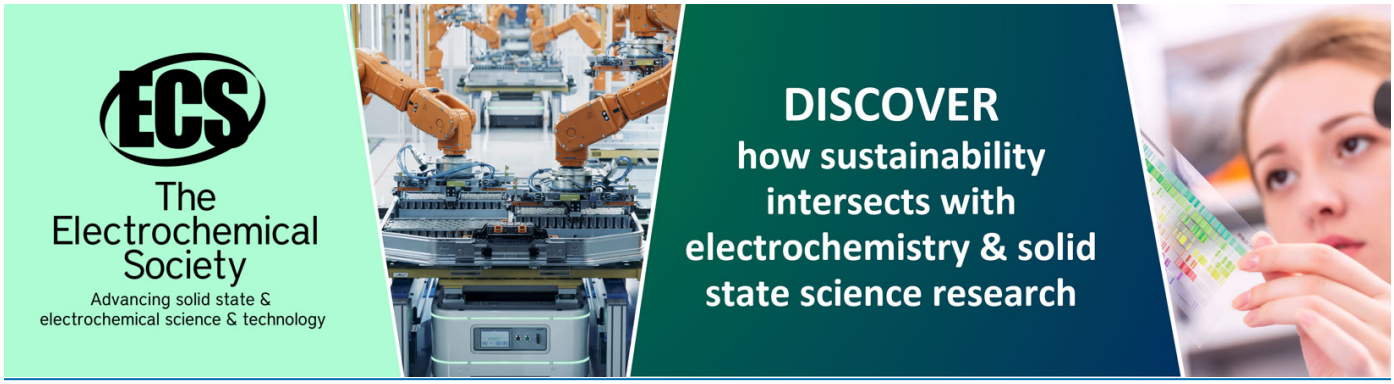
An Approach for Morse Code Translation from Eye Blinks Using Tree Based Machine Learning Algorithms and OpenCV



An Approach for Morse Code Translation from Eye Blinks Using Tree Based Machine Learning Algorithms and OpenCV

G Sumanth Naga Deepak, B Rohit, Ch Akhil, D Sai Surya Chandra Bharath and Kolla Bhanu Prakash

Department of Computer Science and Engineering, Koneru Lakshmaiah Education Foundation, Green Fields, Vaddeswaram, Andhra Pradesh 522502

E-mail : *sumanthguntupalli@gmail.com , rohitbokkisam@gmail.com , akhilchitirala@gmail.com, saisurya.deevi@gmail.com, drkbp@kluniversity.in*

Abstract: For ages, human beings have been communicating with one another through different modes of communication. Communication is a process through which a person can communicate his/her feelings and thoughts to the other person. To communicate we can do it through either speech or sign language. The spoken language is used by abled persons, While the differently abled persons (deaf and dumb) may find it difficult to understand the same. So, for effective communication between the differently abled and abled person sign language has been developed. For private communication between two people, morse code has been developed which is highly efficient to exchange secrets. It also helps in emergencies where a person cannot communicate through hand gestures. Different methods/modes are used in morse code, but our focus is on eye blinking. Our approach towards this area has been to implement morse code using eye blinks in real-time assistance using a webcam to provide predicting power based on machine learning's tree algorithms.

Keywords: *Communication, Hand gestures, Morse code, OpenCV, Eye blink.*

1. INTRODUCTION

Everyone needs communication to express their feelings or opinion or for information passing. Normal people will communicate by speaking and deaf and dumb people by using sign language. Morse code is a type of sign language which is very useful for secret communication and this type of communication is important in army, navy, and air force departments why because in those departments there is so much sensitive information which shouldn't be reviled to others and that information should not be understandable by others. So, they prefer a separate way of communication, which is called the Morse Code. It was invented by Samuel Finley Breese Morse (1791-1872) is an American [9].

Before the invention of the Morse code, people were communicated through handwritten papers and transported by horseback. Because of this a lot of time was wasted on the transport of information in the form of handwritten papers. But the Morse code changed the way of communication.

In this type of communication, they will communicate using eye blinks or finger gestures, or head gestures according to their situation or convenience. Every gesture or eye blink will have a certain

meaning and according to that gesture, they will communicate. This was the quickest long-distance method of communication at the point of its invention why because a single gesture in more code will convey a lot of information. Morse code played an important role in information passing during the Second World War Since it increased the speed of communication.

