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IoTs and AI Applications for Smart Agriculture–A Review

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ABSTRACT: With the development of technology, matters have become wise with skills of self-communication among them. Internet of things (IoT) linked each day domestic belongings to the net and causes them to bright to make selections like the social thoughts. Devices gather the actual atmospheric facts and with the assistance of synthetic intellect (AI) procedures evaluation of records receipts place in order that gadgets act extra vigorously. The current article discusses how IoT revolutionized the agrarian network. With the involvement of generation, it converts smooth to expect temperature, rainfall, humidity, weed identity, the essential for fertilizers, water necessities, and so on. The introductions of current day farming strategies using IoT and AI are transforming the conventional agriculture practices and are making farming a worthwhile mission additionally. The fast arrival of the internet-of-matters (IoT) based fully tools reformed almost each enterprise which includes -smart agriculture which moved the enterprise from numerical to quantitative processes. Such innovative variations are quaking the current farming techniques and growing new possibilities at the side of a variety of demanding situations. The potential of wi-fi sensors and IoT in farming, as well as the tests anticipated to be confronted whilst mixing this era with the old-style undeveloped practices. The increasing demand for food, both in terms of quantity and quality, has raised the need for intensification and industrialisation of the agricultural sector. The "Internet of Things"(IoT) is a highly promising family of technologies which is capable of offering many solutions towards the modernisation of agriculture. Scientific groups and research institutions, as well as the industry, are in a race trying to deliver more and more IoT products to the agricultural business stakeholders, and, eventually, lay the foundations to have a clear role when IoT becomes a mainstream technology.

Keywords: Smart farming, e pest, IoT, AI, automation, weed identification.

INTRODUCTION

Food security is a critical matter that will develop extra significant and serious in the succeeding years as the universal populace raises and the prosperity of rising nations progresses. For the meantime, it is commonly thought that existing agronomic production approaches require previously exceeded the planet's carrying capacity. By 2050, the world's population is expected to reach almost 10 billion, enhancing farming order-in a context of modest monetary expansion via around 50% compared to 2013 and approximately 25% compared to the current amount. Crop production currently occupies roughly 37.6% of the whole terrestrial surface. On the supplementary side, the tendency of development is anticipated to strengthen, with around 70% of the domain's populace expected to be urban by 2050 (Al-Fuqaha *et al.*, 2015). The agriculture sector contributes for 18 percent of GDP in India and employs 50 percent of the country's workers. Throughout human history, significant advances have been made to boost agricultural productivity with fewer resources and labour demands. It makes a substantial contribution to the economic prosperity of industrialized countries and also plays a significant part in the economies of emerging countries. Agriculture expansion has resulted in a large boost in the rural community's per-capita income. As a result, putting a higher emphasis on agriculture will be both rational and appropriate. The agriculture sector contributes for 18 percent of GDP in India and employs 50 percent of the country's workers. The growing need for food, both in terms of quantity and quality, has necessitated agricultural sector expansion and industrialization. The "Internet of Things" (IoT) is a promising customary of knowledges that can benefit modernize cultivation by providing a variability of solutions. Despite this, the great development proportion has on no occasion permitted demand and source to equal throughout any of these eras (Patil and Sachapara, 2017). To feed the world's population, modern agriculture and civilization require increased food production. In the agrarian field, new knowledges and resolutions are presence used to stretch an ideal choice for meeting and handling data although increasing net efficiency. Besides, profits levels will be several times greater than they are now, lashing up food depletion even extra, mainly in emerging nations. As a consequence, these nations will be additional mindful of their food and nutrition value; as a upshot, customer penchants may change away from wheat and cereals and near legumes and finally, meat. Food manufacture must double by 2050 to sustenance this larger extra urban, and better-off populace.

IoT has great possible and is one of the key areas for future progress of internet facilities. Major IT corporations and most nations are keen to discover IoT matters. New uses of IoT are being explored for and recognised, but most of the energy is in the area of resolution adjustment (Jazayeri *et al.,* 2015).

IoT as a possible tool towards the goal of self-organized, choice creation, and mechanization in the agriculture cum agricultural industry. In this respect, precision agriculture (Barcelo-Ordinas *et al.,* 2013) automatic irrigation scheduling (Reche *et al.,* 2015), optimization of plant development (Hwang *et al.,* 2010) farm land checking (Corke *et al.,* 2010), green-house observing (Mao *et al.,* 2012), and farming production process management (Dong *et al.,* 2013) in crops, are among a few key requests which helps in resource use efficiency, sustainable food manufacture, low cost of cultivation.

