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MilkSafe: A Hardware-Enabled Milk Quality Prediction using Machine Learning

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I.ABSTRACT

Every problem has a solution, and the bulk of those answers are made possible by advances in technology. The new ideas and their implementation have dramatically changed the human world in the last twenty years. Everything has been automated, from routine domestic tasks to industrial manufacturing, making daily living considerably simpler. Yet the secret to getting the desired results is deploying the appropriate technology in the correct way. One such technology is machine learning, which uses algorithms to make the machine understand and act more precisely and accurately like a human. A major worry in the dairy business is the quality of the milk, which is predicted by a machine learning model in "MilkSafe: A Hardware-Enabled Milk Quality Prediction using Machine Learning." Sensors were used to gather the milk characteristics, including pH, temperature, turbidity, and colour, which were then entered into the model for analysis and condition prediction. Based on various milk characteristics, the pH, turbidity, colour, and temperature outputs will display a range of values. The milk is rated as low, medium, or high based on these criteria. The sensors will gather this information from the milk with the aid of the microcontroller, and the microcontroller being used in this application is the Arduino UNO. The serial monitor of the Arduino IDE will show the output. The gathered data will be used to train the model, and this model will provide us with the findings of our analysis on milk quality. The algorithms utilised in this study include Naive Bayes, Random Forest, KNN, Logistic Regression, and Random Forest with being the most accurate. Using four input features (colour, turbidity, temperature, and pH), the suggested model produces 98.27% accuracy, enabling a fully automated, dependable, and effectively used convenient gadget. Keywords—Machine learning, sensors, Arduino, Milk Quality.

II. INTRODUCTION

Testing dairy products like milk is a difficult task because they are typically produced in large quantities. Gallons of milk can be spoiled with just one drop of contamination, which poses several concerns to the consumer's health. Particularly when it comes to food products, quality is something that should never be compromised. Milk is an important component in many dairy products like butter, cheese, ghee, curd, etc. and accurate predictions of its standard are essential for efficient production planning. Many factors can affect the quality of milk, such as weather, seasonality, and the health of the cows. Fig1. Impact of consuming low-quality milk Here figure 1 shows the impact of consuming lowquality milk, which apparently leads to health issues.

Fig1. Impact of consuming low-quality milk

Generally, Hardware-only testing systems are more prone to failure and require constant maintenance (Eg: The device used in the dairy booth). The software-only system must be fed with pre-existing data, which cannot be obtained on its own. It is possible to replace these separate hardware and software systems with integrated systems that make use of both Hardware and software. Through the use of suitable sensor responses, these integrated systems significantly increase efficiency while reducing costs. In this research paper, we will be discussing how to use machine learning for milk quality prediction along with the sensors. Here four sensors are considered which is pH, temperature, Colour, and turbidity. There is a separate range of sensor values for varying milk quality and according to that the milk is graded as low, medium, and high.

III. LITERATURE SURVEY

In Using Machine Learning Algorithms to Detect Milk Quality [1] with the help of Neural Network (Neural Network: NN) and Adaptive Boosting (AdaBoost: AB) algorithm, seven attributes of the milk like pH, Temperature, Taste, Odor, Fat, Turbidity and Colour were processed to categorize the milk into low, medium and high grades. The data set is taken from the open source Kaggle platform. A single software, Orange Data Mining Tool aids in data preprocessing, model training, testing and visualization. The success rate of AdaBoost algorithm is comparatively higher when compared to the Neural Network algorithm. Design of Milk Analysis System for Dairy Farmers using Embedded System [2], a low power small size model that provides quicker response. This cost-efficient system uses Arduino controller for analysing the parameters of the milk. The pH is measured using a pH sensor, and the CLR is measured using a lactometer. SNF is computed using the CLR value. The LCD panel shows the milk parameters. Arduino microcontroller is used to interface the sensors. Designing a model that combines both IOT and the embedded system is the major difference in this paper. imply: Machine Learning Python[3] Mlpy which is known as machine learning python is used in this paper. The open source platform provides both supervised and unsupervised prediction. The use of this library increases the accuracy of the model. Use of a turbidity sensor to determine dairy powder rehydration properties [4] uses turbidity sensor to rehydrate the milk which includes particle wetting, swelling and water penetration followed by slow dispersion of particles. The difference between rehydration between various types of milk powders can be detected here. Predicting cow milk quality traits from routinely available milk spectra using statistical machine learning methods [6] involves taking milk samples from 622 individual cows. The motive is to predict the fat, protein, lactose with known detailed protein composition. The prediction was done using Fourier-transform Mid-Infrared Spectroscopy (MIRS) methodology. The paper also involves advanced statistical Machine learning methods. Portable Electronic Curd Quality Tester [9] By choosing specific parameter test options, the suggested gadget may measure pH as well as Fat. Also, it may be utilised to obtain the overall status of the measured sample as "Excellent sample," "Fair sample," or "Bad sample" by just clicking one button. The ability to identify formalin is also added as an extra feature. ARM Based Temperature Monitoring and Control for Milk Pasteurization [10] explains about monitoring the temperature and controlling the pasteurization of milk in industries using arm processor and temperature sensor. This method involves heating the milk in industries, heating is stopped when it exceeds the pasteurization level. ArduinoBased Milk Quality Monitoring System [11] which with the help of Arduino and various sensors like pH, Temperature, Gas, and fat sensor module will collect and process the parameters and thus predict the quality of the milk, which will be sent to the vendor mobile via Bluetooth module. It has an LED indication mechanism that gives green light for good quality and red light for bad quality milk. By using this method reliable results can be generated quickly and this can act as a piece of primary equipment in dairy booth.

