Quality Assessment and Grading of Milk using Sensors and Neural Networks

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Quality Assessment and Grading of Milk using Sensors and Neural Networks

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Abstract - Every person's primary source of nutrition comes from milk. Adulterants should not be found in milk that is of high quality. In most cases, local shopkeepers and supermarket shops alike sell milk. Nevertheless, the local milk merchants utilise a slew of adulterants in their product, changing the composition of milk forever. The usage of degraded milk can lead to major health problems. The milk must therefore be tested for the presence of necessary parameters and any adulterants that have been added to it in order to ensure the quality of the milk. Here, sensors are employed to estimate several factors, such as pH, turbidity and colour. Similarly, the milk sector should be able to transmit the administration continuous data on milk quality during the production of milk bundles using the Neural Network model to help combat illegal items like poor milk quality.

Keywords- **CNN, Neural Networks, sensors, adulteration, milk.**

I. INTRODUCTION

In India milk generation gives relatively higher benefit to the Dairy farmers. All through the world, in excess of 11 billion buyers of milk and milk items are there and 70% are consistently credited to lack of healthy sustenance. In this way milk is noteworthy nourishment for the newborn children. The quality and resistance of crude milk is basic for the dairy products[2][3]. The healthy benefit of milk to human beings needs no presentation. In the meantime, it is harmful that numerous merchants contaminating it with water, cleansers, harsh soft drink, sodium carbonate which has hurtful impact on the human beings particularly little children.

If certain essential quality tests are performed at various stages, a milk dealer and customer can be assured of the quality of crude milk. Milk needs to be dichotomized in order to protect children, especially infants, from illness. As a result, a model for identifying contaminated milk and checking its quality is proposed. Identifying adulterants in milk will be the primary goal of this work. In this model, numerous characteristics, including as pH, smell, temperature and conductivity can be evaluated, as well as the turbidity of the water.

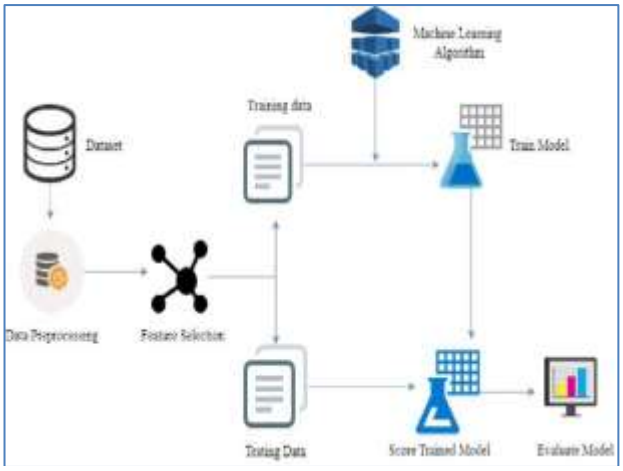


Figure 1: Architecture Model

Artificial neural networks (ANNs) are an algorithmic branch of machine learning that focuses on the brain's structure and functions [9] [10]. Using deep learning for computer education is the most exciting and effective technology out there. When they learn how to better deal with and solve the problem, deep learning approaches are extremely powerful. Learning representation is the term used to describe it.

Representative learning may be the most significant difference between deep learning models and traditional machine learning methods. The great level of innovation in the application of approaches can be attributed to representational learning's inherent power. For example:

- Deep learning models can be used in brave innovative ways including eliminating the head of a learned network and adjusting it for an entirely different problem and producing amazing outcomes.
- The classification and clustering of objects was coupled with deep learning models, a dynamic problem which was historically assumed to involve massive artificial intelligence systems.

This paper suggests a solution focused on deep learning to increase the accuracy level with updated CNN models and better time values and hidden layers. Compared to older ones, the proposed device displays greater precision. This proposed model forecasting and getting accurate values on the basis of CNN[5].

II. BACKGROUND

Food safety, human safety, and water safety are three of the most pressing concerns faced today. Food Safety is the priority here. At this point in time, milk is the primary source of nutrition for most newborns. Because of our research into milk quality [7], it was discovered that the milk is being contaminated. As a result, it was decided to use a Neural Network to further our goal of producing high-quality milk. Everyone should be able to identify the type of milk they are drinking. In determining the nutritional value of milk, dairy companies encounter a number of challenges. The purpose of this model is to evaluate the nutritional value of milk. The tests are carried out in such a way as to determine whether or not the milk products match the norms[1][4].