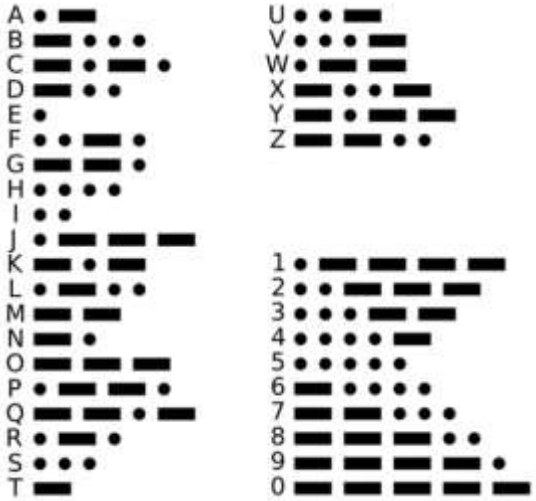


Figure 1. Morse Code Representation using dot dash format [10]

In the above figure, we can see a more code for each alphabet and each digit. Those dot-dash patterns will be decoded from the user input, for example a short eye blink will represent a dot and a long eye blink will represent a dash. The combination of those dots and dash will represent a specific meaning**.**

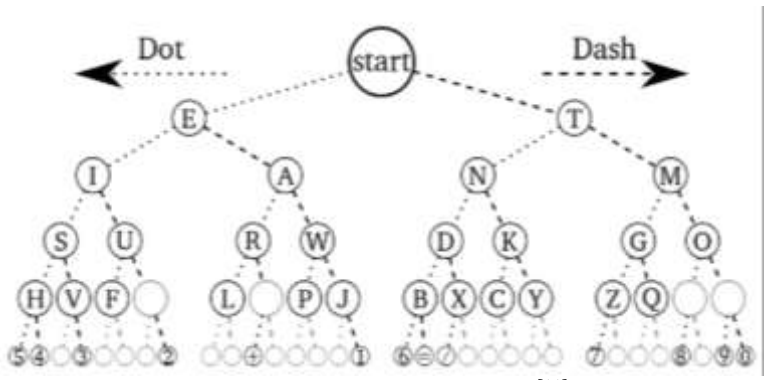


Figure 2. Tree Representation[11]

We can see how those dot dash patterns differ from one to another in the above figure. This figure was built upon the binary search tree logic. In binary search tree if the input is less than the root then it will be assigned to the left sub tree else it will assign to the right sub tree. In this tree if the input is dot then it is assigned to the left sub tree. If it is dash, then it is assigned to the right sub tree. This figure is to understand how the more code differs from one alphabet to another alphabet or from one number to another number.

This type of communication is not only useful for national security purposes, but also useful for deaf and dumb people why because they can convey more information in less time with less effect.

2. LITERATURE SURVEY

Through technology many ways of communication are possible. Communication is differing from one case to another case. Normal people will communicate through speaking and hearing in an

understandable language. Differently abled people like deaf and dumb will have an alternate way of communication like through sign language but the problem with sign language is, it is not comfortable for all the people. [11] To have an effective communication between differently abled people and normal people there is a need for a sign language translator. And this translator is not only useful for good understanding but also for Secret information passing which is very useful in national security. Morse code is a type of sign language which is built upon dots and dashes symbols. [12] There are several surveys on the morse code. The surveys explain the possibilities and drawbacks of the implementations. [13]

The Morse code translator can be implemented by using Eye Blinks and Decoding using OpenCV [1]. The input will be taken as a video that consists of a sequence of eye blinks and using OpenCV we can decode and convert that eye blinks to specific meaning. [14]

Morse code has been implemented using data patterns. In which, the input will be a sequence of 0's and 1's and this sequence will have a specific meaning according to that meaning information will be passed or conveyed [2]. This kind of implementation is not efficient since the input is given through the keyboard. We need a good dynamic model that takes dynamic input in a pattern of 0's and 1's which is difficult. [15]

Another way of implementing Morse code translator is using finger gesture as an input which will convert the input gesture into respective dot-dash pattern [3] but the problem with this model is that the input should be given with high accuracy. If the position of the finger slightly changes then the whole meaning changes which is not acceptable in secret information passing. A model that takes head gesture as input will be better than finger gesture because the model cannot decode the user's gesture exactly because even the slightest changes in the gesture will give an entirely different meaning [4].

