

Machine Learning Based Predictive Model for Data Fusion Based Intruder Alert System

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ABSTRACT

A Linear Regression and Support Vector Machine based algorithm is proposed with the two people detection sensors placed at the entry point of a building. The two sensors are ultrasonic sensor and microphone sensor. A Linear Regression model and SVM model is created for this and based on a simple top-down calculation done of the output of them both, the decision is taken for intruder identification. Arrays of ultrasonic sensors and microphone sensors are employed for aggregated output.

Keywords: Prediction, SVM, ML

1. INTRODUCTION

Machine Learning is a part of Artificial Intelligence that the systems can learn individually or automatically and enhance itself from the experience gained without being programmed or without the interference of human. Its main aim is to make computers learn automatically from the experience.

“Security system is more important in both industrial, offices and residential buildings. For the safety of human lives and their properties, there is no alternative or up to date and security mechanism is not available in public sectors or private sectors. With the advancement of technology in now a days, burglars also possess a new approaches to do the crime. In most areas still traditional security mechanism i.e camera are used for security purpose. In case of CCTV monitoring security systems, a security person always available and check the video of a day to find out the crime and suspect people.”[1]In this idea, a data fusion based intruder alert system is developed based on Machine Learning for the prediction. Through this alert system people can easily find the reason, cause and person who committed those crimes clearly in a limited time period.

2. WORKING

The dataset consists of sensor outputs of i.e., output of ultrasonic sensor and sound sensor. The dataset also consists of intruder alert data. The dataset is trained using support vector machines. The algorithm first identifies the support vectors of each class. The support vectors are the nearest neighbor points between the groups or classes one from each class. After taking the support vectors, Hyper plane is drawn. There are 3 major hyper planes, they are: positive hyper plane, negative hyper plane and maximum margin hyper plane. The positive and negative hyper plane are along the support vectors margins. The maximum margin hyper plane is medium between the positive hyper plane and negative hyper plane in accordance with performance level. The main function is to maximize the margin between the classes. This helps us to classify the classes and give the accurate classification and predicted data.

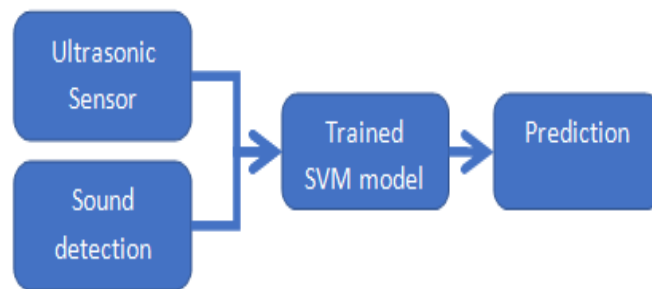


Figure 1. Block Diagram

2.1 Support Vector Machine

“A support vector machine (SVM) is used to analysis the data for classification and regression analysis. It is a supervised learning algorithm that sorts data into two categories as trained data and test data. First consider the trained data set for building the model. Trained data is used for predicting the test data in which it belongs. In this way SVM is a non-binary linear classifier for classification of data. An SVM algorithm not only classify data objects into groups, but also specify the margins between them for separation.”[2]

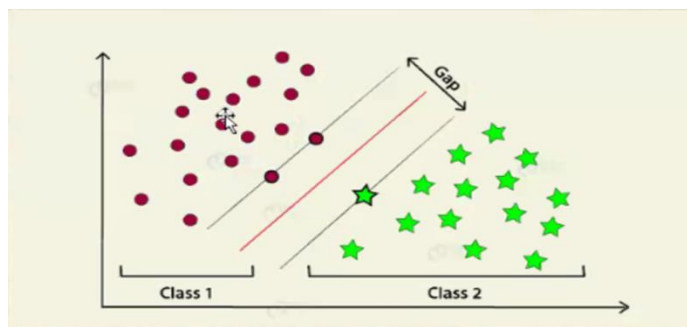


Figure 2. SVM graph

3. ARTIFICIAL INTELLIGENCE

The algorithmic flow presented in this paper falls under the field of Artificial Intelligence and Machine Learning. Presented below is an outline of those technologies.

