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# Modified Survey of Machine Learning Classification Models and Internet of Robotic Things for Smart Metering Systems

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**ABSTRACT**:The study reviewed various machine learning classification models and the internet of robotic things for Smart Metering Systems. A smart meter is an electronic device that records information such as consumption of electric energy, voltage levels, current and power factor. It communicates information to the consumer for the purpose of clarity and billing. The utilization of smart metering systems in Nigeria has boosted accountability and service delivery of energy to consumers. This is because; the smart meter uses a secure national communication network to automatically and wirelessly send the consumer's actual energy usage to the providers. A classification model attempts to draw some conclusion from observed values. Given one or more inputs a classification model will try to predict the value of one or more outcomes. Outcomes are labels that can be applied to a dataset. The term 'Internet of robotic things' (IoRT) itself was coined in a report by foreign researchers to denote a concept where sensor data from a variety of sources are fused, processed using local and distributed intelligence and used to control and manipulate objects in the physical world. In this cyber-physical perspective of the IoRT, sensor and data analytics technologies from the IoT are used to give robots a wider situational awareness that leads to better task execution. Use cases include intelligent transportation and companion robots. Application of the internet of robotic things can be traced to sectors which include health, agriculture, security and education. In addition, the study adopted a systematic review methodology and could be beneficial to scholars and researchers with keen interest in the study area.

**KEYWORDS:**Classification Models, Data, IoRT, Sensor

## I. INTRODUCTION

The study reviewed various machine learning classification models and the internet of robotic things for Smart Metering Systems. A smart meter is an electronic device that records information such as consumption of electric energy, voltage levels, current and power factor. It communicates information to the consumer for the purpose of clarity and billing. The utilization of smart metering systems in Nigeria has boosted accountability and service delivery of energy to consumers. This is because; the smart meter uses a secure national communication network to automatically and wirelessly send the consumer's actual energy usage to the providers. A classification model attempts to draw some conclusion from observed values. There are a number of classification models.

Classification models include logistic regression, decision tree, random forest, gradient-boosted tree, multilayer perceptron, one-vs.-rest, and Naive Bayes. Supervised Learning is defined as the category of data analysis where the target outcome is known or labeled e.g. whether the customer(s) purchased a product, or did not. However, when the intention is to group them based on what all each purchased, then it becomes Unsupervised. This may be done to explore the relationship between customers and what they purchase. Classification and Regression both belong to Supervised Learning, but the former is applied where the outcome is finite while the latter is for infinite possible values of outcome (e.g. predict $ value of the purchase). The term 'Internet of robotic things' itself was coined in a report by foreign researchers to denote a concept where sensor data from a variety of sources are fused, processed using local and distributed intelligence and used to control and manipulate objects in the physical world. In this cyber-physical perspective of the IoRT, sensor and data analytics technologies from the IoT are used to give robots a wider situational awareness that leads to better task execution. Use cases include intelligent transportation and companion robots. Later uses of the term IoRT in literature adopted alternative perspectives of this term: for example, one that focuses on the robust team communication and a 'robot-aided IoT' view where robots are just additional sensors. Cloud computing and the IoT are two non-robotic enablers in creating distributed robotic systems. IoT technologies have three tenets: (i) sensors proliferated in the environment and on our bodies; (ii) smart connected objects using machine-to-machine (M2M) communication; and (iii) data analytics and semantic technologies transforming raw sensor data. Cloud computing provides on-demand, networked access to a pool of virtualized hardware resources (processing, storage) or higher level services [1].

Cloud infrastructure has been used by the IoT community to deploy scalable IoT platform services that govern access to (raw, processed or fused) sensor data. Processing the data streams generated by billions of IoT devices in a handful of centralized data centres brings concerns on response time latency, massive ingress bandwidth needs and data privacy. Edge computing (also referred to as fog computing, cloudlets) brings on-demand and elastic computational resources to the edge of the network, closer to the producers of data [2].

A key challenge of perception in an IoRT environment is that the environmental observations of the IoRT entities are spatially and temporally distributed. Some techniques must be put in place to allow robots to query these distributed data. Dietrich et al., [3], proposed to use local databases, one in each entity, where data are organized in a spatial hierarchy, for example, an object has a position relative to a robot, the robot is positioned in a room and so on. Other authors proposed that robots send specific observation requests to the distributed entities, for example, a region and objects of interest: this may speed up otherwise intractable sensor processing problems. A key component of robots' perception ability is getting knowledge of their own location, which includes the ability to build or update models of the environment. Despite great progress in this domain, self-localization may still be challenging in crowded and/or Global Positioning System (GPS)-denied indoor environments, especially if high reliability is demanded. Simple IoT-based infrastructures such as radio frequency identification (RFID)-enhanced floor have been used to provide reliable location information to domestic robots [3].