IV. EXISTING METHOD

From the literature survey it is evident that both software and hardware have not been integrated to a fine levelwhich could result in technical misconceptions. We all know that old manual procedures are more time and energy consuming, more likely to make mistakes, and more errorprone. It might be possible to implement a system that is entirely automated, requires less labour, and is economical. Regarding the ones that are already in existence, some rely entirely on machine learning models, while others are discovered to be embedded systems only. We learned from the study that too many milk features shouldn't be used to train the model and that no single feature can accurately predict the quality of milk. The project uses real-time data collection rather than online opensource platforms. Raw data that is recorded in real time is referred to as real time data. The samples were recorded using the sensors.

V. PROPOSED METHOD

The proposed system consists of both hardware and software setups. The Hardware setup includes sensors and Arduino UNO Board while the machine learning model forms the software part. The first step in collecting the data set is gathering milk samples from various sources. The necessary parameters are extracted using sensors and the Arduino UNO, which creates the raw dataset. After preprocessing and visualizing, the data is divided into training and testing sets in the following phase. Extraction of the appropriate features like pH, temperature, turbidity, and colour is the vital phase of the procedure, as these values form the dataset. Machine learning models are trained using training data sets and various algorithms like Random Forest classifier, logistic regression, naive Bayes, and KNN Model are used. Of these, the random forest classifier and KNN model give the maximum accuracy, making it the best. The machine learning model of the proposed system is built in Visual Studio Code using Python language. Sensor outputs and machine learning models were integrated using Serial module of Python library. Checking the accuracy and performance of the trained model using testing data is crucial. After this, the user can use the model to assess the quality for any milk sample. The output result based on the sensor input will be categorized according to their grades as low, medium, or high. Humans errors is completely eradicated in this model as most of the important stages are automated. This model simplifies the process of testing without taking too many parameters into consideration and it is cost-efficient. This model can be used anywhere, anytime, and by anyone without much technical knowledge. V. DATASET Own live data that is collected in real time is the data set used in this model. Sensors like pH, Temperature, colour and turbidity is used to obtain the respective values by integrating using Arduino UNO. Using these input features the milk is classified as Low, Intermediate and High(the output variable). The columns Colour and Grade in this dataset include categorical data, which is later transformed into numerical data through one-hot encoding. It is noted that the values of temperature, pH, and turbidity are float values.

VI. RESULTS

In the Arduino IDE, the code was written for four sensors namely pH, temperature, colour, and turbidity. Each sensor has to be provided with its individual codes for its functioning and these codes are written under one program for all the sensors to work synchronously.

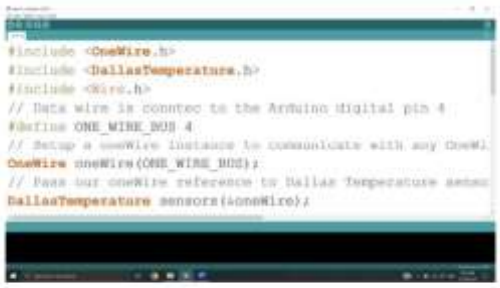

Fig 4. Program in Arduino IDE

The milk samples were taken in a beaker and all the sensors were properly arranged to obtain the data. The following figure 5 represents the working model of the system.

Once the power supply was given, the Arduino starts functioning and the sensors are ready to capture the data. The sensor's readings were noted from the serial monitor of the interface software as shown in figure 6.

