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A Comprehensive Review on IoT Implementations Using Raspberry Pi

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Abstract:- People have been more accepting of various types of personal computers, such as desktop computers, laptops, tablets and smart phone's, during the last few decades. The RPi Foundation was formed in 2012 by Ebon Upton, who released the RPi as a $35 entry-level computer. The RPi is a small single-board computer about the size of a credit card. The RPi is a low-cost computer that can be programmed and customized in ways. Because it can do almost everything a PC can, the Raspberry Pi has earned the monitor "a computer built to recreate the planet". Automation is a fascinating issue that has progressed with new technology and is now acknowledged as a key component of the "Internet of Things" (IoT) concept. Because of the Internet of Things (IoT), everything can communicate with everything else IoT. IoT is quickly becoming a serious platform for a variety of services and applications. Each device has a low-bandwidth Internet connection, which enables the entire system to interact and communicate in ways that promote safety, security, and luxury. The information is stored in a huge database that is only accessible to individuals who have been granted permission to read it on a website. Patient data is sent from medical equipment to the internet of things through a gateway, where it is stored and analyzed.

Keywords:- *The Internet of Things (IoT), Raspberry Pi (RPi).*

I. INTRODUCTION

In our daily lives, technology is increasingly vital. Technology has changed our lives in a variety of ways. The advent of computers and the internet has ushered in a global revolution. In today's world, people rely largely on computers and the internet to carry out their daily tasks. The term "Internet of Things" (IoT) was coined in 1982 to describe the connecting smart devices. During a speech to the Congressional Black Caucus Foundation in Washington, D.C., he said: The term "Internet of Things" (IoT) was invented by Peter T. Lewis in 1985. Kevin Ashton was dubbed the "Father of IoT" for coining the term "Internet of Things" (IoT) in 1999.Kevin Ashton emphasizes the significance of integrating short-range mobile transceivers into devices so that they can communicate with humans and other devices. Human-to-human, machine-to-machine, and human-to-machine interactions are all possible with the Internet of Things, and all of them can influence how we drive. Every day, new innovations of various kinds emerge in various locations around the world. The Internet of Things (IoT) is one such invention. It's received a lot of attention from all over the world and is now used in a range of industries. In recent years, the internet has grown in importance. As a result of the internet, sensors, and new technologies, ordinary objects have evolved into smart gadgets. The Internet of Things (IoT) is the term used to describe the interconnection of these smart devices.

II. LITERATURE SURVEY IoT

- *Based on Healthcare*

According to person, Surya Deekshith Gupta et al., monitoring the patient's vital signs, such as temperature, vital signs, and pulse rate, could be a critical aspect of the healthcare system. The Internet of Things (IoT) has had to a significant impact on the healthcare business, despite the major fact that is still a fresh revolutionary technological innovation. When new technological breakthroughs are linked to healthcare systems, a slew of new choices for improving patient care communication, decision support, and reducing inaccuracies emerge. The completed device might be used as a prototype for a healthcare system that tracks patient's vital signs. This strategy is simple to implement in any hospital, so the database can store a large amount of data [1].

Kumar and his colleagues developed a sensor that monitors to the patient's heart rate, blood temperature, movement and the breathing rate. The combination of Raspberry Pi with IoT has proven to be a game-changer in the realm of healthcare. Sensor data is collected by the Raspberry Pi and wirelessly sent to an IoT website. After that, go to the IoT website and search for this board's MAC address. The output of the sensors is then linked to the IoT website [2]. It is illustrated in Fig 1.

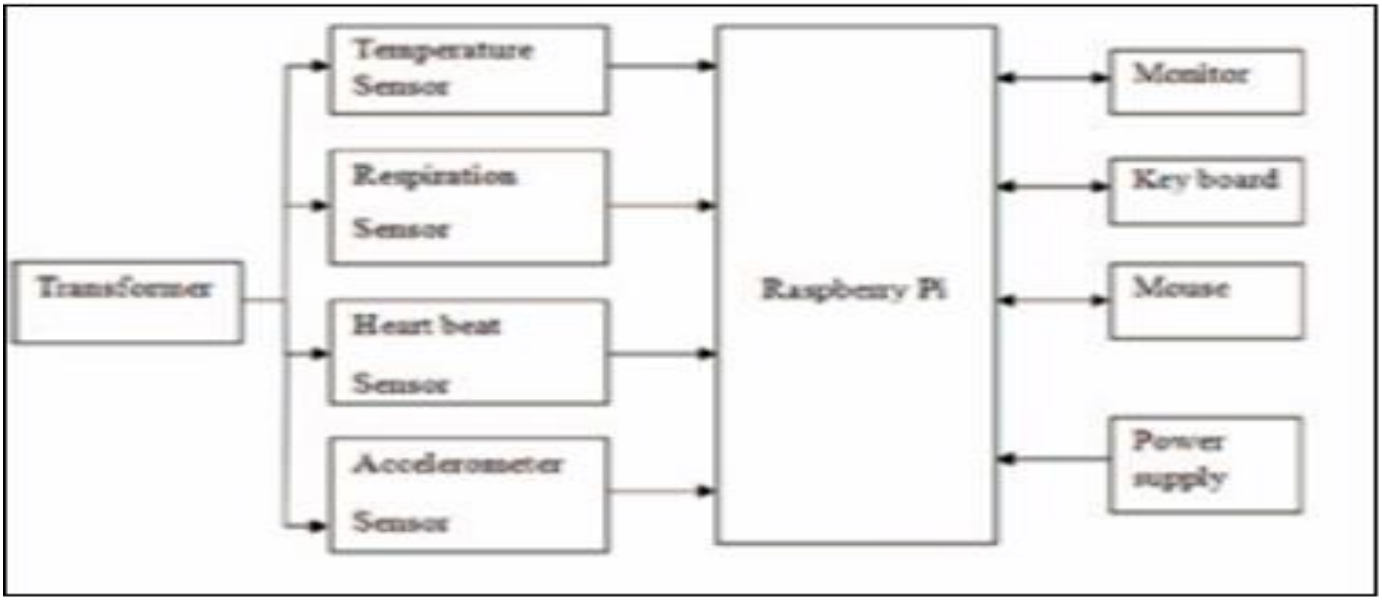

Fig 1 Block Diagram of Patient Monitoring System Using Raspberry Pi.

