CHAPTER 2

LITERATURE SURVEY

2.1   Introduction

This chapter describes smart agriculture methods using Internet of things Technology and Lora Technology, which enhances the yield and ensures the less human intervention for agriculture works. High accuracy and Low power are the prime factors to make any IoT arrange favorable and allowable to the Ranchers and we have designed the controlling mechanism for the flow of water in to agriculture farm depends on the wetness of the soil which is required for the specific crops. The Humidity and Temperature value will be sensed for the specific action by the farmer. The long-range data transmission of the sensed data is possible as projects adopt LoRa technology and able to control filed with help of electrical fence.

In general, a LoRa Wide Area Network (Lora WAN) can cover 20 km in rural area and around 8 km in urban area, which can ensure the high coverage of the irrigation system. Because of low power consumption, the LoRa device can operate up to ten years on battery. In the long term, it brings great benefits, such as water-saving, lower costs of maintenance and deployment. Therefore, a irrigation system based on LoRa technology is proposed in this project. It is a great solution to these problems mentioned above. The system is capable of communication between irrigation devices and applications through LoRa WAN. The main intention of the work is to enable applications to control the irrigation system via cloud. Irrigation node will send its Status information to the gateway and this information will be forwarded to cloud to process and store. By using cloud Application Programming Interfaces (APIs), applications can send command to control the irrigation system. In this way, full utilization of energy can be realized. In this system LoRa modules to establish reliable radio link has been designed and customized data transfer protocol that stratifies the requirements has been deployed.

2.2   Literature Survey

D. Davcev *et al.* [1] suggests Innovative, power efficient and highly scalable IoT agricultural system has been proposed in this system. Lora WAN network has been used here for long range and low power consumption data transmission from the sensor nodes to the cloud services. For analytics purposes data stream has been utilized by the system of cloud services which are highly scalable. This paper shows the useful methods that can be used in smart agriculture system with the help of LoRa technology. The sensor nodes relate to LoRa modules in order to transfer the sensor data to the processing system, in order to upload it on cloud platform.

Santosh Kumar *et al.* [2] in their research, select various sensors and methods for precision agriculture such as temperature sensor, humidity sensor, and Arduino (ATMega328) microcontroller board with the wireless sensor network system. The role of WSN is to sense the remote data from the desired location and transmit through the wireless network which can be viewed by the receiver. The earlier monitoring systems had a lot of limitations such as distance and reliability factors. Previously, the wireless networks used RF technology which was replaced by Bluetooth technology, and Bluetooth has replaced by ZIGBEE technology discusses the development of the WSN system for precision agriculture based on the Zigbee wireless sensor network. ZIGBEE is a specification for wireless personal area networks (WPANs), and operating at 868 MHz, 902-928 MHz, and 2.4 GHz [. Moreover, WPAN is a personal area network in which the device connection is wireless. The ZIGBEE is used as LR-WPAN i.e., low-rate wireless personal area network. According to them, using ZIGBEE devices in a WPAN can communicate at speeds up to 250 Kbps while physically separated by distances up to 50 meters in typical circumstances and greater distances in an ideal environment.

A Lavric *et al.* [3] Review of the challenges and the obstacles   has been presented in this paper regarding LoRa technology with reference to IoT systems. Lot of effort has been put on the study of high-density sensor networks which are used as part of the IoT (Internet of Things) concept and new solutions have been analysed related to it. Long-range transfer of information is enabled by LoRa modules, with a low transfer rate. Considering the requirements this paper presents the evaluation of the LoRa

technology in the field of Io T.A discussion of main obstacles faced during IoT development is done here. The details of challenges faced and requirement of solution for various problems in WSN research have been discussed. Architecture requirements of LoRa WAN communication protocol have been discussed along with the evaluation of LoRa modulation performance.

