A Machine Learning Based Decision Support System for Improvement of Smart Watering Equipment in Agricultural Fields

Sreenivasulu Vasu, Vikram Neerugatti, C. Naga Swaroopa

Abstract: ***The new Paradiagram in the internet technology is Internet of Things, where anything that exists in the world can be connected to the internet with unique identity. It has major applications in the fields like health care, agricultural, retail and automation, etc., Here; we proposed a model for Decision Support System (DSS) which used in the Internet of Things (IoT) based agricultural application. It leverages the deep analytics of smart watering equipment data which was collected from the thing speak cloud platform and to improve the water usage and to develop the fields productions in the agricultural fields. The proposed model was evaluated empirically and demonstrated efficiency by using machine learning prediction model approaches. The proposed model was compared with other classifiers and the result shows the efficiency of the system.***

Index Terms: IoT, machine leaning, deep analytics, decision support system, agricultural fields, thing speak.

I. INTRODUCTION

ESM (electric smart meter) is the business expanding utility domain. It occupies large share compare to smart meter bases. Some of the shares of smart meter such as gas and water are growing day by day [1]. One of the important features of Internet of Things (IoT) technology is small amount of packet and a periodic packet transmission. The communication field of a wide area coverage based low speed transmission characteristics and low power is called Low Power Wide Area (LPWA). In further IoT environment is accuracy data of the data depend on optimized uplink period and power saving of IoT devices are most important [2].

In agricultural sector plays a major role in the economy, is quite untouched by IT industry. Food accessibility and availability can be increased by reducing the losses and increasing production. There are various constrains on increasing the production of food and increasing the agricultural land [3]. In 2020, the world will have connecting over 50 billion of IoT devices and also streaming over 60 ziga bytes of data. In data science is to uncover insights from colossal amount of IoT data due to its complex natures of data volume, velocity, variety and veracity [4].

Deep learning as a novel machine learning model, it utilizes the unsupervised or supervised method to learn and hierarchical features of the tasks of classification and pattern reorganization. CNN (convolutional neural network) is one of the most well-known deep learning model. CNN is a state of art performance in image classification and speech recognition [5]. Main objective of NB-IoT is increased coverage, low user equipment and long battery life, device complexity. Several techniques has adopted single tone transmission, phase rotated modulations, power spectra density boosting, including repetitions, to reduce peak-to-average power ratio in the uplink and so forth [6].

The scope of the technology day by day increased very potential to serve the some community better such as big players like Google, Intel, Face book, Amazon, Samsung, PTC and Flipkart etc. The vision of IoT is multiple technologies ranging from wireless communication and from embedded systems to MEMS (micro-electronic mechanical systems) and much new hackable hardware available in stores to start prototyping [7]. In everyday life IoT has recognized one of the important factors of smart home. It allows monitoring, controlling and managing house environment according to the house owner's lifestyle. It is mainly focuses on speed of communication, communication infrastructure, enhanced hardware development, cyber security and data transmission reliability. Machine learning is known to be fascinating technique for smart home. The functionality is to self-decision making incorporate with smart home energy management system [8].

Many integrated Internet of Thing integrated sensor technologies are used in different applications. Those are health monitoring, localization, human body activities, structural monitoring, and health monitoring. The integrated machine learning software and sensor hardware was several benefits such as (i) Providing real time analytics directly from the board, (ii) Reduce of sensor data traffic and potentially enhanced privacy by communicating parameters instead of raw data, (iii) enabling the sensor system to be continuously retrained and trained, and (iv) scalability in that the algorithms can also operate with attached heterogeneous sensors [9]. In everyday life development of AI (artificial intelligence) system was able to organize the human machine interactions such as communication, facial expression, voice recognition and biometric system etc. and also increase the popularity. Some of the most voices assistance are Amazon Echo which responds to the name of Alex from Amazon, Google Assistant from Google, Siri from Apple, Yandex from Alice and Cortana from Microsoft [10].

Today's world so many health issues related on strong stress correlation among them heart disease, stress and cancer some terminal illnesses.

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In further stress has been shown to weaken immune system, as well as drop performance in all metrics of success. Stress is very difficult to detect and cannot be quantified. One of the best easiest ways to predict is remote stress detector is an IoT device which can detect the stress level of a person using her/his heartbeat reading [11]. The Internet of things devices is projected to grow from 8 billion in 2017 to 20 billion in 2020. Many popular websites, including Amazon, Twitter, paypal, Github, CNN, and Netflix were rendered inaccessible for several hours. Miral source code was publically released on January 2017. Distributed Denial of Service attacks using Miral derived IoT botnets have since increased in severity and frequency [12].