III. PROPOSED SYSTEM

This enterprise is essentially coordinated towards assessing the quality of milk. The proposed systems work with the neural networks and sensors. But quality is a relative property. So, it is possible to determine whether the milk is pure or not by comparing with the other sample's parameters such as pH, temperature, fat etc. Therefore, neural network is used to predict the quality of the milk. Here Neural Network is fed with huge amount of data and the model gets trained using that data. This data includes thousands of milk samples along with its parameters and the grade associated with that sample[5][8]. Once Neural Network learn patterns by adjusting weights of the parameters of milk such as pH, Odor, color, turbidity, temperature, fat, taste[6]. It can able to predict the quality of the milk at a particular instant. The observing framework fundamentally consists of seven distinct parameters. Using these parameters, the nature of milk can be determined. The components are recorded as follows:

A] pH B] Temperature C] Odor D] Taste E) Color

F] FAT G) Turbidity

A. pH

It is a measure of acidity or basicity. PH means Potential of Hydrogen. Basically, milk has pH value between 6.5 and 6.7. So, milk is actually acidic in nature. It is possible to determine whether the fluid is acidic or basic by taking pH value of water as a reference point. This is calculated by pH sensor. PH is measured by pH sensor. PH is calculated as follows

$$pH=-\log [H^{+}]$$

Figure 2: PH Sensor

B. Temperature

The optimum temperature of milk is in between 35 and 45**°C.** If it exceeds this limit milk will be affected by the bacteria. Temperature is measured by using temperature sensor.

C. Odor

Milk emits toxic gases when it is contaminated. Odor of milk is also a parameter of quality. The texture of the milk is enough to measure whether the milk is spoiled or not. It is calculated by odor sensor.

D. Taste

Taste of the milk is dependent on PH and odor of the milk. Taste of milk plays a vital role in judging whether the milk is fresh or not.

E. Color

The color of the milk is white. The range of RGB is 255.The milk can be in the range of 240-255 which is equivalent to white. Color of milk is given by TCS3200 color sensor.

Figure 3: TCS3200 color sensor

F. FAT

Fat also plays an important role in identifying the nature of the milk. Generally pure milk has 3.25 fat content. Fat content is measured by using sensor.

G. Turbidity

Turbidity is triggered by particles suspended in milk by redirecting the light. The Turbidity should be less for pure milk. The turbidity is measured by using turbidity sensor.

IV. WORKING OF THE NEURAL NETWORKS

Neural networks mirror the human brain in many ways, including their structure and function. Algorithms make up this system. It is begun using a dataset for milk grading that includes factors like pH, temperature, odour, colour, turbidity, taste, and fat. The dataset is linked to the neural networks to see how it changes over time. The input layer of the neural network receives these parameters. Each neuron's weights and biases should be initialised with non-zero random values. Weights represent the parameter's relevance, whereas bias is the degree of uncertainty associated with the node. Bias tends to remain stable over time. The neural network's forward propagation process is now complete. For each neuron, begin by calculating the weighted input Z. As an activation function, select the sigmoid. Values in the 0–1 range are scaled using the sigmoid function. If the sigmoid function is close to or equal to 1, a neuron will be triggered. If this isn't the case, no signal is sent to the cell in the next layer. Each neuron's cost function is also calculated for each layer. Finalize the model if the cost function is close to or equal to zero; if not, Back propagation is executed. Gradient Descent Function is used to self-adjust weight and bias in Back propagation. Minimal functions are used to reduce the chance of an incorrect answer. It's useful for optimising your website. Some more forward propagation is done this time. Once an accurate result is received, this process is repeated. This process is repeated indefinitely until the minimal cost function is obtained[4]. Fuzziness in neural networks is used at the output layer to classify the milk.