Vivek Pardeshi and colleagues exhibited a health monitoring system that uses GSM (2G/3G/4G) technology to detect a variety of biological signs such as pressure, temperature, heart rate, and ECG before transferring the data to an IoT server. GSM technology or the internet's are frequently used to track and transmit changes in an individual's health. In the event of an emergency, doctors and family members will receive automatically created alerts if any unexpected behaviour is seen by or around the patient. The LM35 temperature sensor is used to determine the temperature of the skin's surface. Advances in management technology can assist individuals in avoiding future health problems and physicians in taking the appropriate steps [3].

- *Based on Home Automation*

Smart gadgets that monitor physical events and turn them into a stream of knowledge, according to Vladimir Vujović et al., maximize safety, security, comfort, convenience, and energy savings. Instead of traditional sensor elements, sensor web components are used to quickly migrate the communication infrastructure from local to global, bringing the BMS with it. In the context of home automation, the use of IoT technology entails the integration of all electrical devices, as well as monitoring, control and alerting in previously imagined ways. The challenges of adaptation and functionality were solved by developing a one-of-a-kind, solitary, flexible, and low-cost home controlling and monitoring system based on restful web services [4].

Shrikrushna Khedkar and her colleague's device a system that is completely focused on the interaction of electrical equipment in the home. Everything from lighting control systems to home entertainment systems to yard watering and irrigation systems is covered by home automation. Home automation has been increasingly popular in recent years as a result of its low cost. Around 50 billion devices are linked to the internet. A centralized controller that controls lighting, HAVC (Heating, Ventilation, and Air Conditioning), and security locks on gates, doors, and other systems can be included in home automation [5].

Shakthi Murugan K.H and the rest of her crew many applications, such as biometrics, have become increasingly automated as a result of advances in information technology. As home security systems become more popular, mobile device functions have become increasingly vital. We describe a closed-circuit television system that detects motion in each frame in real-time. The system sends the user an SMS message when motion is detected within the designated location, and the video begins recording until the motion stops. Real-time video processing and a Raspberry Pi system using open CV (Computer Vision/Machine Vision) technology are used to accomplish this [6].

In their field, Ashwini Pawar and her teammates are experts. The Internet of Things (IoT) is a type of machine-to-machine communication in which we link things or devices to a platform and disseminate data between them via the platform we use to connect them to our computer/laptop/mobile via the internet. During this post, we discussed fire safety, door security, glass break alarms, and gas leakage prevention. A PIR sensor, MQ2 sensor, vibration sensor, flame sensor, and magnetic sensor are all included with the Raspberry Pi board [7].

Using machine learning technology, Chen-Yen Penget and colleagues designed architecture for a completely new intelligent family service for users. Its mission was to create a machine learning model that merged Google Home with Google Assistant Personal Voice Assistant. The solution, which includes a Raspberry Pi and a practical Bluetooth socket, is particularly useful for full smart home control using machine learning and Google Home voice commands [8].

Rutuparnna Mishra and her colleagues devised a method for gaining access to a computer by photographing your face. Every person has a distinct facial identity. In this situation, the retrieved characteristic is used as a passkey, and it is compared to the database. The system's main goal is to use the CNN approach to detect faces. The system is taught to recognize only authorized personnel's face and to report

trespassers using Convolutional Neural Network (CNN) technology [9]. The artificial neural network model as illustrated in Fig 2.

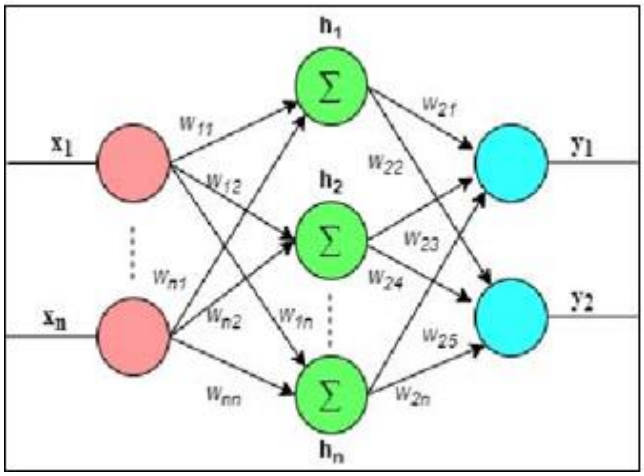

Fig 2 Artificial Neural Network Model

B Varshini and colleagues created a gadget that can identify and monitor face masks as well as blood heat, which could improve public safety. This could lower personnel needs while also adding another layer of protection against the spread of Covid-19 infection. The most effective means to prevent transmission are face masks and hand sanitizers. This has aided in the prevention of disease spread. Accurately recognize people wearing or not wearing facemasks as well as activate and log alarms [10]. It is illustrated in Fig 3.

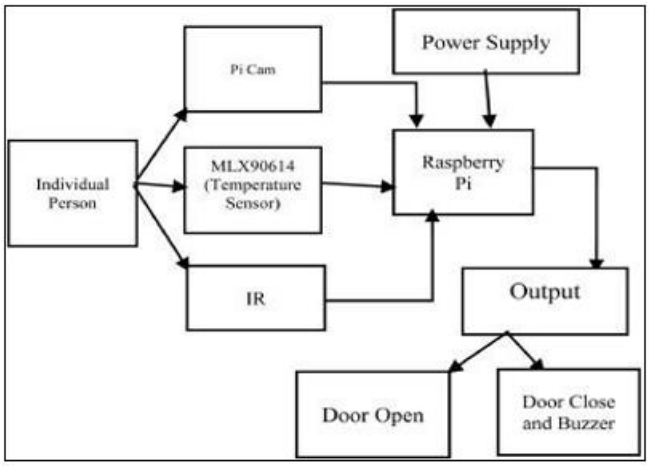

Fig 3 Overall Architecture Diagram of IoT Enabled smart Doors for Monitoring body Temperature and face mask Detection.

Using LBPH and neural network, Jayanta Paul and his colleagues developed a face detection recognition solution for the door-lock system. In the detection procedure, template matching and neural networks are frequently used. In terms of accuracy, neural network techniques exceed the competition. When compared to a simple LBPH- based model, LBPH Fully Connected Facial Authentication (LBPHFCFA) improves biometric recognition accuracy while accounting for the simpler match. Although LBPHFCFA is slower than LBPH-based design in detecting faces the precision compensates [11].

➢ *Based on Environments*

N Vijayakumar et al. propose a system that monitors the physical and chemical qualities of water using an excessive number of water quality parameter sensors. Temperature, PH, turbidity, conductivity, and dissolved oxygen can all be measured using a Raspberry Pi B+ core controller and an IoT module (USR WIFI 232). These gadgets are less expensive, more efficient, and have the ability to process, analyze, send and display data. This technology will be used to monitor the environment, ecosystems, and other aspects of life, with data accessible from anywhere on the planet [12]. It is illustrated in Fig 4.

