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ARTIFICIAL INTELLIGENCE BASED TWO LEVEL HYBRID ARCHITECTURE SMART INDUSTRIAL AUTOMATION BASED ON SMART DEEP LEARNING

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Abstract - In recent years, Deep Learning has promoted the rapid development of artificial intelligence and penetrated into various fields, but the massive data transmission of Artificial Intelligence (AI) training in network will affect the real- time performance of the system. As is known to all, real-time performance is very important in industrial field, especially in motion control. If the system is responding slowly, it cannot receive or send data acquisition and control commands on time. Finally, this will hinder the popularization of AI technology in the field of industrial automation. In this paper, we present a Three-Real-Time architecture; it involves real-time hardware network, real-time operating system and real-time scheduling virtualization layer. We hope to conceive a new industrial edge computing model after instead a traditional industrial controllers. Thus, the application of artificial intelligence technology in industrial automation can be thoroughly solved.

Keyword: Artificial Intelligence, Machine Learning, Automation, Deep Learning,

1. INTRODUCTION

Maximum number of industries and organizations depends on the usage of machines, electronic widgets, and various recourses for completing different tasks. All are operated with the help of machines. Even though there are so many benefits to us, running with them without any safety aspects will cause injury and even leads to loss of life (Joseph Zulick 2019; Fairoze et al., 2018). Machines can works on relevant data or inputs (Bradley et al., 1991). But preparing relevant data to solve a particular problem is a challenging task to engineers. And make sure that the relevant data is in a useful scale and correct format with meaningful features should include. Novelty and adaptation are tremendously significant to the industrial automation (Raffaele Cioffi et al., 2020). as technology advances while the development of standards, designers are often left with future predictions. This causes them to overestimate or underestimate the necessary safety functions (Tina Hull 2019). Safety system helps us take some crucial decisions in Industries. Usage of Internet of Things the system becomes secured and live data monitoring is also possible (Vijayalakshmi and Muruganand, 2017; Deshpande and Sangitasanap, 2016). Large variety of industrial Internet of Things and its applications have been prepared and used in recent years (Da Xu et al., 2014; Khan and Bhat, 2014).

Machine Learning (ML) is one of the emergent platforms for automation, through which new advancements are made and easily monitor as well control the system using datasets. ML is a part of computer science that often uses arithmetical techniques to give computers the ability to be trained with datasets, without programming (S. Kavitha et al., 2019). Machine Learning, Artificial Intelligence and Internet of Things with software engineering practices are very useful practices in providing safety in industries. Machine Learning is a notion which allows the system to learn from experiments. So that it can recognize patterns make predictions and complete tasks (Gatis Mikelsons et al., 2019). So instead of writing the code, just feed data by training it repeatedly with datasets. Machine learning involves training machines with some existing data sets or past data and produce algorithms that the machine can learn from without any explicit programming and help with the predictive analysis of the future data sets.

Basically there are training, validation and testing data sets. We train the classifier using training set, validation set adjust the parameters and then test set, test the performance of classifier. Machine learning implementations shown in fig. 1 are classified into three major categories (supervised, unsupervised and semi-supervised learning) (Aurangzeb Khan et al., 2010; Cabe Atwell 2017) depending on the scenery of the knowledge 'response' or 'signal' accessible to a learning system. Here Supervised Learning learns from example dataset and related target responses that can consist of numeric values or string labels in order to later predict the correct response when posed with new examples.

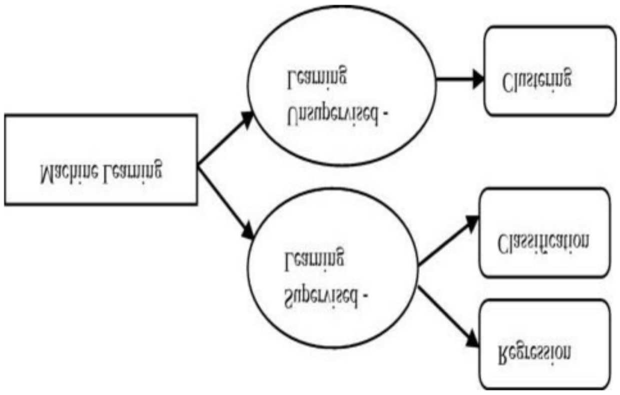


Fig. 1.1 Block diagram of Machine Learning (ML)

Figure 1.1 depicts the working of supervised learning. Another categorization of machine learning tasks (Classification, Regression, and Clustering) takes place when one believes the preferred output of a machine learned system. And proposed methodology uses classification technique.