So, we decided to implement the model which takes eye blinks as an input because of the high possibility of getting an accurate output. [16]

3. EXISTING SYSTEMS

For ages the morse code has been used by many government officials during emergencies and when the normal means of communication are not available, and it is also a type of sign language used by people to communicate. [17] We found some of the existing models like morse code translation using sound that works on the principle of sound clicks. In this method, the person will communicate with his eyes and another person need to convert it into sound (click) and that must be decoded into human-understandable language. In some other models, the morse code is generated using tongue gestures will be inappropriate. In some, they are using costly sensors that are not affordable by common people. A few existing systems have devised different representations (or) data patterns of 0's and 1's to represent a character. The major disadvantage of this kind of system is that it is prone to changes by external factors like noise, strong electrical impulses, changes happening due to internal refraction of light in optical cables. In some models input is taken in form of head gestures and each gesture will have a specific meaning like lifting the head in upward direction means dot, downward direction means dash, towards left direction means a backspace (to delete a dot or dash) and towards the right direction is to conform and convert into text.

4. METHODOLOGY

In our research, we are performing the morse code using eye blinks. First, we have used OpenCV to open the webcam for input. Then with the help of dlib.get_frontal_face_detector()

we detect the face. Then we have used dlib.shape_predictor library for the detection of the eye region, this library is useful to detect the different facial landmarks like the tip of a nose, edges of eye or

mouth or ears, and so on. We have given different time limits to detect dashes and dots i.e., 15 seconds for the dash and 30 seconds for the dot. So, to get a dash as an output we have to blink our eyes once and close our eyes for 15 seconds, and similarly, for a dot, we have to blink our eyes once and close our eyes for 30 seconds. After giving input, we press the 'q' key to close the webcam.

Then we are storing the dots and dashes in a list which is further passed on to our machine learning models for prediction of the character. Upon completion of the prediction, we will display the character on the screen. This whole procedure is performed using the flask framework as an interface for the user. We have used flask in the interface to bridge the gap between the machine learning model and the front-end part (which is enhanced by the HTML and CSS) where the user tries to give the input. Flask has played a major role since when a user gives the input then it goes into a proxy server where our machine learning model gets stored and from there it tries to fetch the output and display it on the screen.

5. ALGORITHMS

In this model we used random forest and decision tree algorithm

Decision Tree

Decision Tree is a supervised machine learning technique. Supervised technique means models of these types would require label (or) the target column to be there before hand for training the model. But unlike other supervised techniques, it can be used for both classification and regression. Decision Tree algorithm is a tree structured, so in it every leaf node denotes the output, the branches denote the rules for decision making and internal nodes denotes the features that are extracted from the data. The decisions are taken based on these extracted features. A decision tree consists of two types of nodes, they are decision and leaf nodes. Decision node's main purpose is to take decisions and they have many branches and leaf node's main purpose is to present the outcome of these decisions and have zero branches. In decision tree we have used Gini index to split the data and form a tree kind of a structure. Among all the different types of algorithms used for splitting the data and formation of tree Gini index is best among them for our dataset. Since it does the perfect split and gives a better accuracy in the end.

Gini Index= $1- \sum_j P_j^2$

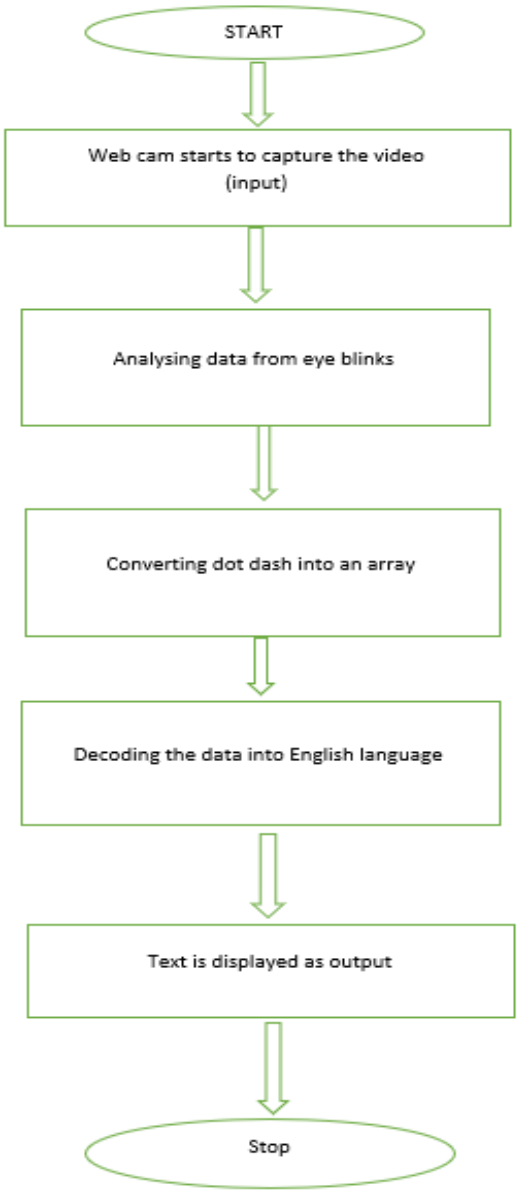


Figure 3. Flow Chart

When we run the program, first the webcam will open and starts capturing the video which will be taken as input. Then we do video processing and analysis how long the eye blinks are to convert that into dots and dashes which will be sent to a machine learning model to analysis and translate it. After analysis it the output is displayed.