S. C. Gaddam *et al.* [4] this paper explains the importance and use of recent wireless technology, LPW AN. LPW AN which is Low Power Wide Area Networks has proved to be beneficial in designing various IoT systems. The concept of IoT is kept in mind while designing the new devices these days, due to increase in its demand by the people. The requirement of an automation has been understood and preferred by people which has increased the need of development in this field. This gave rise to study of wireless technology evaluation.

This paper shows the WAN technology study, of LP WAN which uses wireless network and requires very low power supply. It also provides the long-range communication, providing low bit rate and using low bandwidth. The usage of Internet of Things (IoT) technology in device designing is increasing rapidly. (LPW AN) is popular and leading technology created for IoT networks. LPW AN is wireless based WAN technology that enables Low power consumption, long range, lower bandwidth with low bit rates. The leading low power technologies with wide area network such as LoRa, Sigfox, NB-IoT, L TE-M are useful for developing IoT networks. By keeping these technologies as reference, the comparison study has been presented in this paper. The parameters such as network coverage, cost of maintenance, life span of battery, security of network and network range have been discussed thoroughly. The virtues and limitations also have been presented of LPW AN technology. The real time scenarios have been considered while presenting this study and the details of the best technology among the compared ones has been also given by the author for IoT smart applications.

M Saari *et al.* [5] this study focuses on the new communication technology called LoRa WAN. Evaluation of the LoRa WAN technology in the field of IoT has been done, and especially in sensor network solutions. systematic literature review has been presented in this case study, in the methodology section. More than fifty suitable research papers were identified. Certain questions based on LoRa WAN study were formulated. Most recent and practical applications of LoRa have been revealed. This

study has given give recommendations to the researchers and practitioners on how the LoRa-based technologies are beneficial and can be exploited fully in enhancement of IoT solutions and development of IoT systems.

C Bouras, *et al.* [6] rescue monitoring system has been proposed here which dies the comparative study of various scenarios for IoT. Wi-Fi & LoRa as wireless technologies have been compared initially, however the end devices require high power consumption for processing and thus there is requirement of low power network technologies. LoRa based gateway and Wi-Fi Router is used to connect the end devices have been connected by using used in our scenarios to the Internet Experiments carried out on real time basis indicate that LoRa could be an ideal option for building smart rescue monitoring. For building the ecosystem with rescue concepts this study is beginning of development and use of LoRa technology in this area, by making combine use of various software and hardware.

Hanggoro, *et al.* [7] proposed and designed a greenhouse monitoring and controlling using an android mobile application, which was a complete system designed to monitor and control the humidity inside a greenhouse. It used an android mobile phone, connected using Wi-Fi to a central server which connects via serial communication to a microcontroller and humidity sensor. According to them, Wi-Fi has been implemented all over the world, and 802.11g was the third modulation standard for wireless LANs. It worked in the 2.4 GHz band (like 802.11b) but operated at a maximum raw data rate of 54 Mbit/s, or about 19 Mbit/s net throughputs. It used wireless G for communication path from android to server and vice versa. A. Hanggoro, et al. in their paper, the hardware system was divided into 3 parts which are microcontroller Arduino, a sensor, and IEEE wireless 802.11g. The microcontroller sends the value from the sensor to the android via computer through serial communication and wireless connection.

P. Gangurde, *et al*. [8] designed a novel approach for precision agriculture using a wireless sensor network. In their research, they propose different topologies for precision agriculture. The development and deployment of WSNs have taken traditional network topologies in new directions. Different WSN topologies are Bus, Star, Ring, and Grid. According to them, delay in star case was much less than the delay in a bus, grid, and ring topology. As per their research, average network delay

using the execution for the four cases was 45ms for the star, 71ms for the grid, 81ms for the bus, and 98ms for the ring topology. In star topology, the delay was decreased by approximately 50%.