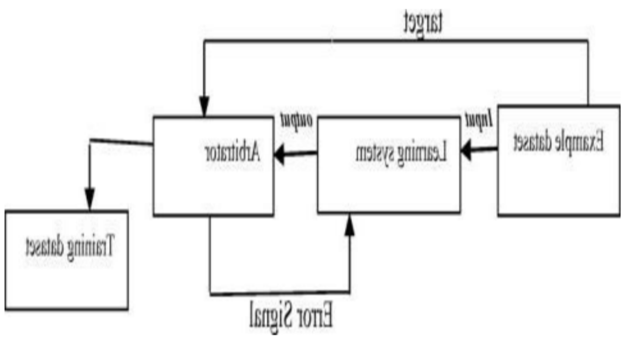


Fig. 1.2 working of supervised learning

After an extended period out of the limelight,* artificial intelligence, or AI, has returned to the public consciousness in a big way. AI's virtues and Services are now discussed daily in the popular press. While the societal implications of AI remain a topic of debate, it is broadly accepted that its business implications will be significant. Among those who track such trends, AI is expected to be a large driver of enterprise competitiveness in the not-so- distant future.

The views shared in a recent report by investment bank Goldman Sachs are representative of this sentiment. The paper states that "the ability to leverage AI technologies will become one of the major defining attributes of competitive advantage across all major industries in the coming years. While the strategy will differ by company size and industry, management teams that don't focus on leading in AI and benefiting from the resulting product innovation, labor efficiencies, and capital leverage risk being left behind."

a) IT industry research firm Gartner anticipates this impact as well, and projects it to take root sooner than later. They foresee that "by 2018, more than half of large organizations around the globe will compete using advanced analytics and proprietary algorithms, causing disruption on a grand scale."
b) The question for enterprises then is not when and if, but how.

Unfortunately, answering even this basic question can be difficult today, because doing so requires a broad and clear understanding of the various ways that AI can impact the business.

2. Related Work

During 20th century a brief history of AI can be given as:

1923 – Karel Kapek's play named "Rossum's University Robots (RUR)" opens in London, first use of the word "robot" in English. 1945 – Isaac Asimov, alumni at Columbia University, invented the term Robotics.

1950 – Turing Test for evaluation of intelligence was introduced by Alan Turing. Claude Shannon published detailed Analysis of chess playing as a search.

1956 – John McCarthy coined the term Artificial Intelligence.

1958 – John McCarthy invents LISP programming language for AI.

1964 – Danny Bobrow's thesis at MIT showed that computers can understand natural language well enough to solve algebra word problems correctly.

1979 – The First Computer controlled autonomous vehicle, Stanford Cart was built. 1984 – Dennett discusses the frame problem and how it relates to the difficulties arising from attempting to give robots common sense.

1990 – Major advances in all area of AI: Significant demonstrations in Machine Learning Case-based reasoning Multi-agent planning Scheduling Data mining, web crawler Natural Language understanding and translation Vision, virtual reality Games

1997 – The Deep Blue Chess Program beats the World Chess Champion, Gerry Kasparov

2000 – Interactive Robot Pets become commercially available. MIT displays robot with a face name – Kismet that expresses emotions.

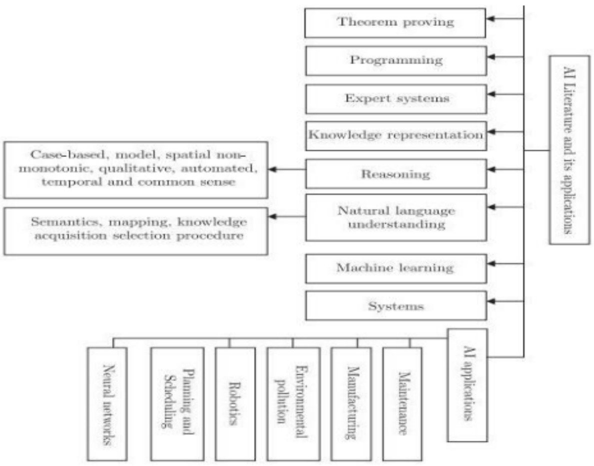


Fig. 2.1 Illustration concerning the relationship among the diverse fields of AI

The two major approaches that has been developed for the regular AI system are: "top down" approach which started with the higher level functions and implemented those, and the "bottom up" approach which looked at the neuron level and worked up to create higher level functions.