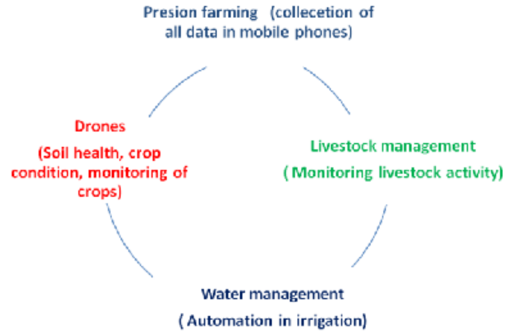
IoT model improves human communication in the physical world through low-cost electronic devices and communication protocols. IoT also monitors dissimilar ecological conditions to create dense and real-time maps of noise level, air, water pollution, temperature, and harmful radiations (Torres-Ruiz *et al.,* 2016)

In 2017, Pivoto *et al*. (2018), viewed smart farming (SF) as the combination of communication skill into machinery apparatus as well as sensors to use in agricultural production structures (Pedersen *et al.* 2008; Ahmed *et al.* 2016). According to Gibbons (2000); Waheed *et al*. (2006), advanced info processing knowledge for timely in-season crop management like variable rate technology, airborne and satellite remote sensing, multispectral and hyperspectral ground-based, computer showing, global positioning systems (GPS), geographic information systems (GIS) are innovative system approaches on which precision agriculture is based.

Panpatte (2018) said that artificial intelligence makes it probable for farmers to assemble large amount of data from government as well as public websites, analyze all of it and provide farmers with answers to many vague problems as well as it offers us with a smarter way of irrigation which results in advanced yield to the farmers.

Kumar (2014) discusses about the diverse irrigation methods with the primary reason of emerging a system with reduced supply usage and enlarged efficiency. Devices like fertility meter and PH meter are set up on the field to regulate the productiveness of the soil by perceiving the percentage of the primary constituents of the soil like potassium, phosphorous, nitrogen. Programmed plant irrigators are planted on the field through wireless technology for drip irrigation. This method safeguards the fertility of the soil and confirms the actual use of water reserve.

Today IOT has many uses in agriculture IOT



Technologies under smart agriculture

1. Automatic irrigation

Internets of Things (IoT) solutions, which are built on the information arrest and refined, dispensation of application-specific devices, are connecting the pretend and carnal worlds. Smart irrigation regulators or detecting nodes observer weather, soil moisture, soil temperature, air temperature, ultraviolet (UV) light radiation, and relative humidity of the crop field to mechanically regulate the irrigating plan to real circumstances of the site, different out-dated irrigation supervisors that function on a pre-set automatic calendar and timers. For these types of smart farm systems, there are a variety of sensors available. Even however capacitive sensors are immediate, they are expensive and must be calibrated frequently with shifting temperatures and soil kinds. Moisture sensors based on neuron probes are extremely accurate, but they pose radiation risks, are difficult to calibrate, and are expensive. Moisture capacity at a single spot in a vast agriculture field prepares not make sense or offer a true image of the whole space. As a result, a spread network of sensor nodes and dispersed driving parts are required to impel water to the exact places enclosed by the device nodes. This organization is composed of spread wireless device system with soil wetness and hotness devices. Smart irrigation helps to minimalize the ecological footmark finished effective marine use. It lets reinvesting in novel and better knowledge's which safeguard supportable and accountable irrigation ended time. Whether you are an irrigation installer, landscaper, upkeep employee, or owner, these schemes are reasonable, save valuable water capitals and save lands in peak disorder. We are all fast reforming our earth and internationally acceptance sustainability as the fight cry for a feasible upcoming. Resident appointment is essential to any populace's labours to decrease its ecological influence. IoT-enabled schemes like these must the possible to carriage consciousness, augment usage of ordinary possessions and produce real variation for a maintainable upcoming future. An Arduino UNO is the microcontroller used in this study. A microcontroller panel founded on the ATMEGA

328P is known as a UNO. The code is stored in 32 KB of flash remembrance on the ATMEGA 328P. Six analog ideas, 14 digital input/output pins, a 16 MHz quartz, an ICSP circuit, and a USB port with a reset switch are included on this board. Arduino software could be used to automate a UNO.