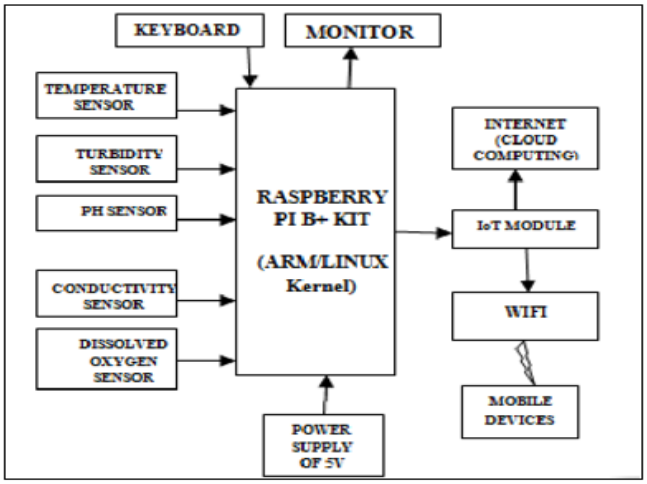

Fig 4 Overall block Diagram of the Real-time Monitoring of water Quality in IoT Environment.

Somansh Kumar and his team developed a self-contained real-time air quality monitoring system that has the following features: PM 2.5, monoxide, carbon dioxide, temperature, humidity, and air pressure are all monitored using the Raspberry Pi, a low-power, low-cost, and highly programmable minicomputer. It's also a plus to be able to work with multiple instruments at the same time. The IoT cloud system demonstrates how to design, configure, and use an API to gain access to IoT resources and capabilities from the cloud. Cloud computing is a practice of consuming the resource of remote servers such as storage, virtual machines, applications and utilities that are hosted on internet rather than building and maintaining infrastructure for computing in house [13]. The simplified diagram as illustrated in Fig 5.

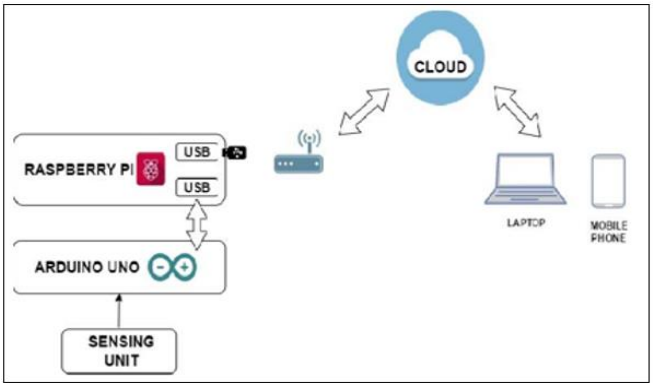

Fig 5 Simplified Diagram of Air Quality Monitoring System.

Agricultural irrigation systems with low-complexity circuits were created by Nageswara Rao et al. The temperature and moisture of the soil within the circuit are required for the system to deliver calibrated data. All three nodes are successfully interfaced with two sensors and two Raspberry Pi microcontrollers. This technology allows the irrigation system to be completely automated while simultaneously providing farmers with real-time data on their fields and crops, allowing them to make the most informed decisions possible. Threshold values may vary depending on the crop and its environment [14]. It is illustrated in Fig 6.

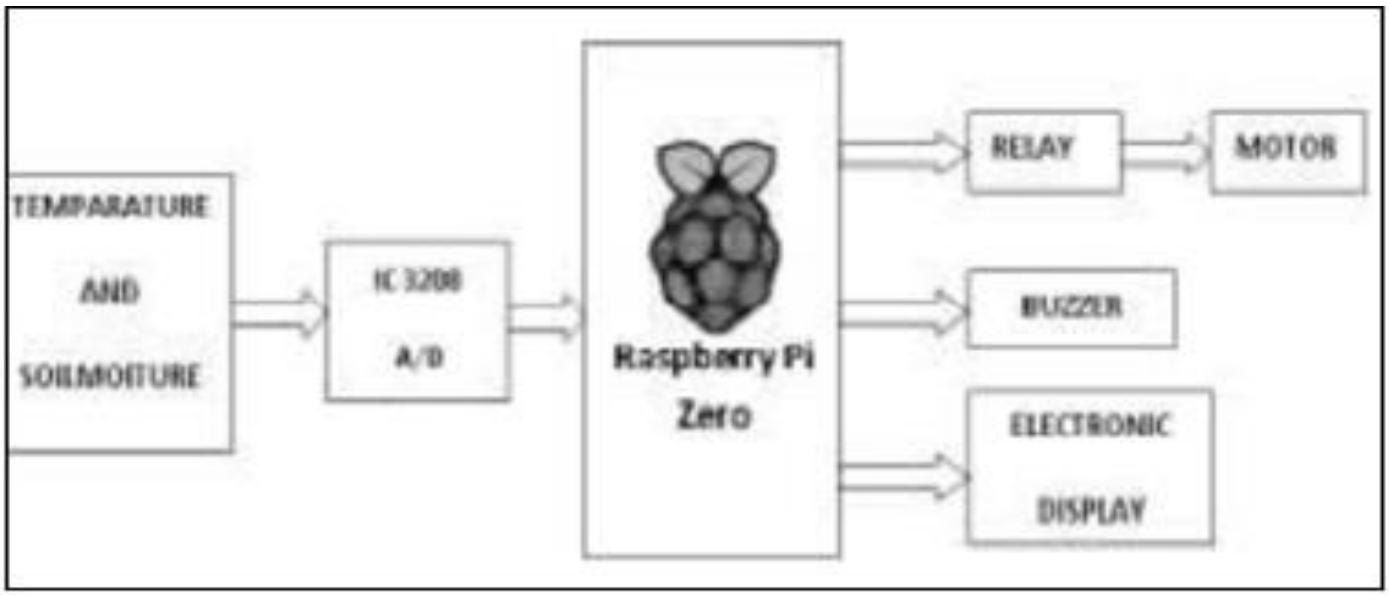

Fig 6 Block Diagram of IoT based Automatic crop field Monitoring.