Internet of Things is a network of physical devices and computers which enables them to collect and share data. The combining of M2M communication, IPC, PLC, business intelligence, SCADA and data analytics, the IIoT is changing the face of manufacturing activities [13].

The quality of DNNs and corresponding rapid adoption of DNN-based application including image classification those are i) language translation, ii) face recognition, iii) video content analysis and these all applications provides machine cognitive intelligence but DNN's overwhelming computation and memory consumption [14]. Dialysis can be treated as performed in different places either in hemodialysis centers known or at home, a technique still unknown and poorly proposed for patients meeting criteria. The current dialysis control is limited to patient medical office visits. The advancement of tele-transmission techniques has increased patient confidence [15].

II. RELATED WORK

In [1] Siryani, et.al presents IoT (Internet of Things) is a connected society and presents a framework is called DSS (decision support system). One of the best efficiency approach is Bayesian Network Prediction model and also three machine learning prediction classifiers are Random Forest, Navie bayies, and Decision tree.

In [2] Jang, et.al proposed a new algorithm is called uplink period optimization algorithm. It is mainly focus on the mitigation of the degradation of accuracy to a variable uplink period and minimizing power consumption of device.

In [3] Purandare, et.al proposed ware house managers to reduce post-harvest losses and an end to end system for farmers. It suggest the system about correct harvesting time and diseases that may affect the crop in its cultivation stages and current status of farm. It can also predict system warehouse manager which will suggest the correct dispatch sequence of the stocks, humidity and also optimum temperature.

In [4] Chung, et.al proposed a new approach to machine learning that uses automated learning techniques and also resolve the massive data problem in the rapid industry of IoT.

In [5] Li, Peng, et al. proposed hierarchical features of big data using tensor represented model to extend the convolutional neural network (CNN) from the vector space to the tensor space. Use of local features and topologies contained in the big data, a tensor convolution operations is defined to prevent over fitting and improve the training efficiency. The experiments on three data sets i.e. CUAVE, SNAE2, and STl-10 are carried out to verify the performance of the deep convolutional computation model.

In [6] Chafii, et al. proposed NB-IoT (Narrow Band-Internet of Things) it is a one of the recent technology by 3GPP in released-13. It provides wide coverage and low energy consumption in order to meet the requirements of its different applications like industry, social and environment aspects.

In [7] Santhosh, et. al. discuss a digital computing is one of the era for developing products and also benefit in all parameters, then Internet of Things to be solved. After that embedded system is to solve automation, then Internet of Things is started to solve visualize the different ways and it is used for next few years.

In [8] Li, Weixian, et al. proposed real-time power consumption data was collected from a Singapore smart home. It presents SHMS (self-learning home management system), HEMS (Home energy management system), DSM (demand side management) and SSM supply side management was developed and integrated for real time operations of a smart home. It also integrated some capability such as PF (price forecasting), PAS (Power alert system) and PC (Price cluster) to enhance the functions.

In [9] Lee, Jongmin, et al. proposed a new model is called GMM (Gaussian Mixture Model) for execution of the NXP FRDM-K64 embedded sensor board. To design customized program and data structures that generate real time sensor features and training or classification results for select IoT applications.

In [10] Polyakov, E. V., et al. discuss about tool that is called voice assistant it was integrated with many intelligent devices such as smart phones, laptops, smart homes and tabs etc., Automatic devices are so smarter to interact with the humans and themselves. Local voice assistant is used without any cloud services is described and it allows significant expand the applicability of those devices in future.

In [11] Pandey, et. al. discuss about the stress beforehand we have used some parameters on the heartbeat. ML and IoT is used to alarm the situation when the person is in real risk. Machine learning is used to predict the patient condition and IoT is used to patient communication of acute stress condition.

In [12] Doshi, Rohan, et. al. discuss the IoT specific network behaviors to inform feature selection can result in high accuracy Distributed Denial of Services (DDoS) detection in IoT network traffic with a different machine learning algorithms and also including neural networks.

In [13] Kanawaday, et. al. discuss the use of ARIMA (Auto Regressive Integrated Moving Average) forecasting on the time series data collected from different sensors from a slitting machine, to predict the quality defects and possible failures, to improving the overall manufacturing process. Machine Learning use is proves a vital components in IIoT having use case in quality control and quality management, improving the overall manufacturing process and lowering the cost of maintenance.