## II. LITERATURE REVIEW

Robotics is an interdisciplinary sector of science and engineering dedicated to the design, construction and use of mechanical robots. Asimov [4], coined and popularized the term robotics through many science-fiction novels and short stories. Asimov was a visionary who envisioned in the 1930s a positron brain for controlling robots; this pre-dated digital computers by a couple of decades. Unlike earlier robots in science fiction, robots do not threaten humans since Asimov invented the three laws of robotics:

i) A robot may not harm a human or, through inaction, allow a human to come to harm.
ii) A robot must obey the orders given by human beings, except when such orders conflict with the First Law.
iii) A robot must protect its own existence as long as it does not conflict with the First or second laws.

### 2.1 Concept of the Internet-of-Things

The Internet of Things (IoT) is the interconnection via the internet of computing devices embedded in everyday objects, enabling them to send and receive data. By the Internet of Things, objects recognize themselves and obtain intelligent behaviour by making or enabling related decisions thinks to the fact that they can communicate information about themselves. These objects can access information that has been aggregated by other things, or they can be added to other services. The Internet of Things (IoT) is the interconnection of physical objects such as vehicles, home appliances, and other items embedded with electronic software, sensors, and connectivity which enable these objects to connect and exchange data. Secondly, the general concept of the Internet of Things (IoT) is to effectively manage big data of physical objects on the internet. Internet of Things is a new technology of the Internet accessing. By the Internet of Things, objects have the ability to recognize themselves and obtain intelligence behavior via signaled communication [4].

#### 2.1.1 Application areas of the Internet of Things

Internet of things (IoT) promises many applications in human life, making life easier, safe and smart. There are many applications such as

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smart cities, homes, transportation, energy and smart environment.

i) Smart cities

Many major cities were supported by smart projects, like Seoul, New York, Tokyo, Shanghai, Singapore, Amsterdam, and Dubai. Smart cities may still be viewed as a city of the future and smart life, and by the innovation rate of creating smart cities today, it will become very feasible to enter the IoT technology in cities development. Smart cities demand requires careful planning in every stage, with support of agreement from governments, citizens to implement the internet of things technology in every aspect. By the IoT, cities can be improved in many levels, by improving infrastructure, enhancing public transportation reducing traffic congestion, and keeping citizens safe, healthy and more engaged in the community. By connection all systems in the cities like transportation system, healthcare system, weather monitoring systems and etc., in addition to support people by the internet in every place to accessing the database of airports, railways, transportation tracking operating under specified protocols, cities will become smarter by means of the internet of things [4].

ii) Smart homes and buildings

Wi-Fi's technologies in home automation have been used primarily due to the networked nature of deployed electronics where electronic devices such as TVs, mobile devices, etc. are usually supported by Wi-Fi. Wi-Fi have started becoming part of the home IP network and due the increasing rate of adoption of mobile computing devices like smart phones, tablets, etc. For example, a network to provide online streaming services or network at homes may provide a means to control all of the device functionality over the network [5].

iii) Smart energy, health and grid

A smart grid is related to the information and control and developed to have a smart energy management. A smart grid that integrate the information and communications technologies (ICTs) to the electricity network will enable a real time, two way communication between suppliers and consumers, creating more dynamic interaction on energy flow, which will help deliver electricity more efficiently and sustainably. The key elements of information and communications technologies will include sensing and monitoring technologies for power flows; digital communications infrastructure to transmit data across the grid; smart meters with in home display to inform energy usage [4]

iv) Smart factory

Smart factory added a new value in manufacturing revolution by integrating artificial intelligence, machine learning, and automation of knowledge work and communication with the manufacturing process. The smart factory will fundamentally change how products are invented, manufactured and shipped. Industries and manufacturing revolution became one of the most developed technologies nowadays, the growth of the industry evolution taken many generations. The first generation related to the mechanical machines in addition to water and stream power. The second industry generation deal with mass production, assembly lines and electricity. In the end of the last century, industries operated under control of computers and automation which recognized as third generation of industries [4]

**2.1.2 Major IoT challenges**

Major challenges encountered during embedded computing via the internet of things application involve the following:

i) Security

IoT has already turned into a serious security concern that has drawn the attention of prominent technological firms and government agencies across the world. The hacking of baby monitors, smart fridges, thermostats, drug infusion pumps, cameras and even the radio in your car are signifying a security nightmare being caused by the future of IoT. So many new nodes being added to networks and the internet will provide malicious actors with innumerable attack vectors and possibilities to carry out their evil deeds, especially since a considerable number of them suffer from security holes.