Random Forest:

Random Forest is an ensemble learning technique. An ensemble technique in itself means creations of multiple models and voting is done among this model and the label or the target is predicted based upon the highest voting factor. Similarly, a Random forest creates multiple tree models and does the prediction. The greater number of tree-models results to a more accurate output and it also helps to prevent over fitting problem. Random forest algorithm takes less training time when compared to other algorithms. It gives output with high accuracy, even when a large dataset is used or even a large part of the data is missing. In the study we have used 1000 random trees with a maximum depth as 2 and created the model.

When we run the program, first the webcam will open and starts capturing the video which will be taken as input. Then we do video processing and analysis how long the eye blinks are to convert that into dots and dashes which will be sent to a machine learning model to analysis and translate it. After analysis it the output is displayed.

6. RESULTS AND DISSCUSION

The existing systems have quite a low accuracy in comparison with our proposed system. Even it is quite cumbersome to use the existing system since the time taken for the executions is quite high, they are going in seconds to predict a single character. The major drawback in existing systems is that it makes the process tiresome and complicated since a person who is performing the morse code using the eye blinks must also remember that dot is represented through the right eye(R) and dash through the left eye(L). Whereas in our proposed system we have reduced the burden on the person by removing the L-R eye pattern to create Morse code structure instead we have used both the eyes and kept a time limit as 15 seconds blink for dash and 30 seconds blink for the dot. We have also kept 40 seconds closed eye time window to remove extra dots and dashes but then also we have a limitation regarding the occurrences of extra dots and dashes which sometimes causes hindrance in predicting the character. Our proposed system has machine learning techniques been implemented with comparative analysis been done with 4 other supervised models, Due to the inclusion of machine learning we have given our proposed system the prediction power to predict the character with high accuracy which were lacking in the existing models.

Figure 4. Taking Input

The above image depicts on how to perform the morse code using eye blinks.

Figure 5. Predicting Output

The above photo shows how the output is displayed on the screen.

***Validation Graphs**:*

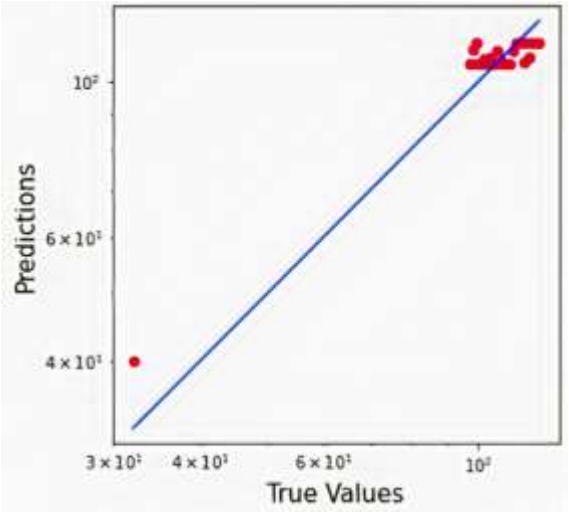


Figure 6. Graph between True values vs Predicated values of Random Forest Regressor

In the above graph the blue colour line indicates the true values, and the scatter plots indicates the predicted values we can see in the above image that there are some points the does not synchronize with the line so that the accuracy of this model is extremely low.