In the 21st century artificial intelligence (AI) has become an important area of research in virtually all fields: engineering, science, education, medicine, business, accounting, finance, marketing, economics, stock market and law, among others (Halal (2003), Masnikosa (1998), Metaxiotis et al. (2003), Raynor (2000), Stefanuk and Zhozhikashvili (2002), Tay and Ho (1992) and Wongpinunwatana et al. (2000)). The field of AI has grown enormously to the extent that tracking proliferation of studies becomes a difficult task (Ambite and Knoblock (2001), Balazinski et al. (2002), Cristani (1999) and Goyache (2003)). Apart from the application of AI to the fields mentioned above, studies have been segregated into many areas with each of these springing up as individual fields of knowledge (Eiter et al. (2003), Finkelstein et al. (2003), Grunwald and Halpern (2003), Guestrin et al. (2003), Lin (2003), Stone et al. (2003) and Wilkins et al. (2003)).

3. METHODOLOGY

Existing systems uses sensors which are monitored and controlled only based on the data received from the industrial site. But, the data will be cleared in servers after the completion of action. As previous data or values are not stored in the system again if any uneven situation occurs again it need sense the conditions and store the data. In this paper we are proposing a framework for data preparation. In first step, the data selection considers what data is presented, what data is misplaced and what data can be deleted. In second step the Preprocessing of data organizes formatting the selected data, cleaning and sampling from it. Final step supports transformation of data; it transforms preprocessed data ready for ML by engineering features using scaling, attribute decomposition and attribute aggregation Fig. 3.1.

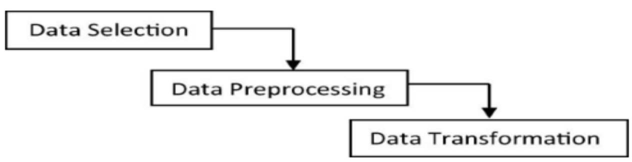


Fig. 3.1 Three step framework for data preparation

Data preparation is a huge subject that can engage many iterations, searching and analysis. Good data preparation is a challenging task in machine learning. There is an important requirement that one should notify the actual data require to address the problem working on it. Future assumptions should record carefully, so that test can be done later if required. Data selection step select the subset of all existing data that will be working on it. There is always a strong desire for including all data "more is better" is available will store. Next step is Preprocess Data, it describes that after data selection, and the main concern is how to use the data efficiently. This step is mainly for formatting the selected data to solve the identified problem. Data preprocessing steps commonly used are formatting, cleaning and sampling. Formatting the data is put it into a relational database model and it would be in a specified format. Cleaning data means removal or fixing of missing data. Sampling means.

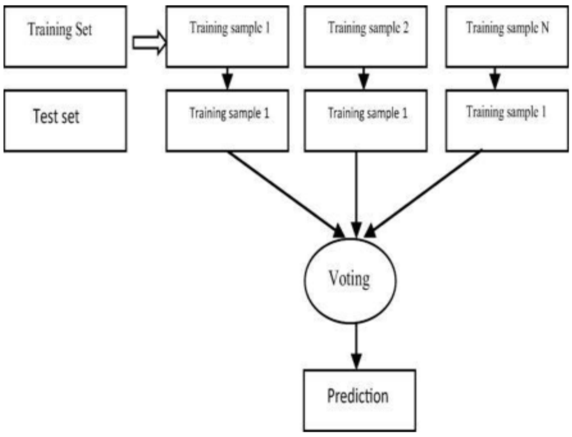


Fig. 3.2: Working of Random Forest Algorithm

Then it will get the prediction result from every decision tree. In the next step, voting will be performed for every predicted result. Finally select the most voted prediction result as the final prediction result.