ii) Connectivity

Connecting so many devices will be one of the biggest challenges of the future of IoT, and it will defy the very structure of current communication models and the underlying technologies.

iii) Compatibility and longevity

IoT is growing in many different directions, with many different technologies competing to become the standard. This will cause difficulties and require the deployment of extra hardware and software when connecting devices.

iv) Standard
Technology standards which include network protocols, communication protocols, and data-aggregation standards, are the sum of all activities of handling, processing and storing the data collected from the sensors. This aggregation increases the value of data by increasing, the scale, scope, and frequency of data available for analysis.

**2.2 Concept of the Internet of Robotic Things**

The internet of robotic things (IoRT) is an emerging vision that brings together pervasive sensors and objects with robotic and autonomous systems. For most of technological history, the focus was on how to make devices communicate with humans, or how to use devices to communicate with other humans. How can we make our TV switch on, how can we make our computer run a game, how can we make the air conditioner give us the temperature we want. We used the internet to send emails to other humans, to check up on other humans on social media, to buy things from other humans [5].

Internet of Things is about limiting human involvement in that communication network. The internet here becomes not a network of humans connected through devices, but a network of devices talking to each other. IoT is basically a network of things capable of communicating with other things. Robotics is also about reducing human involvement. With robotics, we develop ways to delegate human tasks to machines. Robots can assist or even replace humans in doing tasks. Internet of Robotic Things is a field of research that describes the collaboration of the fields of Internet of Things and Robotics. IoRT is not IoT aided by Robotics or Robotics driven by IoT- but rather an amalgamation of the disciplines. It was slowly formed as a result of realizations that the two fields had a lot of overlapping of purpose, and could greatly benefit from a focus on their combination [4]

Although the concept of IoT has existed for more than two decades, and robotics even longer, IoRT is a rather novel field of research. The convergence of the two areas had been gradual but the term IoRT was coined and the concept formally defined in a 2014 report. IoRT is how we can create truly autonomous networks capable of carrying out complex tasks in the physical world. The ability of robotic technology to manipulate the physical world, and the capabilities of IoT to create independent and smart networks, together has great potential [5].

**2.2.1 Features of the Internet of Robotic Things**

To understand what describes an IoRT system, let's first look at the features that characterize IoT and Robotics separately.

i) Internet of Things

Sensing, connectivity, communication, intelligent processing, self-learning, and scalability are some of the features of IoT. IoT networks take sensory input, perform intelligent computations, learn from the environment, communicate with users and with other devices, can be controlled from any distance via simple methods, and perform operations that produce some outcome.

ii) Robotics

Sensing, control, processing, acting and interacting, and motion are some of the features that define a robot. These features are present in varying scales depending on the design and build of the robot. Robots may be capable of operating autonomously and making intelligent decisions and may collaborate with other robots. But most robots are limited to functions within their ranges of motion and focus mostly on interacting with the physical world rather than engage in digital control of systems. One distinctive feature is that IoT devices usually don't produce output by physical manipulation of the environment. They don't move around and interact with the physical environment as robots do. And robots need IoT for intelligent and collaborative thinking. This is where IoRT becomes relevant.

iii) Sensing/ Perception

As IoT devices and robots, IoRT devices perceive the environment- both physical and digital- through software, sensors, and technology like RFID and GPS. "Sensing As A Service" solutions are driven by this feature of IoRT. Sensing is also required for communicating and collaborating with humans as well as with other devices.

iv) Computation

IoRT devices perform intelligent computations using both cloud computing as well as edge computing. Sensory input is used as variables in computations and devices can actively learn from the data. IoRT has the capability to execute complex tasks with multiple variables, paths, and courses of action.

v) Connection/ Communication

Connecting with other devices on the network, with the internet, as well as establishing communication with other devices is pivotal for the functioning of IoRT systems. Communications networks are established via the Internet, Bluetooth, wi-fi, or other systems.

vi) Actuation

Actuating means taking the action required to accomplish the purpose of a device. This may be physical manipulation or cyber action. With the integration of robotics, IoT can actually directly perform actions in the physical world.

vii) Control

Autonomic control is given to IoRT systems, with minimal need for human involvement. Through communication networks, IoRT based systems also have data from other devices available to them. They can learn from data, adjust their plans accordingly, and account for the variation of different variables without the need for human assistance. The human side of control can be given from any distance through any device with an interface.