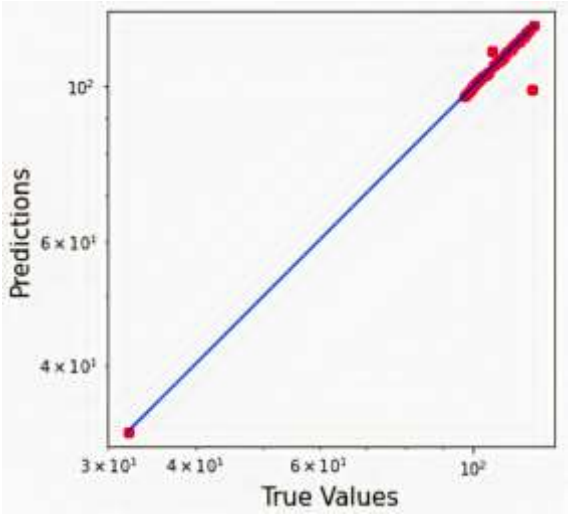


Figure 7. Graph between True values vs Predicated values of Random Forest Classifier

In the above graph the blue colour line indicates the true values, and the scatter plots indicates the predicted values we can see in the above image that there are some points the does not synchronize with the line so that the accuracy of this model is better than the Random Forest Regressor one point is above the line and one point is below.

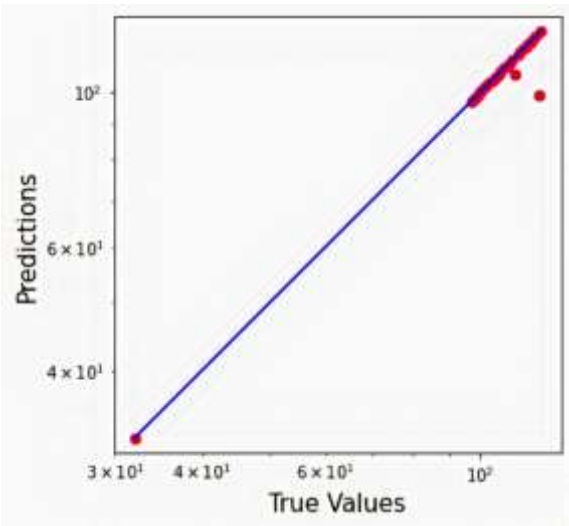


Figure 8. Graph between True values vs Predicated values of Decision Tree Classifier

In the above graph, the blue colour line indicates the true values, and the scatter plots indicates the predicted values we can see in the above image that there are some points the does not synchronize with the line sothat the accuracy of this model is better than the Random Forest Classifier only one point is below.

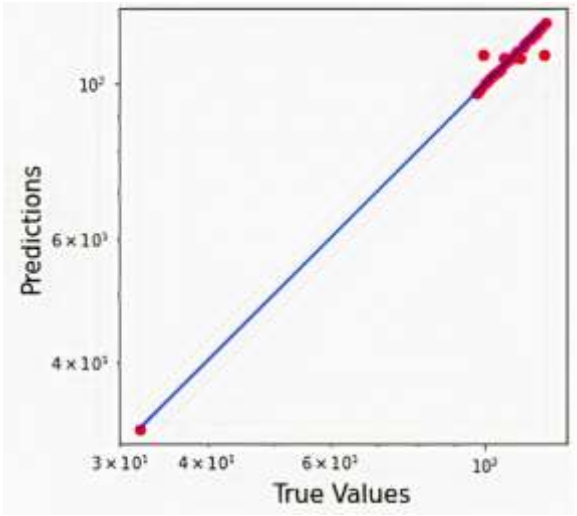


Figure 9. Graph between True values vs Predicated values of Decision Tree Regressor

In the above graph the blue colour line indicates the true values, and the scatter plots indicates the predicted values we can see in the above image that there are some points the does not synchronize with the line so that the accuracy of this model is better than the Decision Tree Classifier here the points are scattered but they are in equidistance to the blue line.

The above graphs are the representations of how well the prediction of the true values is done by our proposed system. From the given graphs we could say that the Decision tree Regressor has a better graph representation since the true values and predicted values are in sync with each other.

Model	Accuracy
Random Forest Regressor	84%
Random Forest Classifier	92%
Decision Tree Classifier	91%
Decision Tree Regressor	96%

Table 1. Accuracies of different models

In the Base paper, we referred to, no machine learning algorithm was used. Only OpenCV techniques were used and got an accuracy of 51.16%. So, in this project, we created four different ML (Machine Learning) models and did a comparative study. Each model gave a different accuracy as you can see in the above table. Among these four models, Decision Tree Regressor has the highest accuracy. So, Decision Tree Regressor is the best model for this project.

7. CONCLUSION

The existing system was quite complicated and people working on this system must have to remember a lot. whereas our system has resolved the complicated issues and added predictive power to it. But the only flaw in the proposed system is that the time limit is associated with dots and dashes. So, in the future, we can improve the model by removing the time limits and implementing advanced machine learning algorithms such as Neural Networks. This model could also be extended to words and sentences and even for paragraphs.

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