A DHT11: The sensor instrument is capable of calculating temperature and humidity. To measure air pressure, it uses a current device and a capacitive moisture sensor. This sensor is cost-effective, uses little energy, and can carry pointers up to 20 meters.

Ultrasonic Sensor: An inquiry component consists of a cable capable of accurately sensing the superficial near of practically all solutions, including water, oils, and saltwater. Sensor components are electrically isolated and insulated from the tissue in which they are implanted, and they will not disintegrate with time.

2. Drones for Spraying

AGRICULTURAL SPRAYER DRONES 3
Agricultural Sprayer Drones
The agricultural industry, which is worldwide, continues to implement advances in
technology that improve the jobs. Aviation has started to enter into this industry with drones.
These drones are mapping fields to measure certain nutrient levels and weed control. An area that
is being explored currently is the sprayer drone. The Unmanned Aerial Systems (UAS) or drones,
are again introducing a new possible job within the agricultural field. Researchers and drone
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The agricultural industry, which is global, continues to apply technological advancements that boost job opportunities. Drones have begun to penetrate this market from the aviation side. Drones are used to map fields in order to measure nutrient levels and weed control. The sprayer drone is one area that is currently being researched. Unmanned Aerial Systems (UAS), also known as drones, are offering a new career opportunity in the agriculture area. Drones equipped with a sprayer system are being developed by researchers and drone enthusiasts to spray fields, wineries, and orchards. Crops must be treated with pesticides, herbicides, and fertilizers in some form or another by farmers all over the world. Spray planes and ground sprayers are being used in agriculture to accomplish this task. Ground sprayers (seen below) may store between 500 and 1500 gallons of liquid. With a 10 gallon per acre pace, they can cover 80 acres with 800 gallons. A spray plane may carry anywhere from 350 to 500 liters of liquid. Depending on the going fee, they can cover up to 80 acres. Each approach is GPS-enabled and can cover numerous 80-acre fields in a single day.

1. When human intervention is not likely for covering pesticides on plants such as rice fields and plantation crops, as well as crops under topography lands, this knowledge is highly valuable.
2. It enhances coverage, increases chemical efficacy, and kinds spraying activities at ease and quicker.
3. The advanced drone-mounted sprayer has a extreme take-off weight of 5.5 litres and a 16-minute endurance time, but it needs to be created with a payload capacity of 15 litres and a 30-minute endurance time for chemical scattering in field crops.

Table 1: Performance evaluation of drone-mounted sprayer in paddy and groundnut.

Sr. No.	Parameter	Groundnut	Paddy
1.	Forward speed, km h^{-1}	3.6	3.6
2.	Width of spraying, m	5.10	5
3.	Actual field capacity, ha h^{-1}	1.15	1.08
4.	Theoretical field capacity ha h^{-1}	1.83	1.80
5.	Field efficiency, %	62.84	60.00
6.	Application rate, ha^{-1}	55.15	55.5
7.	Cost of operation , Rs ha^{-1}	345	367

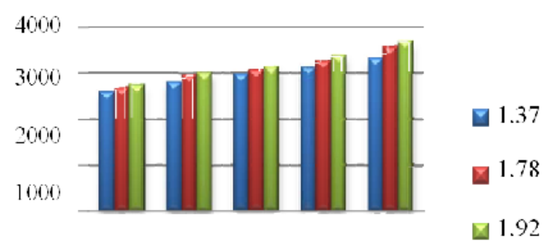


Fig. 1. Effect of the height of spray and operating pressure on the discharge Yallappa *et al*. (2017).