I. Sacaleanu, *et al.* [9] discussed a data compression on the wireless sensor nodes lifetime for LoRa technology, comparing with ZigBee and Enhanced Shock Burst. According to D. I. Sacaleanu, et al. [9] DASMote node with ZigBee protocol acquires 7 parameters and transmits 14 data bytes without data compression. The average current recorded in the transmission was 27 mA, while the current spends on 58.45 ms transmission timeframe was 1.59 mA, thus resulting in a ~20% energy improvement. For the Arduino nodes with the Enhanced Shock Burst protocol, there were acquired 7 parameters and transmit 14 bytes without data compression, 2 bytes for each parameter. The average current in the transmission was 6mA, while the current spends on a 4.64ms timeframe was 28.1μA, thus resulting in a ~7% energy improvement. And the LoPy node with LoRa acquires also 7 parameters and transmits 14 data bytes without data compression. The average current in the transmission was 154 mA, while the current spends on an 1190ms timeframe was 183 mA, thus resulting in a ~31% energy improvement.

Francesco Gregoretti, *et al.* [10] in this paper, the solution using LoRa technology for cost effective wireless control of drip irrigation systems has been presented. The system which utilizes LoRa modules to establish reliable radio link has been designed and customized data transfer protocol that stratifies the requirements has been deployed. It is shown that this solution has the advantages over existing LORAWAN protocol in terms of cost complexity for this specific application.

Wenjo Zhao *et al.* [11] this paper proposes a smart irrigation system based on LoRa technology. In order to validate the excellent execution of the proposed irrigation system, experiments have been carried out. Exploratory outcomes approve the materialness of the proposed framework. Simultaneously, the benefits of LoRa innovation received in keen water system framework have been appeared by tests. The system proposed by us facilitates more efficient, also minimizes the cost of deployment and maintenances. According to the experimental results, the irrigation node equipped with hydroelectric generator can operate up to for decades. The communication distance between the irrigation node and gateway is up to 8 km, thus

the irrigation system can cover up to 200 hectares. By mobile App, users can control the irrigation system remotely and check the status of system in time. It is believed that adopting LoRa technology to smart irrigation system will significantly simulate development of smart agriculture Of course, we have a lot of follow-up work to do to make the system more intelligent and precise controlling.

K Zheng *et al*. [12] in this paper, implemented an air quality monitoring system by using the advanced IoT techniques in this paper. With the guide of the LPWA organization, the air detecting information over a huge inclusion region is gathered and sent to the IoT cloud on schedule. The gateway checking hubs are produced for simple organization and can work the entire day with a battery or a sun-based board. Every one of the elements of the AP are carried out on a GPPbased SDR stage. The detected information is put away in the data set and dissected in the IoT cloud. A lot of investigations have been completed in the metropolitan conditions to approve the dependability of the proposed framework. Some intriguing realities have been uncovered when contrasting the air quality pattern and other comparable information. It is accepted that long haul and huge scope air observing can significantly assist us with understanding air contamination and figure out how to tackle the issue of air contamination at any rate part of the way.

L Atzori et al. [13] suggest that Internet has changed drastically the way we live, moving interactions between people at a virtual level in several contexts spanning from the professional life to social relationships. The IoT can possibly add another measurement to this interaction by empowering correspondences with and among brilliant articles, consequently prompting the vision of "whenever, anyplace any media, anything" communications in this paper, we have overviewed the main parts of the IoT with accentuation on the thing is being done and what are the issues that require further exploration. In fact, current advances make the IoT idea practical yet do not fit well with the adaptability and effectiveness prerequisites they will confront. We accept that, given the interest appeared by enterprises in the IoT applications, before long resolving such issues will be an incredible driving element for systems administration and correspondence research in both mechanical and scholarly labs.

S Manimurugan, *et al*. [14] This work was defined with the objectives of helping the farmers through the recent technologies by reducing their burdens, loss and

enlarging the yields. In connection with that, the survey of their real problems had been undertaken and listed in the previous sections. The most important problem of the list is considered and it is addressed by the proposed smart water irrigation system for the high yield process. Though many sensors used the installation cost of the developed technology should be less. It is also been addressed. As the outcome of this work, it can support the farmer needs 100%, secure them from the loss, with cost less and gain more.