Mr. Dattatraya Shinde and colleagues demonstrate how to monitor soil quality using wireless sensor nodes. I created a simple Raspberry Pi 3 circuit that continuously monitors and reads temperature, humidity, soil moisture, and sunlight in a normal environment, all of which are updated and maintained daily to allow for optimal plant growth. In addition to the numerous values gathered from the various sensors, an LCD displays the status of the various devices. This system is tested in various greenhouse environments &satisfactory observations were found. The controlling device action is also noted and mostly it is seen that quality and productivity of crops is much better than that of crops growing without controlling actions. The time taken by each controlling device is noted which is beneficial for farmers for estimation of total power consumption & total expenditure per year for specific crop [15]. It is illustrated in Fig 7.

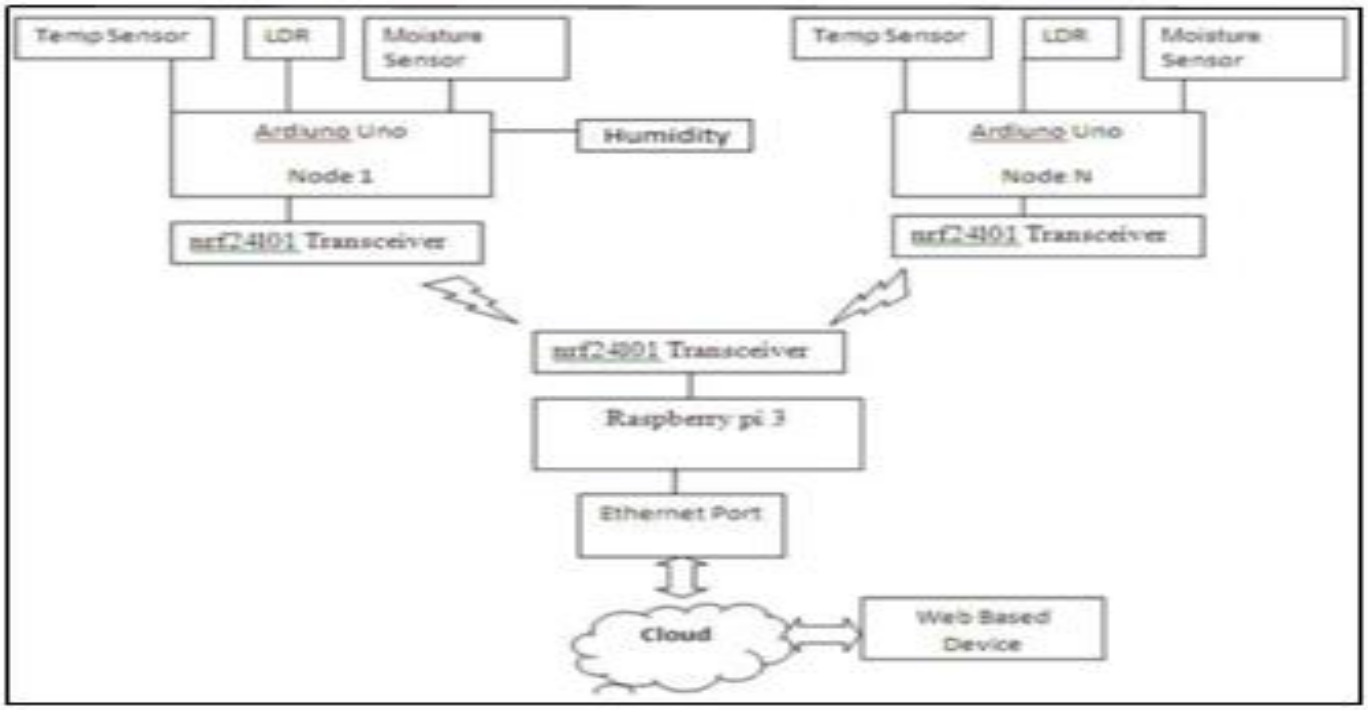

Fig 7 Greenhouse Monitoring and Controlling System

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To calculate the load of the dustbins, Miss Megha S. Chaudhari et al. uses a Raspberry Pi Uno microcontroller coupled to a GSM modem, an ultrasonic sensor, and a weight sensor. The ultrasonic sensor is put on the top of the trashcan to monitor its state, while the load sensor is mounted on the bottom of the trashcan to monitor the load. When the trash bin is full, the Raspberry is set to show the height remaining from the edge height. An expert will send a message to the location's unique administrator [16]. The system architecture as displayed in Fig 8.

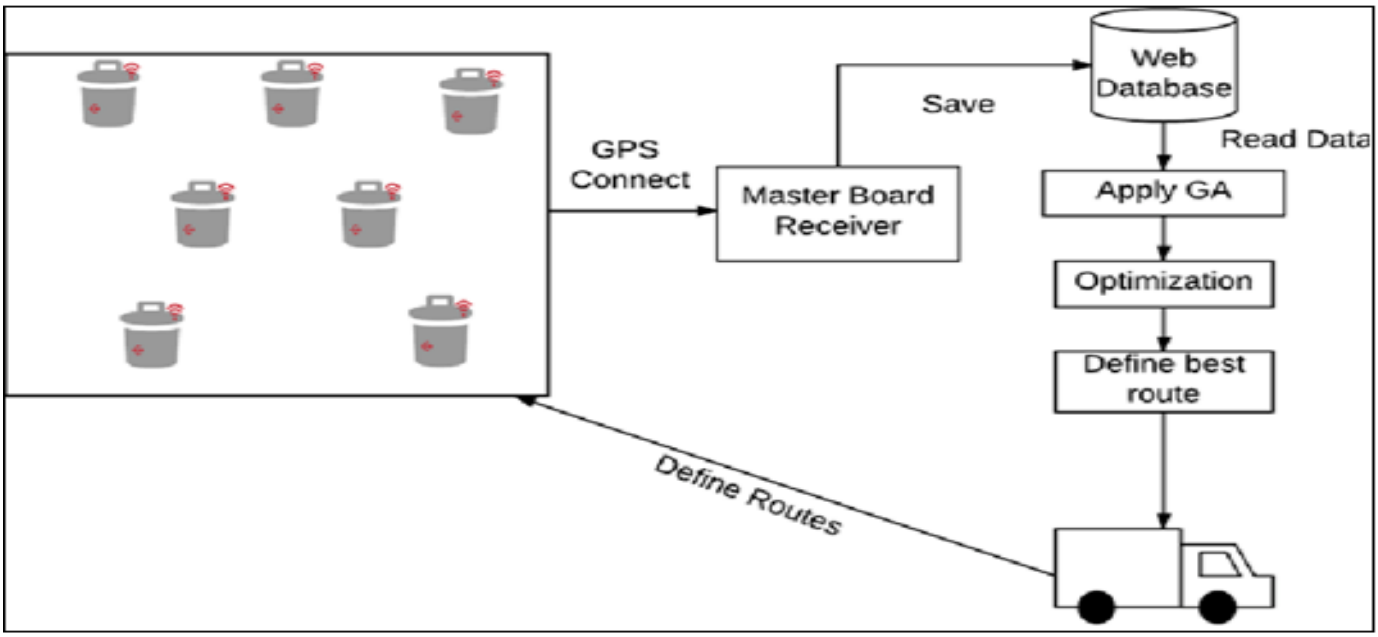

Fig 8 System Architecture of IoT based waste Collection Management System for Smart Cities.