“Artificial intelligence (AI) is the intelligence of machines or systems. Strong AI is usually labeled as artificial general intelligence (AGI) while attempts to find the natural intelligence have been called artificial biological intelligence (ABI). Artificial intelligence means the actions performed by machine with human intelligence. Artificial Intelligence is often used to describe machines that specify tasks or functions that human being associate with the human mind, such as learning, analysis and problem identification and solve it.”[3]

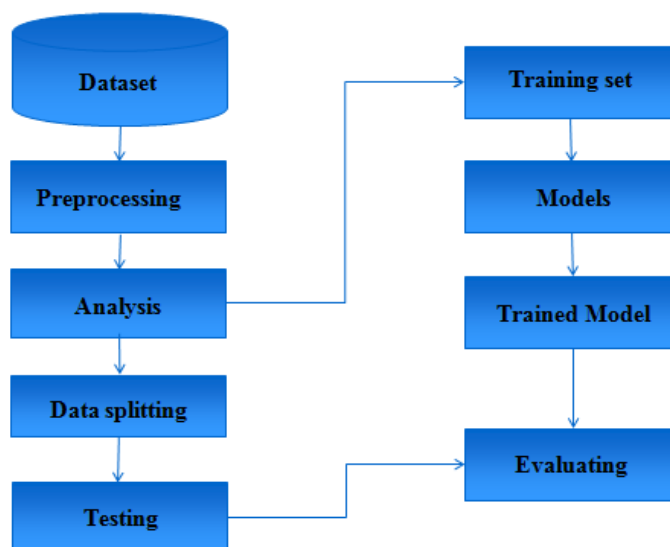


Figure 3. Flow Chart

“Machine capabilities are classified as AI include understanding human speech, and involve and competing in games such as chess, and also participate in imperfect-information games, self-driving vehicles and intelligent routing in networks, and in some real time applications .”[3]

“The goals of AI research is knowledge representation, analyzing, planning, learning and the ability to move and manipulate or change the data objects.”[3]

“Human knowledge can be so precisely specified that a machine can be made to simulate it. It is the human intelligence embedded to machines. We create the AI by following the ethics being endowed with human-like intelligence. Some people also argue that AI to be a dangerous to humanity and machine intelligence can increase the unemployment in society”[3]

“AI techniques improves or advances in computer science as in the form of power, data maintenance, and theoretical understanding of concepts; It helps to solve many computer science and software engineering challenging problems”[3]

4. MACHINE LEARNING

“Machine learning (ML) is used to improve or enhance automatically through experience of data or instructions. It is the part of AI. Machine learning algorithms build a model which is useful for trained the unknown sample based on training data, in order to make predictions or decisions for test data samples without being explicitly using program or algorithms. Machine learning technology is used in following applications like medical field, browsing data, account filtering, voice recognition ,in which it is difficult to develop the programs or solutions to execute the tasks.”[4]

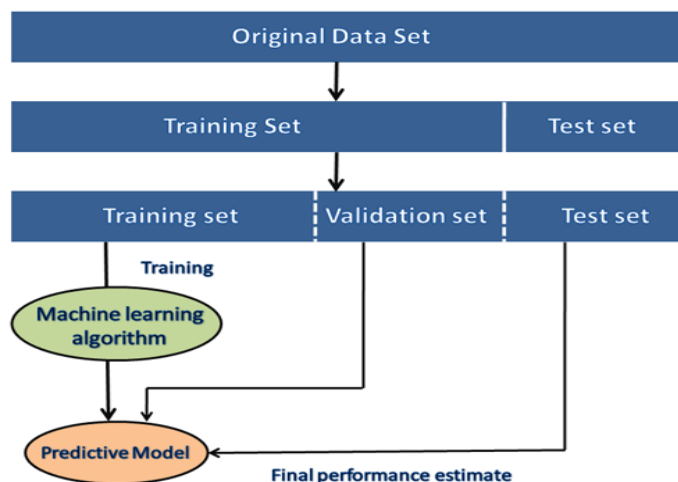


Figure 4. Machine learning Dataset

“Machine Learning also focuses on making predictions for unknown data for its classification whose label is not known. But not all the machine learning is a statistical learning. In Data Mining field the machine learning and its application are referred as predictive analytics of data.”[4]

5. INDUSTRY 4.0

“To increase automation we integrate the machine to machine communication and Internet of Things. By this we improve the solution for implementing smart cities, smart networks without any human assistance.”[5]

Automation has a particular schema or pattern for data presentation. Presented below is how automation in the mass production industry as well as consumer level products are built in today's technological era.

The schema presented in Figure 5 has a lot of other components involved but the generic outline of it stands justifiable for all kinds of automation today.