In [14] Zhang, Xiaofan, et al. presents a series of effective design techniques for implementing DNNs on FPGAs with energy efficiency and high performance. It include the use of configuration performance, resource modeling, DNN IPS and resource allocation across DNN layers, retraining and DNN reduction.

There different design solutions including Long term Recurrent Convolution Network (LRCN) for video captioning, Long Short Term Memory (LSTM) for sound recognition as well as Inception model for Face Net face recognition.

In [15] Fki, Zeineb, et. al. presents in progress to predict dialysis biometric from internet of Thing sensors. Here we presents our ongoing research to develop a modern data analytics environment using machine learning technique.

III. SMART WATERING EQUIPMENT

Fig.1: Smart watering equipment

In Fig. 1 show automatic or smart watering equipment consists of drones and microcontrollers equipped with sensors. This equipment is used to sprinkle the water automatically for the required agricultural fields. Whenever the water is required, by using this equipment the user can cover whole fields without wasting the water and time. This equipment has a feature like to cover the water for the fields, detection of the objects (human beings, animals, birds etc.) that enter into the fields, monitoring the health of the fields, remote monitoring the agricultural fields etc. The PIR sensor is used for detection of the objects, with the help of the GPS [Fig. 2] in the drone and sub drones the field area boundaries has been specified so that the drones will be monitor within the specified boundaries of the fields

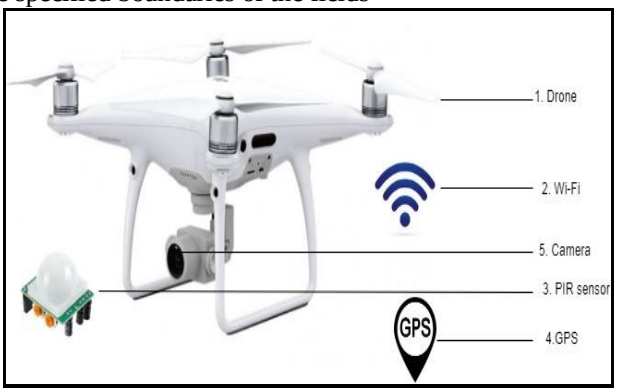

Fig. 2: Drone equipped with sensors

The controller drone will control the sub drones, due to power or any other problem if one drone fails the other drone will work properly. The drones consists of PIR sensor for detecting the objects, has a camera for taking a picture/video of objects and the fields automatically and sends to the user smartphone. On the ground in between the fields depending upon the user choice with the gap 3 to 5 feet's the microcontroller was placed.

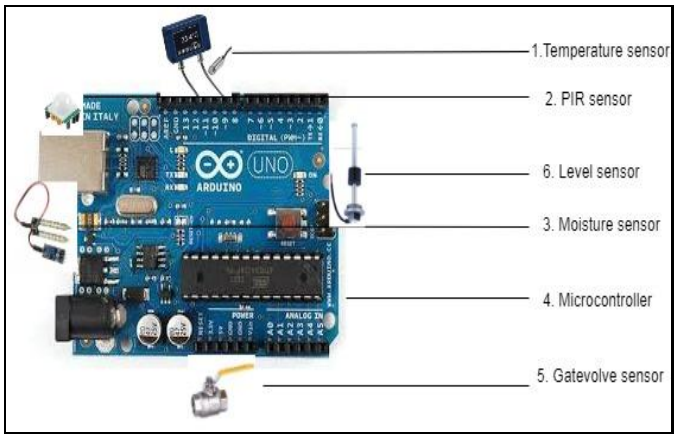

Fig.3. Microcontroller equipped with sensor

The microcontroller consists of temperature sensors to know the current temperature of fields, PIR sensor to detect objects, moisture sensor for detection of moisture level on the fields, gate wall sensor for automatic watering the fields and level sensor automatically set of the as shown in Fig. 3. This equipment will water the fields based on the moisture sensor that which detects the content of the water in soil. Whenever the water is less automatically the gatevolve sensor will open the water tap and sprinkles the water around the fields. Based on the level sensor the water level was detected and automatically the gatevolve will be shutdown. This equipment was experimented with in one Acre agricultural fields and the data was posted in the cloud platform Thing Speak. The communication between the devices, cloud and the user is shown in Figure. 3. Here the communication will be based on the WiFi technology.