Poonam S Jakhotiya et al. [15] the practice of smart agriculture using LoRa to LoRa WAN network. There are two LSN50 nodes, one at transmitter and the other at receiver. Node at transmitter is equipped with variety of sensors that collect and transmit data to our cloud services, while node at receiver is equipped with actuators for controlling the technology enhances the former methods of collecting and analyzing data in the agro environmental system. By leveraging LoRa technology and LoRa WAN protocol, agribusiness can digitally monitor, analyze, and monitor every aspect of their business. LoRa automatic sprinklers, turn on/off the valve, etc... technology provides a solid platform for the When a command is sent through TTN network, the LSN50 node gets the data from the sensors which can be seen through TTN and the future of smart agriculture as it is easy to deploy and helps farmers to grow their business.

M R Seye et al. [16] the authors evaluate LoRa performance at 83 km2 urban area. They used 14 dBm transmit power, 12 spreading factors and 868 MHz frequency of LoRa. In this experiment, they used a gateway device and a node device. They installed the gateway device at highest building there. The node device is mobile from 1 km to 8 km. Node device will send a data to the gateway periodically. RSSI of this experiment is -70 dBm with 13% packet loss in 2 km and drop to -150 dBm with 70% packet loss in 8 km.

S Y Wang et al. [17] the authors were made a temperature and humidity monitoring system at their campus. The node device was transmitting the sensor data to the gateway 6 days non-stop. The gateway device was installed at the highest building in the campus. The distance of gateway device and node device is 834 m, 890 m, 1,100 m, and 1,140 m. Packet loss in this experiment was up to 90%. This was

caused by the gateway device installed near with 4G cellular base station. The transmission was interfenced by the transmission from 4G mobile communication

J Ren *et al*. [18] the authors were made a sailing monitoring system based on LoRa. This system can monitor the environment of sea and sailboat, including the speed and direction of wind and current, the location and attitude of sailboat. This system consists of two sink nodes and a gateway. Sink node is installed at the sailboat. Sink node will send the data to the gateway and gateway will receive the data. In the first case, the sink nodes and gateway will be moving with 400 m distance. In this case, the packet loss is 0.34%. In second case, the gateway was installed at 20 m high building and the sink nodes will moving. In this case, the packet loss is reach 63.26% at 3.4 km. The communication of this system still forms one way communication.

Brouwer *et al.* [19] the authors were made a sailing monitoring system based on LoRa. This system can monitor the environment of sea and sailboat, including the speed and direction of wind and current, the location and attitude of sailboat. This system consists of two sink nodes and a gateway. Sink node is installed at the sailboat. Sink node will send the data to the gateway and gateway will receive the data. In the first case, the sink nodes and gateway will be moving with 400 m distance. In this case, the packet loss is 0.34%. In second case, the gateway was installed at 20 m high building and the sink nodes will moving. In this case, the packet loss is reach 63.26% at 3.4 km. The communication of this system still forms one way communication.

Gutiérrez *et al.* [20] There have already been studies of end-to-end reliability in which their results have reflected a great reliability in simulations. Greenhouse agriculture is a methodology that helps to improve the quality of vegetables, fruits and crops using controlled parameters. The environment has controlled mechanisms using real-time data from sensors, and processing tools such as cloud computing to increase accuracy and efficiency.

Shengwei Lin *et al.* [21] defines the MAC communication protocol (Aloha based random access) and system architecture (start topology) for the network based on LoRa physical layer communication link. To support different applications, the nodes of Lora WAN are classified into three categories: Class-A node is battery-based sensor to save power consumption, Class-C is main-powered controller to continuously

listen the commands from Lora WAN gateway, and Class-B node is battery-based controller. For Class-A node, it will open two slots to receive the command or response from the gateway after it initiated a transmission to gateway. Thus, the gateway can communicate with a Class-A node only after the Class-A node transmitted a packet. Which means the communication time latency from gateway to Class-A node is unpredictable, and may not suitable for timesensitive controllers.