- X=dataset.iloc[:,: -1] - TRAINING DATA SET values,
- y=dataset.iloc[:, 4] - TESTING DATA SET values
- Next, we will divide the data into train and test split.

The following code will split the dataset into 70% training data and 30% of testing data.

- from sklearn.model_selection import train_test_split
- X_train, X_test, y_train, y_test = train_test_split(X, y, test_size) – IMPORT FUNCTION FOR SCRIPTING LINES

Next, train the model with the help of Random Forest Classifier class of sklearn as follows:
Formulae: sklearn.ensemble import Random Forest Classifier.

Main function of algorithm

- classifier = RandomForestClassifier (n_estimators)
- classifier.fit (X_train, y_train)
- At last, we need to make prediction. It can be done with the help of following script –
- y_pred = classifier.predict(X_test) Working process of an algorithm

1. **Step 1:**

   First, start with the selection of random samples from a given dataset.

   It means Pick N random records from the dataset.

   X = dataset.iloc[:,: -1] -TRAINING. y = dataset.iloc[:, 4]-TESTING

2. Step-2:

   Next, this algorithm will construct a decision tree for every sample. Then it will get the prediction result from every decision tree.
   Build a decision tree based on these N records.
   Choose the number of trees in algorithm and repeat steps 1 and 2.

   X_train, X_test, y_train, y_test = train_test_split(X, y, test_size)- SPLITING THE TREE

3. Step-3:

In this step, voting will be performed for every Predicted result.

In case of a classification problem, each tree in the forest predicts the category to which the new record belongs. Finally, the new record is assigned to the category that wins the majority vote.

y_pred = classifier.predict(X_test).

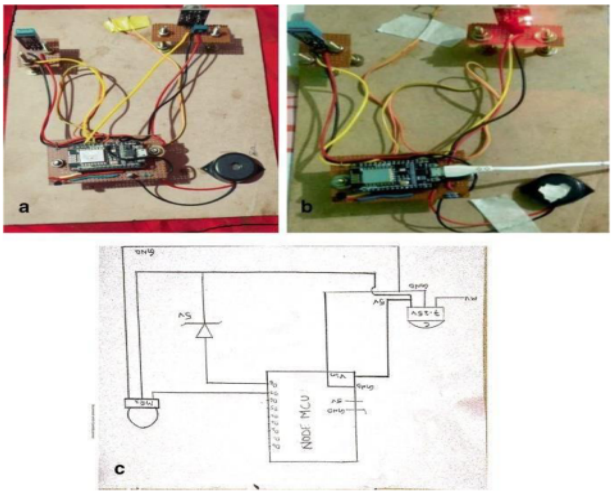


Fig. 3.3:

(a) Laboratory prototype of IoT based system model
(b) IoT based system model with alarm
(c) Block diagram of Node mcu circuit

Things are automatically assigned to deploy, manage, and schedule the behavior and timely switching as per requirements. These enable things and devices to perform task in real time automatically. It measure the distance of target objects or materials through the smart ML process and measure the distance without damage from machines to worker. Using this system one can operate the IoT from anywhere easily. The system will not only raise alarms but it also sends notification to mobile with danger warning whenever it detect odd situation or odd values in the industrial parameters.

System modules: Proposed model focuses on the safety and accurate control of IOT sensors. The system model of our scheme consists of user authentication, IOT parameters (sensors), training dataset, and testing dataset.

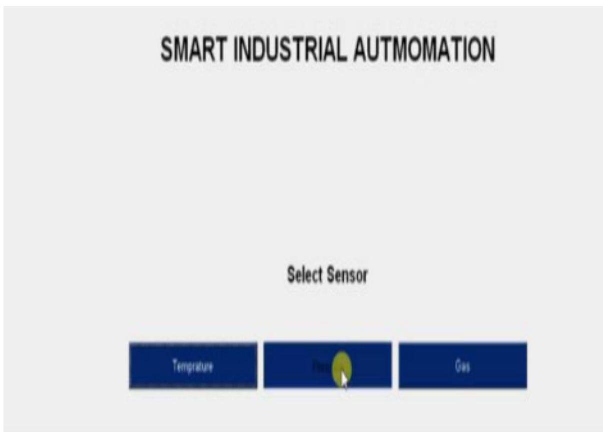
User authentication: First user need to register into the blynk application with respective hotspot id and password. It is a Platform with IOS and Android apps to control Arduino, Raspberry Pi. It's a digital dashboard where you can build a graphic interface by simply dragging and dropping widgets. It will connect the hardware to respective software.