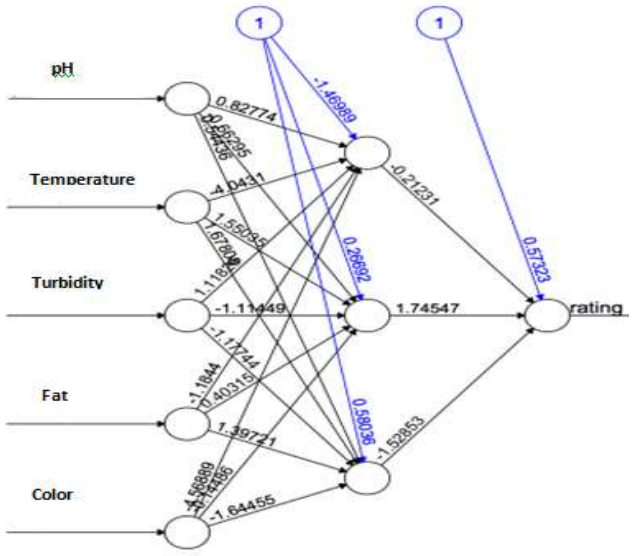
A. Algorithm

Step1: Input Dataset
Step 2: Pass parameters to the input layer of Neural Network.
Step 3: Initialize Weights and Bias with random values.
Step 4: Perform forward propagation,
Calculate weighted input
$Z=\sum (W_i X_i + b)$
Step 5: Activation Function:
$y=1/ (1+e^{(-z)})$
f(x) = 1 if y>0.5
= 0.5 if y=0.5
= 0 if y<0.5
Step 6: Activate neuron if f(x) =1
Step 7: Calculate cost function:
$J=-1/m [\sum (Logy+ (1-Y) log (1-Yp))]$
Where Yap is predicted outputand Y is actual output
Step 8: If J=0
Finalize the model. goto Step 10.
Otherwise,
Backpropagation. goto Step 9.
Step 9: In Backpropagation,
W=W- [α*(dJ [w, b]/dW)]
B=b-[α*(dJ[w,b]/dW)]
goto Step 4
Step 10: if f(x) =1
Then A-Grade
Else if f(x)=0.5
B-Grade
Else
C-Grade
Step 11. End

V. FITTING NEURAL NETWORKS

Processed information from the first layer of a neural network is sent to its hidden levels as input. The last layer, which generates the output, receives the data from the hidden layer. The adaptable nature of neural networks is a major benefit.
When a neuron exceeds a certain threshold, it gets activated. To ensure the lowest possible error in forward propagation, a cost function is constructed at each node. Adding a bias to a neural network can help the model fit better to a certain dataset. It adjusts itself by a method known as back propagation to learn the weights of the

input to the specific node at a certain layer.



Error: 0.68735 Steps: 238
Figure 4: CNN with weights and Bias.

In the input layer, sensors are used to collect milk parameters. Finally, at the output layer, the output (grade of milk), which is a combination of inputs from the hidden layer is obtained.

The rating of the milk can be predicted after fitting the data to the model. Neuronal networks have a big difficulty in that they overfit data to the model, which is problematic. Because of over-fitting, the training test is accurate, but it cannot reliably predict the rating when testing data. So, the testing dataset is divided into testing and cross-validation datasets. The projected rating and the actual rating of the cross-validation dataset are compared in this section. In order to determine whether or not the model is overfitted.

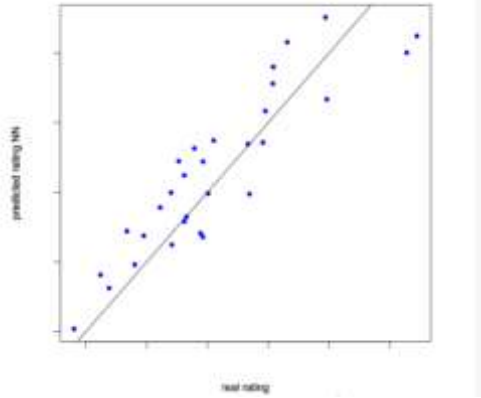


Figure 5: Predicted rating vs. real rating using neural network

In traditional machine learning models the error decreases with increase of length of the data up to some extent once it reaches to a point if the length of the data set is increased, the model is unable to learn hidden patterns from the data and error does not varies with length of data. Whereas in Neural Networks, Accuracy increases with the increase of length of data.

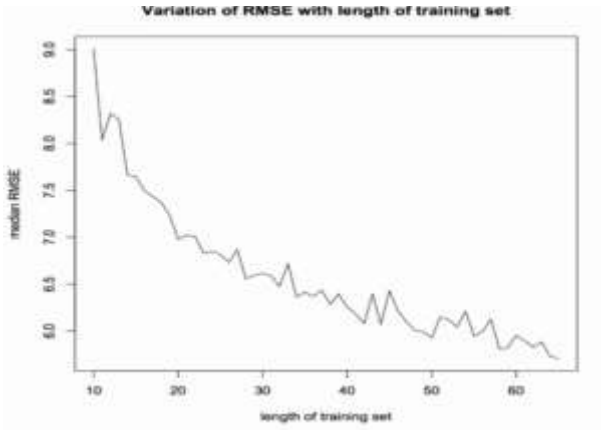


Figure 6: Variation of RMSE

A. Advantages

Milk Grading using this model has numerous advantages. Some of them as follow

1. Primarily, it enables the consumer to select the particular grade of milk.
2. This methodology requires low labor cost and it is less expensive when compared to other methodologies.
3. Maintenance cost is low so anyone can use it without any training.
4. The milk is classified with high accuracy.
5. It overcomes the limitations of conventional methods which is beneficial to organizations and consumers.

