH

• Long-term stability: <± 0.5% RH / yr in

• Temperature

• Resolution: 16Bit

• Repeatability: ±0.2?

• Response time: 1 / e (63%) 10S

Electrical Characteristics:

• Power supply: DC 3.5?5.5V

• Supply Current: measurement 0.3mA standby 60µ A

• Sampling period: more than 2 seconds

RAIN SENSOR :

A rain sensor is a switching device activated by rainfall, the main advantage of using rain sensor is that whenever there will be any drops of rain then it will automatically shut down the device and will give alarm through sensors to the farmers for which they can take a proper action. The sensing part contains an etched area consists of 3 carbon electrode separated by an waterproof resins. The sensing area is smooth to allow water droplets to run off more easily, Thus it made it easy for the farmers to know everything by seating in one place and control everything and take certain precautions.

LCD :

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over

seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.
A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.

Character LCD pins with 2 Controller :

Usually these days you will find single controller LCD modules are used more in the market. So in the tutorial we will discuss more about the single controller LCD, the operation and everything else is same for the double controller too. Lets take a look at the basic information which is there in every LCD.

BF - Busy Flag :

Busy Flag is an status indicator flag for LCD. When we send a command or data to the LCD for processing, this flag is set (i.e BF =1) and as soon as the instruction is executed successfully this flag is cleared (BF = 0). This is helpful in producing and exact amount of delay for the LCD processing. To read Busy Flag, the condition

RS = 0 and R/W = 1 must be met and The MSB of the LCD data bus (D7) act as busy flag. When BF = 1 means LCD is busy and will not accept next command or data and BF = 0 means LCD is ready for the next command or data to process.

Instruction Register (IR) and Data Register (DR) :

There are two 8-bit registers in HD44780 controller Instruction and Data register. Instruction register corresponds to the register where you send commands to LCD e.g LCD shift command, LCD clear, LCD address etc. and Data register is used for storing data which is to be displayed on LCD. when send the enable signal of the LCD is asserted, the data on the pins is latched in to the data register and data is then moved automatically to the DDRAM and hence is displayed on the LCD. Data Register is not only used for sending data to DDRAM but also for CGRAM, the address where you want to send the data, is decided by the instruction you send to LCD.

CHAPTER 17

DOMAIN

INTERNET OF THINGS

PROJECT PLANNING PHASE

17.1 Arduino UNO displaying value for humidity and temperature:

```
#include<dht.h>
dht DHT;

#define DHT11_PIN A0

Void setup(){
Serial.begin(9600);
}

void loop()
{
DHT.read11(DHT11_PIN);
Serial.print("Temperature = ");
Serial.println(DHT.temperature);
Serial.print("Humidity = ");
Serial.println(DHT.humidity);
delay(1000);
}
```

OUTPUT:

Send
Tem9.00
Temperature = -999.00
Humidity = -999.0
Temperature = -999.00
Humidity = -999.00
Temperature = -999.00
Humidity = -999.00
Temperature = -999.00
Humidity = -999.0
Temperature = -999.00
Humidity = -999.00
Temperature = -999.00
Humidity = -999.00
Temperature = -999.00
Humidity = -999.0Temperature = -999.00
Humidity = -999.00
Temperature = -999.00
Humidity = -999.00
Temperature = -999.00
H
Autoscroll
Show timestamp
Newline
9600 baud
Clear output

Checking temperature conditions:

I'm going to offer you a pattern, not a simple if-else if-else block.