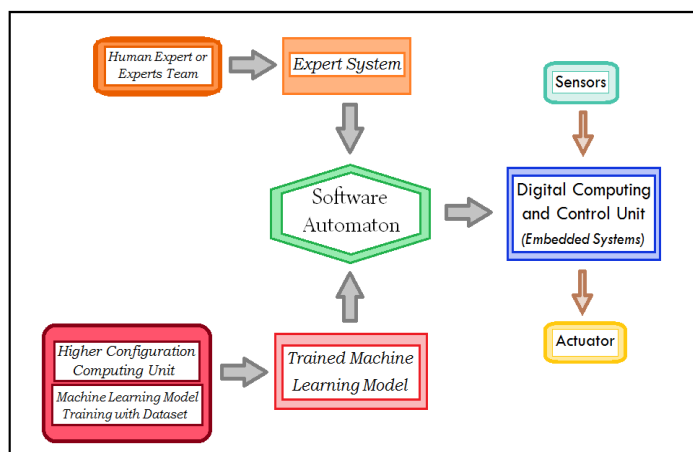


Figure 5. Schema of Automation

Till now software automation was developed by human experts. With the invention of machine learning technology, the software automaton was not designed by human being. The human experts just build the machine learning software and

give the sample data as training information. The machine learning software identifies the pattern between the input and the output parameters of the dataset in the form of a mathematical model. This mathematical model can be used as a building module to other computing devices. This mathematical model is referred to as the 'trained machine learning module'. The software automaton of all the current digital embedded devices is a mathematical model that gives a numerical output for a numerical input based on arithmetic and logical conditions. This software automaton, as explained above, can be either directly developed by a set of human experts by means of setting the boundary conditions themselves based on observation and requirement or can be downloaded as an executable module from machine learning training systems that are trained with relevant dataset. In whatever way the software automaton is developed, it can be loaded onto the relevant embedded computing module that can be used for either sensor based closed loop automation or open loop automation.

The technological components of Industry 4.0 include IoT, augmented reality, virtual reality, cloud computing, 3D printing, big data analytics, networking, data security, human-machine interaction and others. IoT is a very effective way to collect real world data. Sensors integrated with data acquisition and transmission systems can be placed anywhere and the collected data can be pre-processed if required and used as datasets to train machine learning models.

Cloud computing is employed for optimized utilization of computing resources. There are many third party vendors like Google and Amazon which are very reliable in terms of data security and speed of computation. These services offer companies and organizations a cheap and reliable way

Big data analytics is the set of technological components involved with collecting, collating and managing large quantities of data for analytics and decision making. When so much data is involved, especially with third party service providers, data security plays an important role.

One of the paramount concerns about Industry 4.0 is the unemployment it can create due to powerful automations. The field of human-machine interactions and co-working has been a very developing field now to mitigate the above mentioned problem.

6. RESULTS AND DISCUSSION

| Ultrasonic Sensor Signal | Microphone Sensor Signal | Intruder (1) Inmate (0) |
|-----------------------------|-----------------------------|----------------------------|
| 89 | 4 | 1 |
| 78 | 6 | 1 |
| 92 | 12 | 1 |
| 78 | 3 | 1 |
| 88 | 20 | 1 |
| 87 | 16 | 1 |
| 91 | 8 | 1 |
| 79 | 13 | 1 |
| 85 | 15 | 1 |
| 87 | 14 | 1 |
| 5 | 91 | 0 |
| 7 | 81 | 0 |
| 11 | 92 | 0 |
| 4 | 87 | 0 |
| 22 | 83 | 0 |
| 18 | 76 | 0 |
| 7 | 92 | 0 |
| 12 | 80 | 0 |
| 16 | 83 | 0 |
| 13 | 84 | 0 |