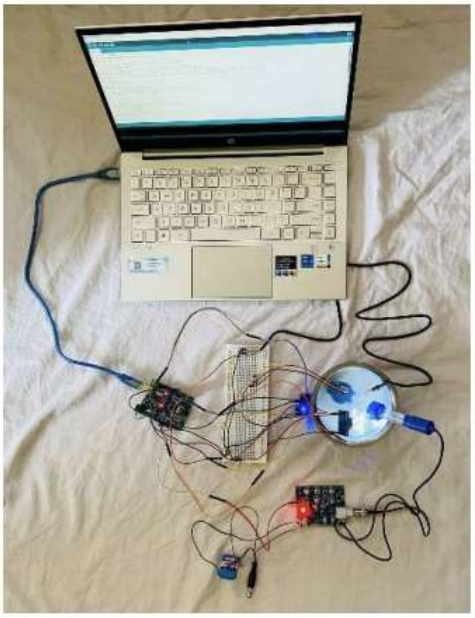

Fig 5. The working model

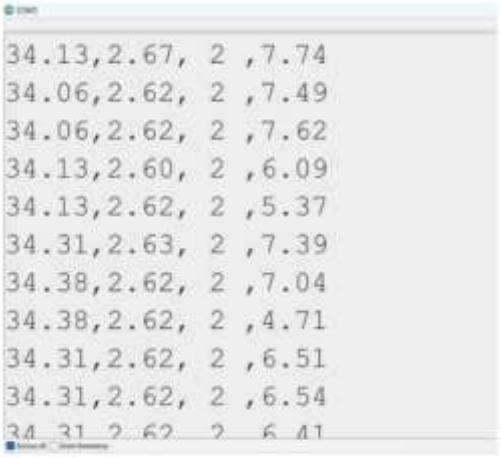

Fig 6. Serial Monitor Outcome

After importing the serial library in python, the machine learning system was used to make decision on the quality of milk. The following representation, figure 7 shows the box plot images of all the input parameters namely Colour, Temperature, pH and Turbidity.

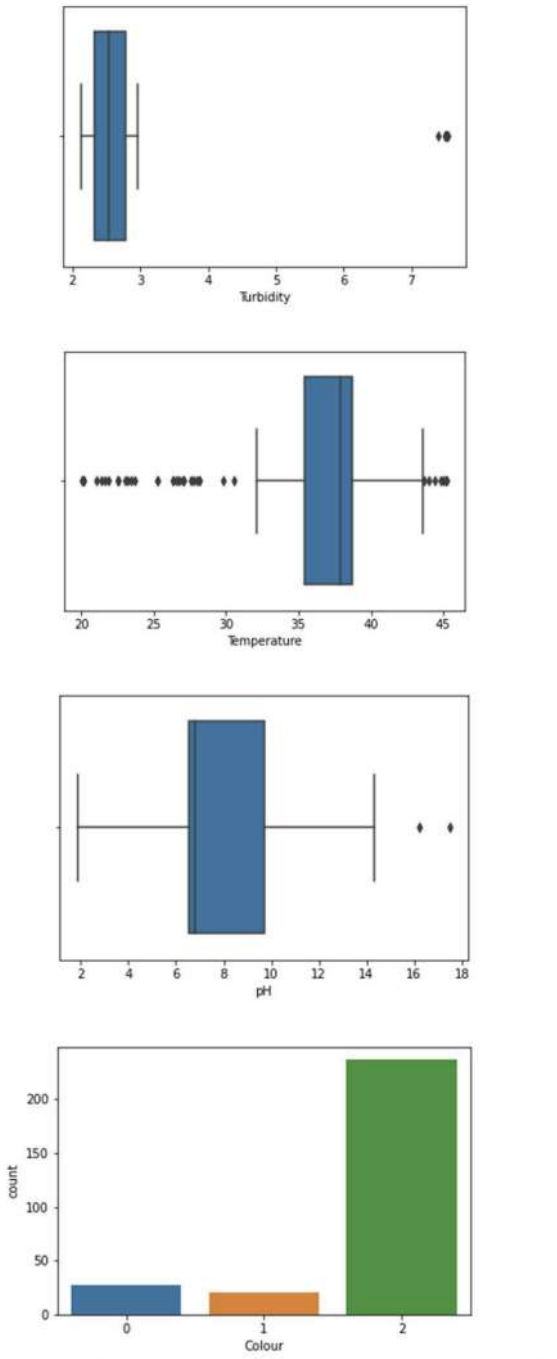

Fig 7. Diagrammatic Representation for Input Features

In the colour graph, 0(blue) stands for brown, 1(orange) stands for pale yellow and 2(green) stands for white.

VII. CONCLUSION

Almost everyone in the world drinks milk, which is one of the main economic contributors (5%). Since this costeffective product is packed with proteins, calcium, and other vital elements, only high-quality milk should be consumed. IOT and machine learning are used in the current study to evaluate the milk's quality. Machine learning algorithms like random forest (Accuracy:98.27%), Naive Bayes algorithm (41.37%), KNN (98.27%), Logistic Regression (48.27%) are applied in training the model, of which Random forest is found to be the efficient one because of their highest accuracy. Measurement is made simple and efficient through the use of an Arduino board and software framework. Since one drop of milk is more than sufficient to evaluate the tonnes and tone of milk, this model may be applied to both small and large-scale dairy operations.

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