3. Remote sensing for weed management

Weed and crop plant perception. Several strategies for wild plant and crop plant sensitivity have been created after years of study and expansion. The discovery of flora, organization of weed floras and crop plants, and plant localisation are the primary issues in crop and weed plant perception. The most extensively utilized approach is machine vision. The crop or weed species studied, the difficulty of the pictorial picture (ranging from inside meticulous conditions to marketable fields), and the devices utilized all differ. Insight approaches are classified according to the automobile stages that carry the devices and the crop traits that are processed. For perceiving and checking plants, satellites, airborne vehicles (including unmanned aerial vehicles, or UAVs), and ground vans (such as field robots or commercially available off-highway vehicles) are usually used. Significant field watching using satellite and aerial sensing was common in applications like variable-rate herbicide covering (Lan *et al.,* 2010; Torres-Sánchez *et al*., 2013). These stages have a inferior spatial tenacity, and the working period is pretentious by the climate and air circumstances (Moran *et al.,* 1997). Higher spatial resolution plant images may be acquired via ground vehicle-based detecting and low-altitude aerial-based recognizing, allowing for reliable crop row detection and crop localization for applications like immediate, in-row weed management. Ground vehicle–based approaches, on the other hand, must meet requirements such as crop clearance, crop row arrangement, and the ability to cross the arena in a variety of soil conditions (Hague *et al.,* 2000). Two types of features often used in these procedures were spectral reflectance and biological morphological characteristics (Slaughter *et al.,* 2008). Gai *et al*. (2019) defined the advancement of a robotic weeder for mechanical weeding in row crops and multiple crop types utilizing a new weeding actuator design. The actuator was planned to be put on a tractor toolbar as a tractor implement, but it may also be combined into a field robot. The weeder's weeding tool is a rotating vertical tine that cuts, uproots, and burys weeds. Closed-loop regulator of servo-motor-driven turning weapons locations each spinning tine gathering comparative to the plant row. Based on the incidence or non-appearance of crop plants, the revolving spikes change in and available of the crop row. The insight system working an RGB-D sensor (Kinect v2, Microsoft, Redmond, Wash) to notice and restrict crop floras using color and form landscapes in actual. Afterward noticing the actuators were intended to be castoff as a tractor device (right), paying revolving upright tines as the tidying tool for efficiently wounding, evacuating, and interring weeds. Source: adapted from Gai *et al.* (2019).

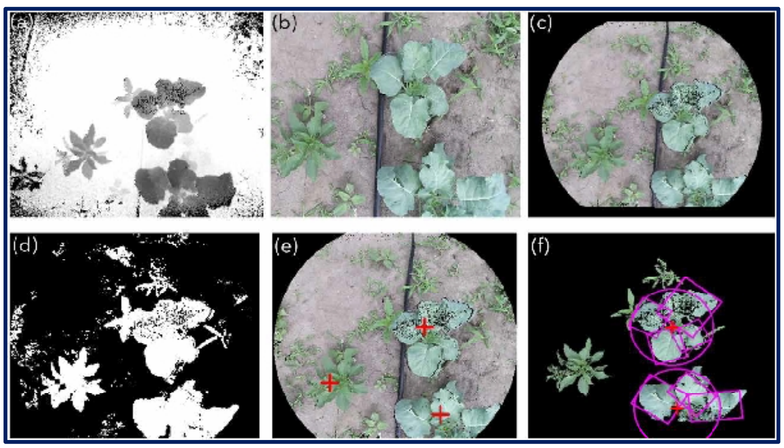


Fig. 2. Weed detection using image processing and CNN.

Sample broccoli plant images (16 DAT; 40k lux) at apiece image dispensation step including (a) depth and (b) colour images; (c) colour process and clean copy; (d) segmented image, with white flora pixels; (e) noticed plants noticeable with symbols; and (f) feature-based localization refinement and classification with target crop plants labelled with crosses. Source: adapted from Gai *et al.* (2019).

This weeder's perception system combined data from hue and range sensors to create a high-performing crop plant perception system. Data pre-processing, flora pixel division, plant removal, feature removal, feature-based localization modification, and harvest plant organization are the six processes in the image processing pipeline (Fig. 2). In point clouds, incorrect pixels and noisy pixels were deleted during the pre-processing step. The soil surface was modelled as a even in the 3D fact cloud during the segmentation step, and pixels above the plane were handled as outliers and crop pixels. Plant pixels were gathered in the plant extraction step based on their spatial correlations.

A group of reflectance and form features for recitation separate plants and plant covers were removed during the feature extraction process. Plant center positions were calculated using venation landscapes in localization refinement. The collected features were then used to make crop-versus-weed organization for each removed plant in the cataloguing step.