Figure 6. Input Sample Dataset

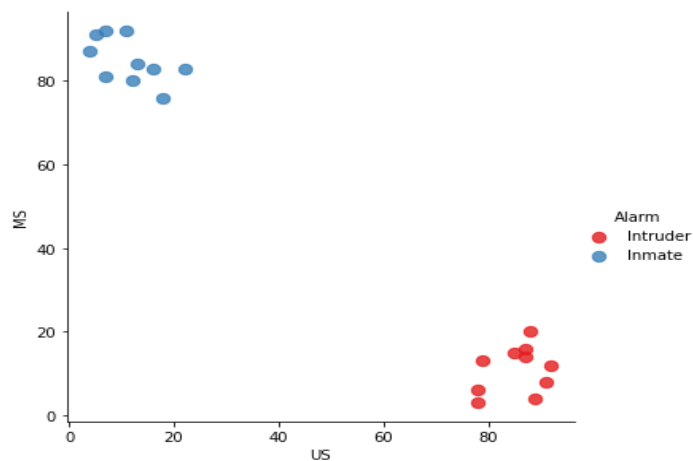


Figure 7. Output graph 1

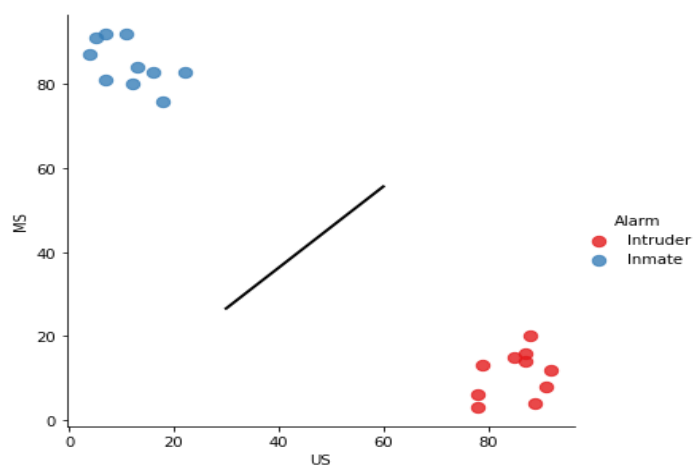


Figure 8. Output graph 2

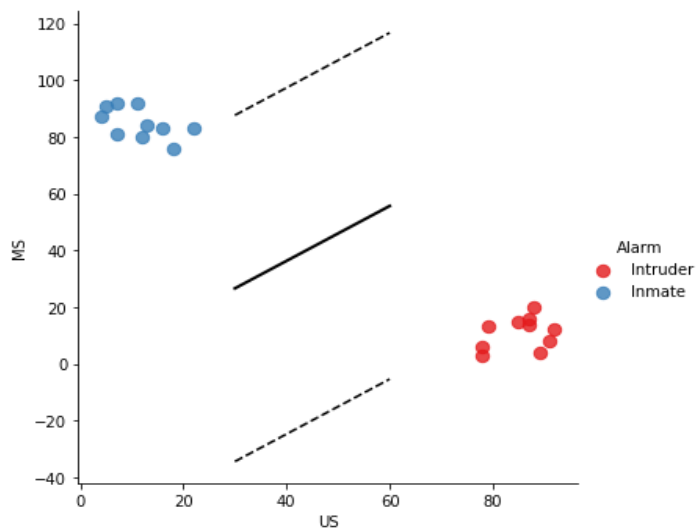


Figure 9. Output graph 3

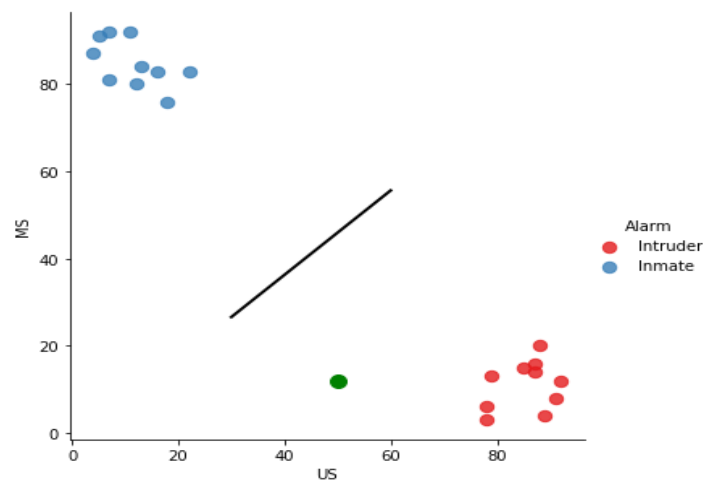


Figure 10. Output graph 4

This machine learning based predictive model is implemented employing Python programming language. The relevant library files have been included for execution of the code. The dataset was given as input and the predictive model obtained. The prediction model was tested and the results were satisfactory. The output graph of the machine learning model has been presented above. In this project, a Support Vector Machine algorithm is employed. The two parameters are the microphone sensor readings and the ultrasonic sensor readings. The intruder and inmate of a building are classified as two classes.

7. CONCLUSION AND FUTURE WORK

The experiment is conducted successfully and results were obtained as expected. The trained model is able to predict the alert depending upon the sensor's outputs. This enables us to raise the alert upon any intruder is found. The predictive model-based outputs are much faster and accurate. In future there can be extended by adding addition alert modules thus enabling faster action upon finding an intruder.

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- [4] https://en.wikipedia.org/wiki/Machine_learning
- [5] https://en.wikipedia.org/wiki/Fourth_Industrial_Revolution