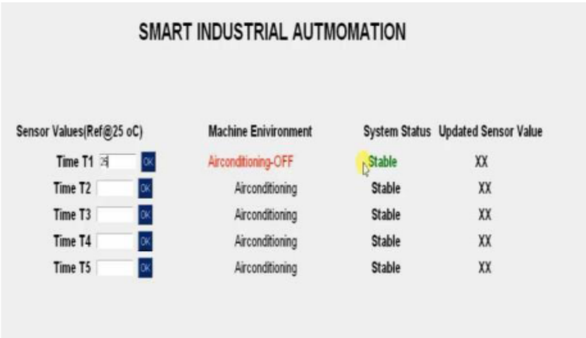
IOT parameter system: It is device of different sensors namely smoke, gas, temperature, humidity and fire with node mcu chip and buzzer shown in figs. 5 (a) and 5 (b). It is designed in order to detect the odd situation or danger situation in industry and address the user before so that they can control the accidents in industry. It has node mcu chip which is previously embedded with c code to connect with software shown in below fig.

Training Dataset: The model is initially fit on a training dataset, which is a set of examples used to fit the parameters of the model. The model is trained on the training dataset using a supervised learning method. In practice, the training dataset often consists of pairs of an input vector and the corresponding output vector, which is commonly denoted as the target. The model fitting can include both variable selection and parameter estimation. Train the classifier using training set, it has values which are stored previously so instead of writing code what we do is using these values we train the model repeatedly with help of random forest algorithm. It is the main module, and without the training dataset we cannot get the result.

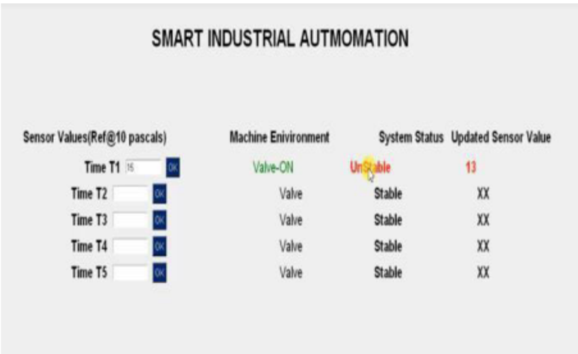
Testing Datasets: Finally, the test dataset is a dataset used to provide an unbiased evaluation of a final model fit on the training dataset. If the data in the test dataset has never been used in training (for example in cross-validation), the test dataset is also called a holdout dataset.