IV. PROPOSED MACHINE LEARNING BASED DECISION SUPPORT SYSTEM

The proposed decision support system model consists of seven components, there are automatic watering equipment, thing speak cloud platform, data extraction from cloud, data preprocessing, prediction system, controller, and decisions required as shone in Fig 4. The first component is the automatic watering equipment which is placed in the required agricultural fields. The working nature of this equipment was explained in section 3. The second component is thing speak cloud platform which will collect the data from the equipment every minute. We can extract the data in the format of Comma separated values (.CSV) from these thing speak cloud platform. The extracted data will be processed by using any processing tool that depends on the user. In the preprocessing Component the collected data from the cloud is preprocessed. The machine learning approaches like Navie Bayes (NB), Random Forest (RF), Decision Tree (DT), Bayesian Network (BN) was applied in Prediction System Component. Then in Controller Component, in the perceptive of the user, developer, marketing, production, scope, scalability, and others views were taken.

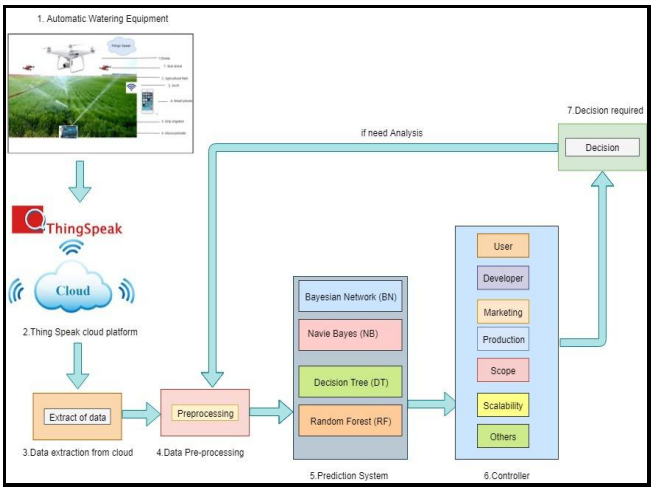

Fig.4: Proposed Decision Support System Model

In Decision component the decisions will obtained. If the obtained decisions are not satisfied again the data will be preprocessed. The data can be preprocessed again and then obtain the required decisions based on the user needs.

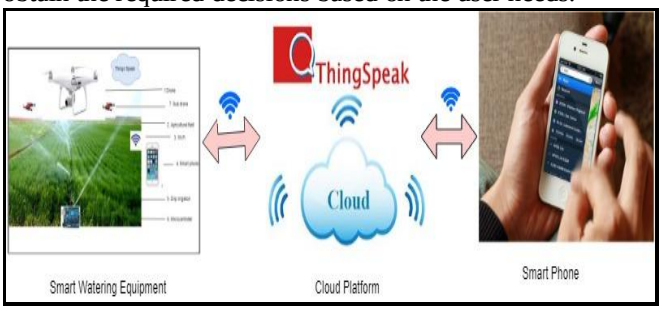

Fig.5. Communication between the smart watering equipment and smart phone

V. RESULTS

The automatic watering equipment after placing in the required fields was connected to the thing speak cloud platform by registering to the thing speak cloud platform by giving the appropriate user information. Once the account created the channel is created for the automatic watering equipment. This channel will collects data from sensors that equipped to the equipment from this channel the data from year 2010 to 2017 was collected in the .CSV format. The collected data is preprocessed and applied machine learning based techniques in the Weka tool. The data consists of 10 attributes with 2000 records. After applying these data in the Weak tool, the results were shown in the Table.1.

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Table.1. PERFORMANCE COMPARISON WITH DIFFERENT MODELS

Model	Accuracy	Error Rate
Random Forest (RF)	94.96%	+/-1.25%
Decision Tree (DT)	92.43%	+/-2.51%
Navie Bayes (NB)	95.75%	+/-2.34%
Bayesian Network (BN)	53.82%	+/-7.33%

VI. CONCLUSION & FUTURE WORK

The recent trend of network computing area is Internet of Thing. One of the enabling of Internet of Thing technology is machine learning technique. This paper consists of novel agricultural based smart watering equipment, by integration of that equipment to the cloud data was collected and analyzed based on the machine learning techniques. After applying the machine learning techniques on these equipment data, the results shows that random forest machine learning techniques is providing good results. When compare to other techniques like Navie Bayes (NB), Decision Tree (DT), and Bayesian Network (BN).

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