4. e-pest surveillance in selected cropping ecosystems through eSAP

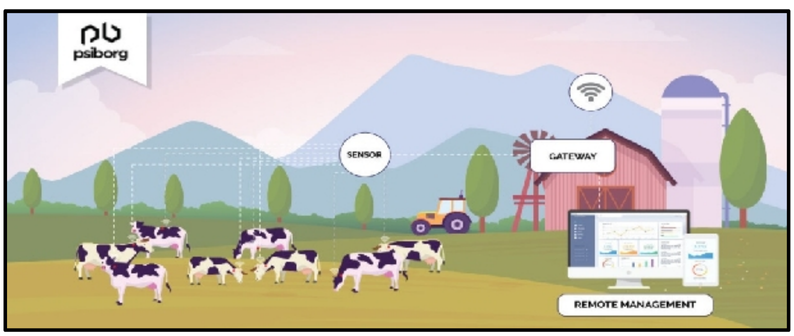
eSAP (Electronic Solutions Against Agricultural Pests) is a ground-breaking crop health management ICT solution. The latest version of eSAP addresses insect pests, microbiological illnesses, nutritional inadequacies, and weed issues.

Pest identification: This is unique of e-most SAP's prominent structures. Pest identification architecture is built on a unique image-based branching model. To naturally aid users in recognizing the pest, good photos that describe pests and their indications are used. Every step includes audio aid in the local language; the user does not need to be literate.

Pest surveillance: Identification of pests is not enough to take corrective action; it is also necessary to establish the scope of the pest problem that exists on each farm. There are pest-specific survey forms that are intuitively constructed for this purpose, allowing you to quantify the damage caused by various pests. Founded on the review and the pre-determined financial verge values for individually pest, the data is automatically assessed. The results and suggestions are displayed on the field device in real time. Depending on this, the user can choose to implement control measures or only wait aimed at the situation to worsen.

Pest management: After establishing the amount of the damage, a list of recommended control measures is made available for each insect. The strategy considers the crop, crop age, and crop portion that would be affected. The user can use the automated suggestions based on the survey results to implement strategies. Offline management solutions are also accessible. Depending on the availability of telecommunication signals, any novel plan or pest organisation skill can be ended obtainable remotely.

e-Pest investigation in particular cropping ecosystems by e SAP. The Extension Department conducted a study on "insight examination of e-SAP by agriculturalists in the regions of application of e-SAP" and found that farmers have overwhelmingly positive feelings about the knowledge in altogether facets of crop protection (70 percent of the trial agriculturalists provided positive responses). e-SAP has aided farmers in overcoming a main challenge: accurate documentation of agricultural pest complications. Furthermore, e-SAP has successfully propelled the idea of pest problem quantification as well as the notion of pest-intensity-based administration. Numerous growers who receive written prescriptions now take them toward the stores and demand that they be provided the same. It had a tremendous influence on pesticide stores' and farmers' contacts. Their confidence in dealing with insect problems has grown. This is largely due to the extension functionary's entire involvement in the identification and quantification procedure. In Karnataka, three additional agricultural universities have embraced e-SAP. To far, more than a million farms in Karnataka have benefited from e-SAP. More than 100 extension employees who were hired as part of several programs now have jobs. The number of opportunities to sell inefficient (and occasionally fake) substances has decreased dramatically. The amount of pesticides used was also in accordance with the prescription, resulting in less pesticide use that was indiscriminate. Through e-SAP, scientists have found a slew of new pest concerns in their regions of operation. The white-tip disease of rice and banana skippers have been notable. These discoveries were made possible by an e-SAP feature that flags difficult-to-identify difficulties in the field. More importantly, the discovery of novel difficulties and conforming pest management tactics can be broadcast to field instruments in minutes, allowing ground operators to manage these issues on their own going forward. Managers have made certain area-wide 7 choices based on information made obtainable in actual through the e-SAP system. The management of cotton leafhopper resistance in the Raichur area is a good example. Notwithstanding the execution of management techniques, real-time data revealed that the insect population in the area was not dropping. The specialized team soon discovered that the populace needed developed pesticide resistance. Administrators decided to change the plan through the support of investigators. The new technique was made available in real time on field devices, allowing the pest population to be successfully managed before it reached dangerous levels. The impact of e-SAP has been enormous.