You might want to have an interface Temperature

```
interface Temperature {
/** Returns true if the temperature matches the criteria. */
boolean within(final int temperature);

/** Returns an appropriate, descriptive, message. */
String message();
}
class BoilingTemperature implements Temperature {
public boolean within(final int temperature) {
return temperature > 99;
}
public String message() {
return "Water boiling";
}
}

class FreezingTemperature implements Temperature {
public boolean within(final int temperature) {
return temperature < 1; // Should be 3 degree! But anyway.
}
public String message() {
return "Water freezing";
```

```
}
}
class YourCustomTemperature implements Temperature {
public boolean within(final int temperature) {
return temperature > 6 && temperature < 40;
}
public String message() {
return "Your custom message";
}
}
final List<Temperature> temperatures = new ArrayList<>(6);
temperatures.add(new BoilingTemperature());
temperatures.add(new FreezingTemperature());
temperatures.add(new YourCustomTemperature());
...
public static void main(String[] args) {
System.out.println("Give the temperature : ");
final Scanner sc = new Scanner(System.in);
int temp = sc.nextInt()

for (final Temperature t : temperatures) {
if (t.within(temp)) {
System.out.println(t.message());
}
}
}
```

17.2 Python code for blinking led and traffic lights for raspberry pi:

Solution:

Our script needs to do the following:

1. Initialize the GPIO ports
2. Turn the LED on and off in 1 second intervals

```
Import RPi.GPIO as GPIO
from time import sleep
GPIO.setwarnings(False)

GPIO.setmode(GPIO.BOAR
D)

GPIO.setup(8, GPIO.OUT, initial=GPIO.LOW)

while True:

GPIO.output(8, GPIO.HIGH)

sleep(1)

GPIO.output(8, GPIO.LOW)

sleep(1)

import RPi.GPIO as GPIO
from time import sleep
GPIO.setwarnings(False)
```

```
GPIO.setmode(GPIO.BOAR
D)

GPIO.setup(8, GPIO.OUT, initial=GPIO.LOW)

while True:

GPIO.output(8,
GPIO.HIGH)
GPIO.output(8, GPIO.LOW)
sleep(1)
```

With our program finished, save it as blinking_led.py and run it either inside your IDE or in the console with :

```
$ python blinking_led.py
```

17.3 Write a code and connections in wokwi for ultrasonic sensor:

```
#define ECHO_PIN 2

#define TRIG_PIN 3

Void setup() {
Serial.begin(115200);

pinMode(LED_BUILTIN, OUTPUT);
pinMode(TRIG_PIN, OUTPUT);
pinMode(ECHO_PIN, INPUT);

}

float readDistanceCM() {
digitalWrite(TRIG_PIN, LOW);
delayMicroseconds(2);
digitalWrite(TRIG_PIN, HIGH);
delayMicroseconds(10);
digitalWrite(TRIG_PIN, LOW);
int duration = pulseIn(ECHO_PIN, HIGH);
return duration * 0.034 / 2;

}

void loop() {
float distance = readDistanceCM();
```