C Yoon *et al* [22]   IoT-based agriculture system has been proposed to provide automatic irrigation service. LoRa is very suitable for agriculture application due to its long-distance and lowpower characteristics. Nevertheless, since Lora WAN may cause transmission collisions (due to Aloha based MAC protocol) and long transmission latency from gateway to Class-A node, we employ an alternative and more cost effective TDMA-based MAC protocol (LoRa P2P) to construct the smart irrigation system.

Marco Centenaro *et al*. [23] suggest LoRa uses chirp modulation. LoRa is one of the wireless networks which provides services for Smart city applications and hence finds commercial interest all over the world. Smart city requires an existing cellular network like 4G/LTE/VoLTE for accessing internet to provide connectivity among the M2M devices. Machine Identification Module (M2M sim card) provides services to the M2M network from existing Mobile operators. Recent Research says 50billion devices will be connected in India by 2022 for smart city/village and smart home projects. The existing cellular network cannot provide service for this application. Marco et.al [15] introduced a new approach to provide connectivity in the M2M, LoRa and LPWANs are inherently different from usual IoT architectures, which are typically characterized by short-range links and mesh topology can be used long range links in smart city applications.

Pritesh Y Shukla *et al* [24] Current reviews and researches says that there is lack of consideration of water in smart village projects. Hence our research and product development concentrates on water which is an important thing for human life. The distribution of quality water in Urban and rural areas to consumers, general public are a challenging task. Since the water must travel through different areas and prone to get polluted from the environment. The requirements of water quality for agriculture, maximum concentration on irrigation water and saline water for livestock and poultry.

Kunwar P Singh *et al.* [25] proposed an IOT based water level monitoring system using Arduino with ethernet for internet connectivity. Since the proposed system can be suitable for prototype and cannot handle huge amount of traffic from a greater number of systems. Also, this system requires internet where the net connection is not available in most of the villages. The distribution of water and monitoring the quality of water is also done manually. Due to the manual process, huge man power is required and wastage of water in lots of places. In order to make the system automatic without the human intervention and to save the water an automated using Machine-to-Machine (M2M) with LoRa communication is proposed.

M Monica Subashini *et al*. [26]   The benefit of LoRa is its extended distance ability. It has a more economical connection than any other uniform communication technique. The general specification of LoRa technology can be summarised as: "Single Operating Voltage: 2.1V to 3.6V (3.3V typical), Temperature Range: -40°C to +85°C, Low-Power Consumption, Programmable RF Communication Bit Rate up to 300 kbps with FSK Modulation, 10937 bps with LoRa Technology Modulation, Integrated MCU, EUI-64 Node Identity Serial EEPROM, Radio Transceiver with Analogue Front End, Matching Circuitry, 14 GPIOs for Control and Status, Shared with 13 Analog Inputs, Low-Power Long Range Transceiver Operating in the 433 MHz and 868 MHz Frequency Bands, High Receiver Sensitivity: Down to -146 dB, up to 15 km Coverage at Suburban and up to 5 km Coverage in an Urban Area",

F Ganz et *al* [27] the authors proposed an IoT based agricultural devices which are portable hand-held devices to find the state of environment and soil. These devices consist temperature, humidity sensors, pH sensor, EC sensor and a colour sensor for both soil and environment and GPS, ZigBee modules for radio communication. The sensed data is sent to cloud service at regular intervals for analysis purpose.

Ravi Kishore Kodali *et al*. [28] Agriculture is a subject where water is needed in greater quantity. As a result of high crop yields, Oversight is an important job for farmers. Due to a variety of agricultural issues, further development is also urgently required and practical economic strategies for growing plants Wasteful water is a real issue in agriculture. During cultivation, the fields receive a larger amount of water. There are several strategies for saving or manipulating water waste in agriculture.