Shunmuga Sundari.M and colleagues created an IoT based greenhouse system that measured temperature, humidity, and CO2 levels as well as analyzed plant health. A image inspection component is included in the proposed system, which acquires, analyses, segments, and categorizes plant health. Open CV is used to analyze the photographs on the Raspberry Pi. The illness information is shared with farmers and agriculture specialists for further investigation. The MCU MSP432 uses relays to control the actuators and motors when certain threshold values are reached. Data security is another important issue that can be handled by using XTEA in 32-bit microcontrollers and Raspberry Pi. Agriculturists can use the autonomous framework to monitor and control the ecology of their greenhouses from afar [17]. The general architecture diagram as illustrated in Fig 9

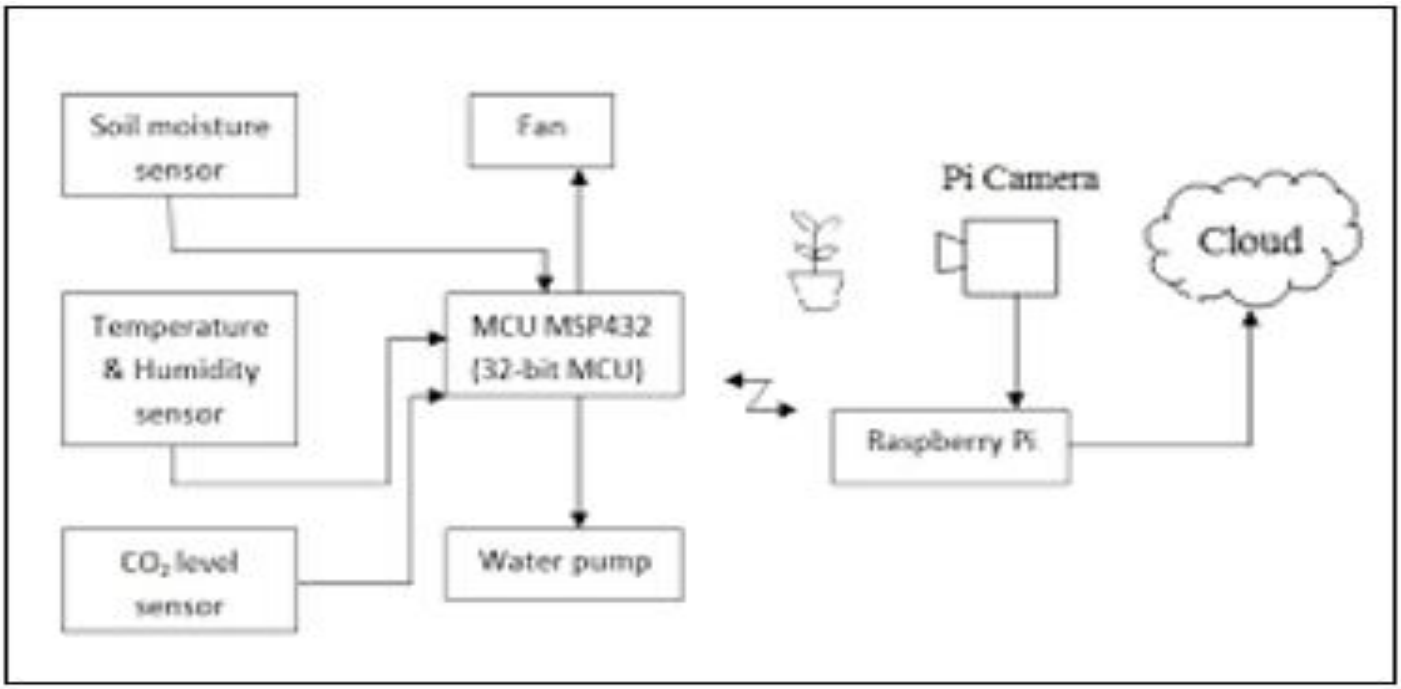

Fig 9 General Architecture Diagram of Secured IoT Based Smart Greenhouse System with Image Inspection

Poornaiah Billa et al. recommended keeping track of weather and soil conditions, as well as selecting crop varieties based on climatic and soil characteristics. This technique stresses the procedures that must be eliminated in order to maximize crop production by exhibiting images of plants. Animal attacks, diseases, and pests, among other things, are depicted in the picture of plants. The IoT based system proposed in this paper might be a complex system that could be made even better by making it mobile and combining a variety of applications to increase agricultural yield [18].

Shavarsidha Gunde et al. proposed automatic water pumping. A low cost ultrasonic sensor is used to control the water level. A submersible pump prevents pump cavitations by being completely submerged within the tank. This strategy can also alert the user to SMS messages and, as a result, the availability of cloud data. Because there is a global shortage of drinkable water, using an autonomous water pumping system is a good concept. The system's efficiency is expected to be around 95%. As a result, water may be used more efficiently. As a result, there is less water waste [19].

- *Based on Cloud Service*

Aamir Nizam Ansari et al. presented a security alarm that leverages the Internet of Things (IoT) to monitor and receive alarms when motion is detected, similar to how images and movies are uploaded to a cloud server. An IoT based application may be used to monitor activities and send messages when motion is detected. When the cloud is down, the images and movies are saved locally on the Raspberry Pi and then shared once the connection is restored [20]. The project's architecture is displayed in Fig 10.

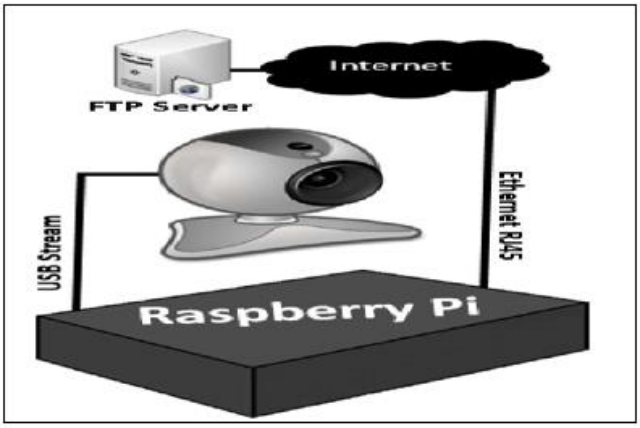

Fig 10 Project Architecture of an Internet of Things Approach for Motion Detection Using Raspberry Pi.