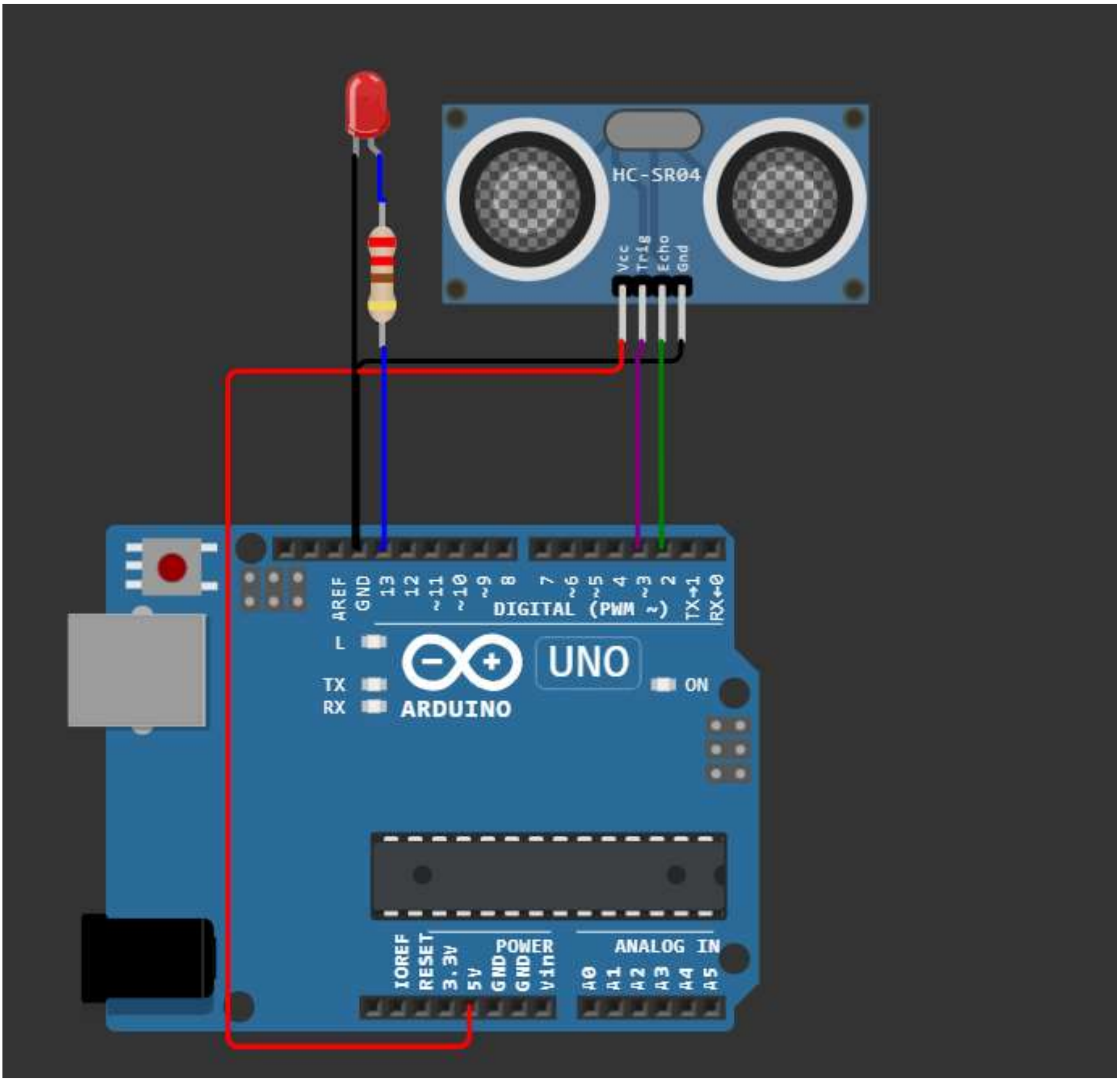
```
bool isNearby = distance < 100;
digitalWrite(LED_BUILTIN, isNearby);

Serial.print("Measured distance: ");
 Serial.println(readDistanceCM());

 delay(100);
 }
```

Wokwi link:

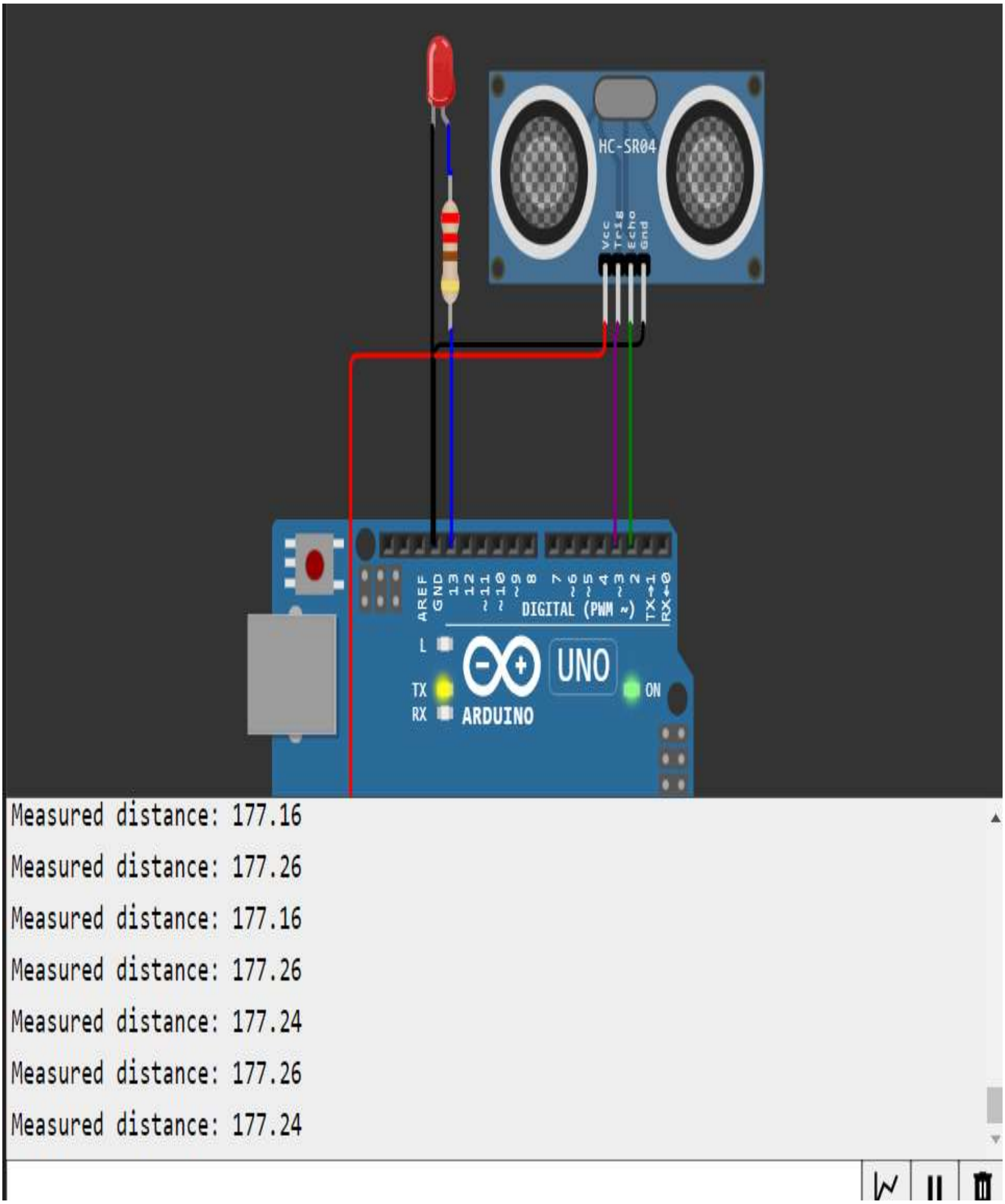
https://wokwi.com/projects/345781784553718355

CHAPTER 18

Output



After measuring distance:



CHAPTER 19

Conclusion

Using IoT technology, farmers and producers may better manage their resources, such as fertilizer consumption and the number of trips made by farm vehicles, while minimizing waste and maximizing productivity, including water, electricity, and other inputs. In IoT smart farming systems, sensors monitor the agricultural field and automate the irrigation system. Farmers can monitor their fields from anywhere. This paper concluded the research direction in smart agriculture and farming. Technology has shaped agriculture's history. Historians have identified several agricultural revolutions that changed practice and output. Technological advances have fuelled these revolutions. The Industrial Revolution mechanized agriculture, improving farm labour productivity.

Modern mechanized agriculture has replaced numerous farm activities by hand or by oxen, horses, and mules. Weather forecasting and barbed wire were 19^{th}century advances. Portable engines and threshing machines became popular after improvements. In the 20^{th}century, synthetic fertilizers and insecticides, mass-produced tractors, and agricultural aircraft for aerial pesticide application were developed. Precision farming, disease monitoring, agricultural drones, satellite imagery, and sensors are just ways technology makes farming easier for farmers. Intelligent software analysis for pest and disease prediction and soil management are only a few of the many analytical activities that IoT-based sensor networks may do. New issues in smart farming include the security of the farming data, technical failures, and technical incompetence.

CHAPTER 20

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