5. Livestock tracking and geofencing

The economy of a country is heavily reliant on livestock. Domestic animals are those that are raised for the purpose of producing goods such as food, fiber, milk, eggs, and labor. Cattle and goats are examples of farmed ruminants that are commonly referred to as livestock. Every year, approximately 70.7 percent of cattle thefts go unreported. Several software programs for livestock theft prevention have evolved, and they are designed to protect cattle 24 hours a day. Farmers and cattle owners will appreciate this Geofencing option for livestock tracking. A livestock tracking technology allows you to track the movements of livestock animals all over the world in near real-time. These travels are tracked using tiny GPS tags worn by the animals. Livestock Management Solutions are simple methods for gathering data that can help you make better decisions about your livestock herd. It uses real-time monitoring to help farmers understand the health and well-being of their cattle. As a result, farmers can easily access and manage their investments using an online internet portal that can be accessed from a mobile or desktop device.

It can also calculate your average daily weight gain immediately after each log entry.

Benefits of Livestock Tracking solution.

• Improved monitoring of RFID-tagged animals reduces pilferage, shrinkage, and loss.

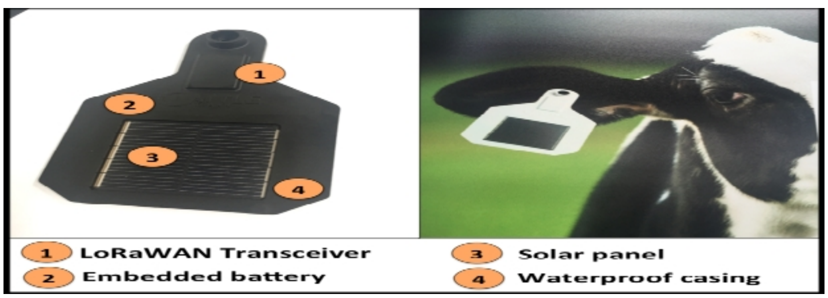
• The data collected by the livestock tracking technology can be imported into a variety of popular animal management programs.

• Keep track of what you need, such as your due date, vaccination information, hormones, weight gain or loss, and medications.

• Keep track of cattle disease and performance in order to calculate and visualize individual or group performance.

6. Soil management using IOT

Actual data on temperature, volumetric water content, rainfall, and other parameters is collected by IoT sensors. Farmers can use this data to spot trends and forecast irrigation requirements. Farmers may check crop water levels remotely using wireless monitoring technology, saving time and labor. Farmers can get real-time information on their mobile devices as well as their computers. IoT sensors and actuators increase irrigation efficiency, ensuring that crops are not under or overwatered. In the industry, there are numerous IoT solution vendors who can implement the whole IoT solution in 3-4 weeks. Sensors are powered by batteries and use less energy, resulting in longer battery life and lower maintenance costs. Soil management using IoT assists farmers in monitoring the soil and deciding which crop to grow in it. Farmers can monitor the temperature, pH, and humidity of the soil on a regular basis. Farmers can check soil monitoring results at any time using their mobile phones and the wireless network. They can immediately spot irregularities on their land and employ pesticides to overcome the abnormalities if they notice them. Sensors such as temperature sensors, pH sensors, and humidity sensors are used to test the soil. Dissimilar crops need altered irrigation systems, and farmer can boost production by preserving ideal soil moisture for a precise crop utilizing real-time soil moisture data.



CONCLUSION

IoT-enabled farming has assisted in the execution of pioneering practical answers to ancient wisdom. This needs assisted in connecting the gap amongst production, quality, and yield amount. Data collected by acquiring and introducing data since several devices for actual usage or storage in a record ensures fast action and negligible plant damage. Harvest is administered faster and reaches superstores in the direct time possible cheers to seamless endwise intellectual operations and better occupational process implementation. As a consequence, IoT farming requests allow farmers and farmers to collect valuable data. Huge landlords and minor growers must know the IoT marketplace's probable for farming and tool smart knowledge to recover their manufacture's affordability and sustainability. Through the world's populace unceasingly growing, farmers and minor agriculturalists may effectively encounter request provided they use farming IoT answers in a gainful way.

FUTURE SCOPE

Internet of Things has emerged as a leading technology around the world. It has gained a lot of popularity in lesser time. Also, the advancements in Artificial Intelligence and Machine Learning have made the automation of IoT devices easy. Basically, AI and ML programs are combined with IoT devices to give them proper automation. Due to this, IoT has also expanded its area of application in various sectors. Here, in this section, we will discuss the applications and the future scope of IoT in healthcare, automotive, and agriculture industries.

Conflict of Interest. None.

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