According to Dhvani Shaha et al, biometrics can take advantage of the cloud's limitless computational resources, as well as its notable properties of flexibility, scalability, and cost reduction, to reduce the cost of biometrics system computational resources and improve the performance of biometrics systems processes. The goal is to create a low-cost biometric system that uses a low-cost wireless enrolment node and a cloud-based biometric service for authentication. The capture peripherals on the Raspberry Pi have been verified [21].

According to Prachi H. Kulkarni et al, the cornerstone of an IoT device is an autonomous industrial meter reader that uploads obtained numerical data to cloud storage for centralized processing. The Raspberry Pi serves as the device's implementation platform. A Raspberry Pi camera module handles image capture, a feature extraction algorithm handles optical character recognition, Google forms handles internet upload, and a Google spreadsheet handles online processing [22].

Neha Patil and her team are working on a low-power IoT based safety alert that can detect and indicate gesture or other activities before sending photographs to a cloud server. When gestures or other indicators are present, IoT-based use is frequently used shakily to monitor actions and receive alerts. Credit-card-sized Raspberry Pi running Open Source Computer Vision (Open-CV) software handles image processing and focus techniques, after which it transmits images to concerned people through email via the Wi-Fi module. A standard webcam is used in this strategy [23].

A controlling unit, memory, sensor or sensor network are all part of a typical data logger system created by Paresh Nasikkar et al. Implementation of a mechanical engine data logger system that serves as a defect diagnostic system and logs data on a web server for remote access. The data is stored in the cloud and may be accessed from anywhere. Because the target device may be an ICE, data is frequently acquired from it, regardless of its location [24].

Satbir Singh and colleagues developed an artificially intelligent traffic control system. For traffic flow control, the number of cars passing via a passage near active traffic congestion zones is frequently recorded in an impression station. The city's traffic congestion node can broadcast timely gathered information over the web and cloud to limit vehicle intake. This looks to be a low-cost, portable solution of minimizing crossing traffic congestion during rush hour [25].Systematic flow diagram of the image processing operations as illustrated in Fig 11.

Fig 11 Systematic flow Diagram of the Image Processing Operations for Obtaining the Count of the Present Vehicles

➢ *Based on Camera System*

Prottasha Ghosh and her colleagues developed a one-of-a-kind IoT-based evidence gathering device to ensure the safety and security of young women. A Raspberry Pi, a flex sensor for turning the device on by human hand motion, a buzzer for immediate alarm, a camera for catching objects, and a GPS and GSM module for tracking the location and sending SMS make up a nice automatic running security gadget. The Raspberry Pi module and a GSM module were used to send SMS to the chosen numbers and track the victim's location. As a result, whether the evidence is defective or not will be a point of contention [26].

Bandi Narasimha Rao and his colleagues created portable surveillance cameras that might be used to monitor regions where humans aren't allowed, perhaps saving lives. It will be brought to any site thanks to the motor driver. It's possible to discern the difference between a variety of woodland animals. A camera that records video and take photos while moving in various directions. The built-in online browser is frequently used to control the motor's direction. The design includes a webcam that may be used to snap pictures and record videos [27].

A security and monitoring approach is proposed by Saurabh Singh Rajawat and colleagues. A Raspberry Pi-3 model, a PIR sensor, a Raspberry Pi-3 camera, a thumb drive and a WIFI adapter are used in this project. Thumb drive devices are used to store captured images and recorded films. Even in low light, the device will detect movement via the sensor and send a signal to the Raspberry Pi computer, which will activate the camera and take an image of the individual. We're particularly intrigued by the device's ability to take images in low light and at night [28].

With a camera setup, Ken T. Murata et al. showed a Raspberry Pi-based edge computing development environment. On the Raspberry Pi, the HpVT video transmission protocol is built for use on 4G LTE mobile networks. A variety of surveillance camera systems use the HpVT programming environment. These examples demonstrate how to use the Raspberry Pi and the HpVT environment to create visual IoT systems for security, the environment, medical and healthcare, and home automation [29].

Sushrut Nagesh Kulkarni et al. presented a comprehensive method for offering an automatic item sorting solution in the same way that information (number of various objects) is stored in a SQL database for further examination. Our objective is to assess its utility and effectiveness as a mechanical object sorting mechanism. OpenCV (Open Source Computer Vision) is a programming library for real-time computer vision. The motor driver is taught to govern the servo motors that may assist in driving the object to the desired sorted region using the processed information in OpenCV Human effort is reduced when automated is used in a system that incorporates object sorting based on colour and form resulting in enhanced accuracy as well as time and money savings [30].

Vaishnavi Mande and colleagues devised a method for autonomous video processing based on the Raspberry Pi, which was assisted by the Internet of Things (IoT). Video processing is an important component of video communication innovation, and it is influenced by factors such as video quality, data loss, model cost-effectiveness, ratio, and fog. Humidity/fog sensors ensure that there are no problems in areas with a high humidity ratio or foggy circumstances. Businesses can save time and money by using video communication. As a result, all video conferencing issues have been resolved [31].

➢ *Based on Robot*

Zhi-ping SUN et al proposed a Raspberry Pi as the nuclear core processor to be used within the IoT of the family embedded robotic system, used 802.11g and TCP/IP, HTTP to achieve infinite distance signal transmission, and adopted the H264 video coding scheme for real-time monitoring of video image signal coded, and decoded RTP/RTCP for video streaming transmission, and used C/S architecture, B/S architecture, and also the database designer with the server to make that the security reliability of the robot [32].

Sai Subramanya Vamsi Chavali and others, our goal is to make it easier to move data from one mobile object to another by using lossy or lossless data compression techniques. Additionally, as a mobile semi-autonomous robot that travels to far regions to transmit and receive data, proposes and develops Discrete Cosine Transfer (DCT) and Inter-Process Communication (IPC). An IPC is in charge of receiving and transferring data. Network layers facilitate IPC by allowing precise interaction between numerous objects. In military and coal mining applications, our proposed robot-based strategies could improve accuracy and bandwidth utilization [33].