### 2.3 Machine Learning Classification Models

Machine learning is a field of study and is concerned with algorithms that learn from examples. Classification is a task that requires the use of machine learning algorithms that learn how to assign a class label to examples from the problem domain. An easy to understand example is classifying emails as “spam” or “not spam.” There are many different types of classification tasks that you may encounter in machine learning and specialized approaches to modelling that may be used for each. The study reviewed the following machine learning classification model:

i) K-Nearest Neighbor (K-NN)

In pattern recognition, the k-nearest neighbour algorithm (k-NN) is a non-parametric method used for classification and regression. In both cases, the input consists of the k closest training examples in the feature space. The output depends on whether k-NN is used for classification or regression: In k-NN classification, the output is a class membership. An object is classified by a plurality vote of its neighbours, with the object being assigned to the class most common among its k nearest neighbours (k is a positive integer, typically small). If k = 1, then the object is simply assigned to the class of that single nearest neighbour. In k-NN regression, the output is the property value for the object. This value is the average of the values of k nearest neighbours. K-NN is a type of instance-based learning, or lazy learning, where the function is only approximated locally and all computation is deferred until classification. Both for classification and regression, a useful technique can be to assign weights to the contributions of the neighbours, so that the nearer neighbours contribute more to the average than the more distant ones. For example, a common weighting scheme consists in giving each neighbour a weight of 1/d, where d is the distance to the neighbour. The neighbours are taken from a set of objects for which the class (for k-NN classification) or the object property value (for k-NN regression) is known. This can be thought of as the training set for the algorithm, though no explicit training step is required [6].

ii) Support Vector Machine (SVM)

In machine learning, support-vector machines (SVMs, also support-vector networks) are supervised learning models with associated learning algorithms that analyse data used for classification and regression analysis. Developed at AT and T Bell Laboratories by Vapnik with colleagues Boser et al. [6], Guyon et al. [7] and Vapnik et al. [8], it presents one of the most robust prediction methods, based on the statistical learning framework or VC theory proposed by Vapnik&Chervonenkis, [9], and Vapnik [10]. Given a set of training examples, each marked as belonging to one or the other of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier (although methods such as Platt scaling exist to use SVM in a probabilistic classification setting). An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on the side of the gap on which they fall. In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick, implicitly mapping their inputs into high-dimensional feature spaces. When data are unlabeled, supervised learning is not possible, and an unsupervised learning approach is required, which attempts to find natural clustering of the data to groups, and then map new data to these formed groups. The support-vector clustering algorithm, created by HavaSiegelmann and Vladimir Vapnik, applies the statistics of support vectors, developed in the support vector machines algorithm, to categorize unlabelled data, and is one of the most widely used clustering algorithms in industrial applications [7]

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Classifying data is a common task in machine learning. Suppose some given data points each belong to one of two classes, and the goal is to decide which class a new data point will be in. In the case of support-vector machines, a data point is viewed as a p {\display-style p} p-dimensional vector (a list of p {\display-style p} p numbers), and we want to know whether we can separate such points with a (p − 1) {\display-style (p-1)} (p-1)-dimensional hyper-plane. This is called a linear classifier. There are many hyper-planes that might classify the data. One reasonable choice as the best hyper-plane is the one that represents the largest separation, or margin, between the two classes. So we choose the hyper-plane so that the distance from it to the nearest data point on each side is maximized. If such a hyper-plane exists, it is known as the maximum-margin hyper-plane and the linear classifier it defines is known as a maximum-margin classifier; or equivalently, the perceptron of optimal stability. Support vector machines (SVMs) are powerful yet flexible supervised machine learning algorithms which are used both for classification and regression. But generally, they are used in classification problems. In 1960s, SVMs were first introduced but later they got refined in 1990. SVMs have their unique way of implementation as compared to other machine learning algorithms. Lately, they are extremely popular because of their ability to handle multiple continuous and categorical variables [6].

iii) Logistic Regression

In statistics, the logistic model (or logit model) is used to model the probability of a certain class or event existing such as pass/fail, win/lose, alive/dead or healthy/sick. This can be extended to model several classes of events such as determining whether an image contains a cat, dog, lion, etc. Each object being detected in the image would be assigned a probability between 0 and 1, with a sum of one. Logistic regression is a statistical model that in its basic form uses a logistic function to model a binary dependent variable, although many more complex extensions exist. In regression analysis, logistic regression (or logit regression) is estimating the parameters of a logistic model (a form of binary regression). Mathematically, a binary logistic model has a dependent variable with two possible values, such as pass/fail which is represented by an indicator variable, where the two values are labelled "0" and "1".