B. Disadvantages

1. Since sensors are used to find the values of different parameters of milk, so initial cost is high.
2. Since Neural Networks are used, high computational power is required.
3. Neural Networks sometimes may suffer Vanishing gradient problem and over fitting.
4. Normalizing and cleaning the data is extra burden.

C. Applications

It has wide range of applications,

1. It provides quality assurance to the customers and farmers.
2. It is efficient method to reduce milk adulteration.
3. It enables customers to take decisions based on computer-based statistics and analysis concerning the quality of milk.

VI. CONCLUSION & FUTURE WORK

In order to detect milk that has been tampered with by small-town merchants and ensure that the people who need it have access to it, this approach makes use of Neural Networks to make quality predictions. Milk quality may be predicted quite accurately in large-scale dairy operations by making comparisons with previous samples of milk. This model has the ability to identify previously unknown patterns among milk quality characteristics by experimenting with various parameter combinations, and it can accurately forecast milk quality in a way that traditional approaches cannot. This model's primary goal is to incorporate Neural Networks into everyday elements of our lives. Basically, the focus of this research is to classify milk according to its quality.

This practice will reduce the contamination of milk and ensures the health of customers.

1. It replaces all conventional methods and provides sensible solutions to the contemporary problems in milk grading.
2. An android application can be developed to view quality of the milk even from home.
3. Customer can compare quality of milk between two particular vendors and even between two particular regions.
4. The process of milk examination methods can be automated with less interference of humans.
5. Edge computing and some machine learning techniques can be applied in future scope of milk grading.
6. Machine learning and deep learning techniques can be incorporated in dairy products.

REFERENCES

[1] Brudzewski, K. & Osowski, Stanislaw & Markiewicz, T.. (2004). Classification of milk of an electronic nose and SVM neural network. Sensors and Actuators B: Chemical. 98. 291-298. 10.1016/j.snb.2003.10.028.

[2] Syeda Erfana Zohora, A.M.Khan, A.K.Srivastava, Nisar Hundewale, “Electronic Noses Application to Food Analysis Using Metal Oxide Sensors: A Review”, International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-3, Issue-5, November 2013.

[3] Ashwin Judal, A. G. Bhadania, “Role of Machine Vision System in Food Quality and Safety Evaluation”, International Journal of Advance Research and Innovation, Volume 3, Issue 4 (2015) 611-615

[4] Weihong Ma, Jinwei Fan, Qifeng Li, Yuhang Tang, A raw milk service platform using BP Neural Network and Fuzzy Inference, Information Processing in Agriculture, Volume 5, Issue 3, 2018, Pages 308-319, ISSN 2214-3173,

[5] Habib Asseiss Neto et.al, “On the utilization of deep and ensemble learning to detect milk adulteration”, BioData Mining (2019) 12:13

[6] Karakaya, D., Ulucan, O. & Turkan, M. Electronic Nose and Its Applications: A Survey. Int. J. Autom. Comput. 17, 179–209 (2020).10.1007/s11633-019-1212-9

[7] Al Attabi, Zahir & Ehsan, Saleem & Rahman, Mohammad. (2021). Quality Assessment of Milk by Sensory and Instrument Methods. 10.1007/978-3-030-68636-9_16.

[8] A Sivaranjani, S Senthilrani, B Ashok kumar & A Senthil Murugan (2021) An Overview of Various Computer Vision-based Grading System for Various Agricultural Products, The Journal of Horticultural ScienceBiotechnology, 10.1080/14620316.2021.1970631

[9] Mugunthan, S. R., and T. Vijayakumar. "Design of Improved Version of Sigmoidal Function with Biases for Classification Task in ELM Domain." Journal of Soft Computing Paradigm (JSCP) 3, no. 02 (2021): 70-82.

[10] Vijayakumar, T. "Comparative study of capsule neural network in various applications." Journal of Artificial Intelligence 1, no. 01 (2019): 19-27.