➢ *Others*

The most serious issue, according to Bekaroo Girish and his colleagues, is that each of those computers requires electricity to operate, making ICT a power hog. Recent computers different activities, such as communication and web browsing, have been shown to be critical components that influence their power utilization. As a result, it's critical to investigate the capacity to consume ICT devices such as desktop computers, laptop computers, tablets, and smart phones, especially since the Raspberry Pi was just released (RPi).The Raspberry Pi facility usage was evaluated in relation to the primary operations that end users can do on the platform [34].

Youssefi Ziad and his associates. Although the Raspberry Pi has grown in popularly among the general public and college students for do-it-yourself projects and maker culture, educators have yet to use it to teach software fundamentals. Linux was chosen since it is the operating system of choice for student programming projects. The Raspberry Pi 3 has four core processors, and its Linux package is designed to demonstrate concurrency and multi-threading, both of which are important concepts in the operating system class. If students have their own Raspberry

Pi, they will experiment with designing and integrating their own OS components using open-source Linux [35].

According to M Narayana Murthy et al. the office automation system includes of electrical equipment such as air conditioning, lights, blowers, and low machines. An office automation system's client and server sides are the two most important components. On the client-side, the Raspberry Pi and four relay channels are present, and the Raspberry Pi IP address is linked to an HTML online page on the server side that displays the office temperature value regularly [36].

Branko Balon Raspberry Pi computers are being considered for usage in secondary and post-secondary schools, along with the rest of the team. The Raspberry Pi, which is about the size of a credit card, is a small computer with a lot of power. The Raspberry Pi Foundation, a non-profit whose main goal is to reintroduce computer skills to students, designed it without a doubt. Because it is the most recent edition of the world's most popular single-board computer, we chose the Raspberry Pi 3B for educational purposes. Students are taught through example and encouraged to approach challenges in novel ways. Conclusion: This is a fantastic chance for young people to learn new engineering science and electrical skills [37].

Mani Dheeraj Mudaliar and colleagues describe energy saving in a variety of methods. However, it is necessary to look at the industry's history and present energy habits to put in place appropriate energy conservation measures. The switch gear manufacturer has opted to build an efficient energy monitoring system to watch and analyze day-to-day energy usage as the first step toward energy conservation programmers. This technology is extremely useful for analyzing corporate daily energy trends and implementing energy conservation measures in the future in order to run the business at a lower cost and with more efficient power consumption [38].

Rabea Cheggou and colleagues presented an intelligent system that allows parents to monitor their children remotely or locally via an online application. The goal of this solution is to provide parents with a smart, user-friendly, and cost-effective technology for infant monitoring. It's also worth mentioning that our technique might come in helpful in a medical environment. Implement a sophisticated baby monitoring system that will detect the infant's screams and movements in his cradle, as well as monitor his room's temperature remotely and in real-time. This technique employs a convolutional neural network to detect and analyze the baby's condition in his cradle in order to improve its efficiency [39].

Sun Yong et al created a number controller with the Raspberry Pi as the main control chip and an STM32F030C8T6 microcontroller as the secondary control chip. Using intelligent voice control, smart mirrors can achieve full speech control from any cast music, chat, or broadcast. The extranet's API interface, which is connected to the network via WIFI, collects weather data, clothing index, time, date, and other data. At the same time, the desired information is displayed on the plasma display. The system is capable of face recognition, speech recognition, audio playing, the device of room lighting brightness, and switch status [40].

III. CONCLUSIONS

The Internet of Things (IoT) is a set of technologies that enable various goods and things to communicate with one another and use various network technologies. They will be able to provide high-quality and low-cost healthcare services to people by combining big data analysis, cloud computing, and technology. From any place, setup and operation are straightforward. This method saves time and money by reducing the amount of time spent manually sorting. The web of Things holds a lot of potential in terms of technological innovation and human ease. IoT has also proven to be advantageous and promising for emerging countries economic and industrial development. It is expected to have a significant impact on businesses and organizations in almost every industry around the world. As a result, regardless of their business specialism, most technology businesses strategic objectives are expected to include determining how to harness the IoT potential. Every connected device sends and receives data packets, necessitating trustworthy connectivity, storage, and security, as well as an exponential increase in the number of connected devices.

REFERENCES

[1]. M. Surya Deekshith Gupta and Vamsikrishna Patchava, Virginia Menezes, 'Healthcare based on IoT using Raspberry Pi' 2015 International Conference on Green Computing and Internet of Things (ICGIOT).
[2]. R. Kumar and Dr.M.Pallikonda Rajasekaran 'An IoT Based Patient Monitoring System Using Raspberry Pi' 2016.
[3]. Vivek Pardeshi, Saurabh Sagar, Swapnil Murmurwar, and Pankaj Hage, 'Health Monitoring Systems using IoT and Raspberry Pi – A review' International Conference on Innovative Mechanisms for Industry Applications (ICIMIA 2017).
[4]. Vladimir Vujovic (2015), 'Raspberry Pi as a sensor web node for home automation' Volume 44 Pages 153-171.
[5]. Shrikrushna Khedkar and Dr.G.M.Malwatkar, 'Using Raspberry Pi and GSM Survey on home automation' International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT) – 2016.
[6]. Shakthi Murugan.K.H1, V.Jacintha, and S.Agnes Shivani 'Security System Using Raspberry Pi' 2017 Third International Conference on Science Technology Engineering and Management (ICONSTEM).
[7]. Ms. Ashwini Pawar and Prof. V. M. Umale, 'Internet of Things Based Home Security Using Raspberry Pi' (2018).