.   Kansara *et al*. [29]   This paper proposes to use a system to monitor the field data, which provides additional attention to the field. Make agriculture smart by embedding the IoT This document is intended for an intelligent irrigation system based mainly on ESP32 LORA. The video displays different environmental elements such as temperature, humidity and the amount of water required across crops, using sensors such as temperature, soil moisture and water flow.

C M. Devika *et al.* [30] The information is accumulated and given to the ESP 32 located in the farm that is linked to any other ESP32 located inside the variety of two to 9KM (variety may be advanced if an antenna with excessive benefit is used) via LORA protocol and the motor is controlled automatically by using moisture sensor and water flow sensor.

Andreev *et al. [31]*the LoRa modulation is a proprietary spread spectrum method based on chirp spread spectrum modulation, which uses wideband linear frequency modulated pulses whose frequency increases or decreases over a certain amount of time. First, this makes LoRa resistant against multipath fading and Doppler effect. Also, this improves receiver's sensitivity due to the respective processing gain of the spread spectrum technology and gives tolerance to the frequency mismatch between a transmitter and a receiver. The chip rate is equal to the programmed bandwidth (chip-per-second-per-Hertz) and can take values of 125, 250 or 500 kHz. Moreover, the spreading factor (SF) for a LoRa link may be varied depending on the communication distance and desired on-air time. Since the spreading codes for different SFs are orthogonal, the simultaneous transmission in the same frequency channel using different SFs is possible. Interference problems are mitigated by employing the forward error correcting codes in combination with frequency hopping spread spectrum (FHSS). In total, ten channels with different bandwidths are available for LoRa in the EU 868-870 MHz ISM band.

Galinina *et al.* [32] tells major applications foreseen for LPWAN are the automotive and intelligent transportation systems, although there is much in common between the traditional wireless sensor network (WSN) and an LPWAN, especially in respect to the requirements for networks and devices, there are few critical differences in their approaches. The first and the major difference is that unlike the traditional WSN which employ mesh or ad-hoc topology, all the current LPWAN technologies

require setting up the base stations (concentrator/gateway) to serve the end-devices. The latter communicate only to the base stations, thus forming a star network around them. Depending on the technology, the coverage area of one base station may span over dozens of kilometres.

Z. Rasin *et al*. [33] suggest that by using lora along with new techniques helps the crop yield is increased to some level and man power also reduced but ESP8266 turned into used like an extension to Arduino to ship the information over the WIFI protocol without connecting it to the internet. GPRS and GSM indulge more price from the carrier provider. ZigBee is an outdated protocol

H. Van et al. [34] describes that Smart irrigation is emerging as new scientific disciplines that use data-intensive methods to increase agricultural productivity while reducing its environmental impact. Modern agricultural operations generate data from a variety of sensors, leading to a better understanding of both the operation environment and the operation activities. This enables more accurate and efficient decision-making. In addition, this allows optimizing resources and achieving the intended objectives from this sector. The water is conserved when implementing these technologies in irrigation systems.

Popa *et al*. [35] The LoRa data are hashed with high-frequency pulses to produce a signal with a frequency range higher than that of the original data (i.e., chipped). The high-frequency signal is then encoded in chirp signal chains, which are sinusoidal signals whose frequency changes over time. The two types of chirp signals are up-chirp and down-chirp. The frequency of up-chirp increases with time, whereas that of down-chirp decreases with time. According to the principle of encoding, bit 1 uses up-chirp, and bit 0 uses down-chirp before transmitting to the antenna for sending. This principle helps reduce the complexity and accuracy of the receiver circuit and outperform traditional modulation schemes, such as frequency shift keying [Moreover, LoRa has many advantages such as CMC, 2021, vol.68, no.2 1617 frequency-free operation and easy instalment. It can also be deployed on a large scale owing to its simple architecture and integrated with two security layers: one at the network layer and the other at the application layer with AES encryption. Using the LoRa technique can solve the problem of coverage expansion of WSNs.