4. RESULTS

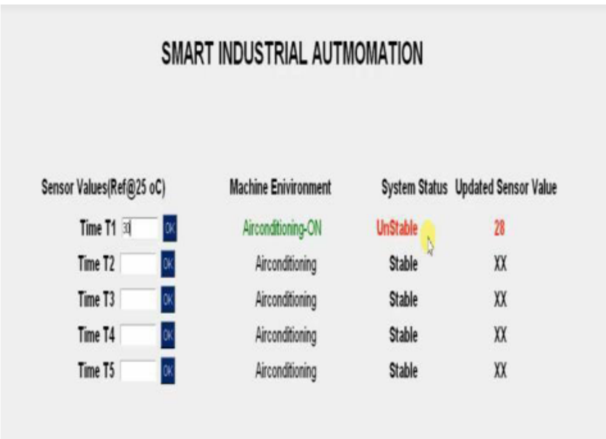


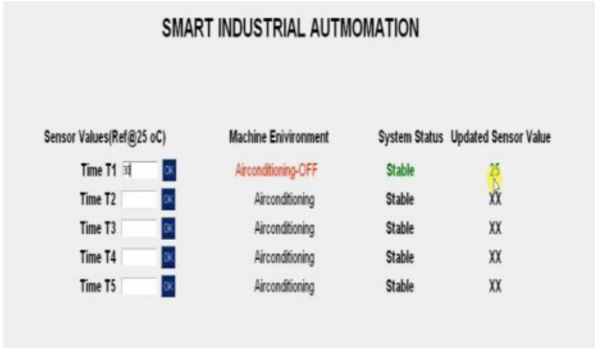


OUTPUT WHEN T1=25

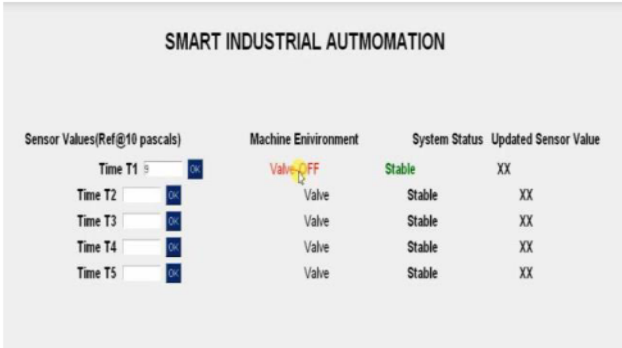


OUTPUT WHEN T1=30oC

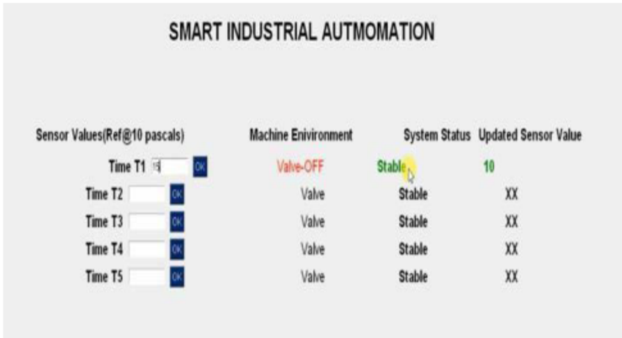




SENSOR=PRESSURE



OUTPUT WHEN T1=9pascals



OUTPUT WHEN T1=15pascals

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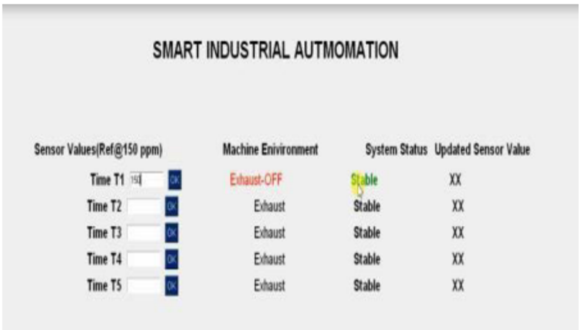

OUTPUT WHEN T1=150ppm

OUTPUT WHEN T1=200ppm

5. CONCLUSION

Existing systems uses sensors which are monitored and controlled only based on the data received from the industrial site. But, the data will be cleared in servers after the completion of action. As previous data or values are not stored in the system again if any uneven situation occurs again it need sense the conditions and store the data. System sometimes cannot give the accurate results because sensor cannot differentiate things like human. It may fail to take important decisions and give false alerts. The proposed system is to prevent accidents and control appliances in the industry. This system is capable for detecting fire, heat, various hazard gases and uneven conditions by providing the location of the affected region and generates alarms and control machines using the concept of IOT. The proposed system is trained repeatedly using the concept of machine learning. Where we store the data and monitor the sensor and upload information to users. Based on that data or previous history it will give notifications or generate alerts if any hazards take place in industry. System is able to differentiate things like human and also capable of taking crucial decisions. It will give accurate results. In this paper we proposed a framework for data preparation to machine learning algorithm. Adopted random forest algorithm possesses flexibility and high accuracy. Here we proved that accuracy is 0.97 from Table 2, so we can provide safety aspects in industrial automation with the proposed methodology. This paper extending the use of random forest algorithm to fulfill the purpose of reduce false deduction, take important decisions and to get accurate results in very short period of time. It will raise alarms besides it will send notification to the mobile with danger message before accidents occur.

By sorting out the literature of edge computing, industrial automation and artificial intelligence, this paper puts forward the problems existing in the process of intelligent transformation and upgrading of industrial automation industry. In the future, we will build a Three-Real-Time platform, a network engineering research center for edge computing. To improve the real-time algorithm, the virtualization of industrial automation controller, and the optimization of embedded artificial intelligence inference.

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