[8]. Chen-Yen Peng and Rung-Chin Chen, 'Voice Recognition by Google Home and Raspberry Pi for smart socket control' 2018 Tenth International Conference on Advanced Computational Intelligence (ICACI) March 29-31, 2018, Xiamen, China.
[9]. Rutuparnna Mishra, Anshit Ransingh, Manoj Kumar Behera and Chakravarty, Senior Member IEEE, 'Convolutional Neural Network Based Smart Door Lock System' 2020 IEEE India Council International Subsections Conference (INDISCON).
[10]. B Varshini, HR Yogesh, Syed Danish Pasha, Maaz Suhail, V Madhumitha and Archana Sasi, 'IoT Enabled smart doors for monitoring body temperature and face mask detection' (2021).
[11]. Jayanta Paul, Rajat Subhra Bhowmick, Baisakhi Das and Biplab K Sikdar, 'A Smart Home Security System In Low Computing IoT Environment' (2021).
[12]. N Vijayakumar and R Ramya, 'The Real-time monitoring of water quality in IoT environment' 2015 International conference on circuits, Power and Computing Technologies [ICCPCT-2015].
[13]. Somansh Kumar and Ashish Jasuja 'Air Quality Monitoring System Based on IoT using Raspberry Pi'.
[14]. R. Nageswara Rao and B. Sridhar, 'IoT Based Smart Crop-Field Monitoring and Automation Irrigation System' Proceedings of the Second International Conference on Inventive Systems and Control (ICISC 2018) IEEE Xplore Compliant – Part Number: CFP18J06-ART, ISBN: 978-1-5386-0807-4; DVD Part Number: CFP18J06DVD, ISBN: 978-1-5386-0806-7.
[15]. Mr. Dattatraya Shinde and Prof. Naseeem Siddiqui, 'IoT Based Environment change Monitoring and Controlling in Greenhouse using WSN 2018 International Conference on Information, Communication, Engineering and Technology (ICICET) Zeal College of Engineering and Research, Narhe, Pune, India Aug 29-31, 2018.
[16]. Miss. Megha S. Chaudhari, Mrs. Bharti Patil, and Mrs. Vaishali Raut, 'IoT based waste collection management system for smart cities: An overview' Proceedings of the Third International Conference on Computing Methodologies and Communication (ICCMC 2019) IEEE Xplore Part Number: CFP19K25-ART; ISBN: 978-1-5386-7808-4.
[17]. Shunmuga Sundari.M, Mathana. J.M and Nagarajan. T.S, 'Secured IoT based smart greenhouse system with image inspection' 2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS).
[18]. Poornaiah Billa, K Venkatesh J. Venkata Sai, K. Lohith and A. Sampath Kumar, Effective monitoring and protecting system for agriculture farming using IoT and Raspberry Pi (2021).
[19]. Shavarsidha Gunde, Prof. A.K Chikaraddi, and Dr. V.P Baligar's 'IoT Based Flow control system using Raspberry Pi' International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS – 2017).
[20]. Aamir Nizam Ansari, Mohammad Sedkyl, Neelam Sharma, and Anurag Tyagi, 'An Internet of Things approach for motion detection using Raspberry Pi' 2015 International Conference on Intelligent Computing and Internet of Things (ICIT).
[21]. Dhvani Shaha and Vinayak Bharadib, 'IoT based Biometrics Implementation on Raspberry Pi' 7th International Conference on Communication, Computing and Virtualization 2016, Procedia Computer Science 79 (2016) 328-336.
[22]. Prachi H. Kulkarni1 and Pratik D. Kutel, V. N., 'IoT based data processing for automated industrial meter reader using Raspberry Pi', 2016 International Conference on Internet of Things and Applications (IOTA) Maharashtra Institute of Technology, Pune, India 22 Jan -24 Jan 2016.
[23]. Neha Patil, Shrikant Ambatkar and Sandeep Kakde 'IoT based smart surveillance security system using Raspberry Pi' International Conference on Communication and signal processing, April 6-8, 2017, India.
[24]. Tanaya Tavade and Paresh Nasikkar, 'Raspberry Pi: Data Logging IoT device' 2017.
[25]. Satbir Singh, Baldev Singh, Ramandeep, Baljit Singh and Amitava Das, 'Automatic vehicle counting for IoT based smart traffic management system for Indian urban settings'.
[26]. Prottasha Ghosh, Tanjim Masroor Bhuiyan, Muhib Ashraf Nibir, Md. Emran Hasan, Md. Rabiul Islam, Md. Rob Hasan and Tanvir Hossain, 'Smart security device for women based on IoT using Raspberry Pi' 2021 2nd International Conference on Robotics, Electrical and Signal Processing Techniques (CREST).
[27]. Bandi Narasimha Rao, Reddy Sudheer, Mohan Aditya Sadhanala, Veerababu Tibirisetti, and Sairam Muggulla, 'Movable surveillance camera using IoT and Raspberry Pi' (2020).
[28]. Saurabh Singh Rajawat, Subhranil Som and Ajay Rana, 'IoT Based Theft Detection Using Raspberry Pi' 2020 8th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO) Amity University, Noida, India. June 4-5, 2020.
[29]. Ken T. Murata, Praphan Pavarangkoon, Somnuk Phon-Amnuaisuk, Takamichi Mizuhara, Kazunori Yamamoto, Kazuya Muranaga, and Toshiki Aoki, 'A Programming Environment for Visual IoT on Raspberry Pi'.
[30]. Sushrut Nagesh Kulkarni and Sanjay Kumar Singh, 'Object Sorting Automated System using Raspberry Pi' Proceedings of the International Conference on Communication and Electronics Systems (ICCES 2018).
[31]. Vaishnavi Mande and Mandar Lakhe, 'Automatic Video processing based on IoT using Raspberry Pi' 2018 3rd International Conference for Convergence in Technology (I2CT) The Gateway Hotel, Xion Complex, Wakad Road, Pune, India. Apr 06-08, 2018.

[32]. Xing-Qian LI and Yue ZHANG and Hongwei ZHAO, 'IOT Family Robot Based on Raspberry Pi' 2016 International Conference on Information System and Artificial Intelligence.
[33]. Abdul Razak, Sai Subramanya Vamsi Chavali, Sudeep good Malkapuram, and Suharsha Vommina, 'Trans Receiving Multimedia using Raspberry-Pi' International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT) – 2016.
[34]. Girish Bekaroo and Aditya Santokhee, 'Power Consumption of the Raspberry Pi: A Comparative Analysis' 2016 IEEE International Conference on Emerging Technologies and Innovative Business Practices for the Transformation of Societies (EmergiTech).
[35]. Ziad Youssefi 'Making Operating Systems more Appetizing with the Raspberry Pi'2017.
[36]. M Narayana Murthy and P.AjaySaiKiran,' A Smart Office Automation System Using Raspberry Pi (Model-B)'Proceeding of 2018 IEEE International Conference on Current Trends toward Converging Technologies, Coimbatore, India.
[37]. Branko Balon and Milenko Simić, 'Using Raspberry Pi Computers in Education' MIPRO 2019, May 20-24, 2019, Opatija Croatia.
[38]. Mani Dheeraj Mudaliar and N. Sivakumar, 'IoT based real-time energy monitoring system using Raspberry Pi' (2020).
[39]. Rabéa Cheggou, Siham Si hadj's hand, Oussama Annad, and El Hadi Khoumeri,` An intelligent baby monitoring system based on Raspberry PI, IoT sensors and convolutional neural network' 2020 IEEE 21st International Conference on Information Reuse and Integration for Data Science (IRI).
[40]. Sun Yong, Geng Liqing, and Dan Ke, ' Design of Smart Mirror Based on Raspberry Pi' 2018 International Conference on Intelligent Transportation, Big Data and Smart City.