In the logistic model, the log-odds (the logarithm of the odds) for the value labelled "1" is a linear combination of one or more independent variables ("predictors"); the independent variables can each be a binary variable (two classes, coded by an indicator variable) or a continuous variable (any real value). The corresponding probability of the value labelled "1" can vary between 0 (certainly the value "0") and 1 (certainly the value "1"), hence the labelling; the function that converts log-odds to probability is the logistic function, hence the name. The unit of measurement for the log-odds scale is called a logit, from logistic unit, hence the alternative names. Analogous models with a different sigmoid function instead of the logistic function can also be used, such as the probit model; the defining characteristic of the logistic model is that increasing one of the independent variables multiplicatively scales the odds of the given outcome at a constant rate, with each independent variable having its own parameter; for a binary dependent variable this generalizes the odds ratio [7].

iv) Decision Tree

Decision Tree algorithm belongs to the family of supervised learning algorithms. Unlike other supervised learning algorithms, the decision tree algorithm can be used for solving regression and classification problems too. The goal of using a Decision Tree is to create a training model that can use to predict the class or value of the target variable by learning simple decision rules inferred from prior data (training data). In Decision Trees, for predicting a class label for a record we start from the root of the tree. We compare the values of the root attribute with the record’s attribute. On the basis of comparison, we follow the branch corresponding to that value and jump to the next node. Decision trees classify the examples by sorting them down the tree from the root to some leaf/terminal node, with the leaf/terminal node providing the classification of the example. Each node in the tree acts as a test case for some attribute, and each edge descending from the node corresponds to the possible answers to the test case. This process is recursive in nature and is repeated for every sub-tree rooted at the new node [8].

## III. CONCLUSION

The study reviewed various machine learning classification models and the internet of robotic things. A classification model attempts to draw some conclusion from observed values. Given one or more inputs a classification model will try to predict the value of one or more outcomes. Outcomes are labels that can be applied to a dataset. The term ‘Internet of robotic things’

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(IoRT) itself was coined in a report by foreign researchers to denote a concept where sensor data from a variety of sources are fused, processed using local and distributed intelligence and used to control and manipulate objects in the physical world. In this cyber-physical perspective of the IoRT, sensor and data analytics technologies from the IoT are used to give robots a wider situational awareness that leads to better task execution.

## REFERENCES

[1] Simoen P., Mauro D., and Alessandro S., The Internet of Robotic Things: A Review of concept, added value and applications, International Journal of Advanced Robotic Systems, vol. 2018:1, No. 11, 2018

[2] Chen, H., Markus O., and Illoh H.,.Applications of Fuzzy Logic in Data Mining Process.In Z. H. Bai Y., Advanced Fuzzy Logic Technologies in Industrial Applications.Advances in Industrial Control. Springer: London, 2016.

[3] Hannah M. and Julie S., A Review of Age Friendly Virtual Assistive Technologies and their Effect on Daily Living for Carers and Dependent Adults, HealthCare, Vol. 7, No. 49; doi:10.3390/healthcare7010049, 2016

[4] Hayley R., Bruce M. and Elizabeth B., The Role of Healthcare Robots for Older People at Home: A Review, International Journal of Soc. Robotics, Vol. 6: No. 575 – 591, 2014

[5] Daniel S., Fabian L. and Ingo T., Agent-based M and S of Individual Elderly Care Decision-Making, Proceedings of the 2018 Winter Simulation Conference, 2018

[6] Boser N., Helena F., and Joe E., Harnessing Machine Learning Classification Models, International Journal of Engineering Technology, Vol. 8, No. 6, 2019

[7] Guyon Y., Onbak L., and Sylvianus O., Large-Scale Software Repository and Source Code Mining for Machine Learning Classification, ACM Transactions on Software Engineering and Methodology (TOSEM), Vol. 25, No. 1, 2016

[8] Vapnik B., and Chervonenvis M., A Modified Approach to Artificial Intelligence (AI) for Activity Guidance, International Journal of Computer Application (IJCA), Vol. 8, No. 9, 1 – 5, 2010

[9] Benson M. and Nkamopi B., A Deep Generative Approach to Search Extrapolation and Recommendation, in the 25th ACM SIGKDD Conference on knowledge discovery and data mining (KDD '19), August 4 – 8, 2019, https://doi.org/10.1/45/3292500.3330786, 2019

[10] Vapnik B., Deploying Smart Program Understanding on a Large Code Base, A proceeding of the 1st IEEE International Conference On Artificial Intelligence Testing (AITest), San Francisco East Bay, CA, USA. Pp. 73 - 80