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Artificial Intelligence and Deep Learning Based Agri & Food Quality and Safety Detection System

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Abstract: Deep learning, also known as DL, is a technique that has been shown to be effective for evaluating enormous datasets, such as those that may be found in the fields of image processing, speech recognition, and popularity. Recent advancements have been made in this direction by the fields of food science and food engineering. No one has ever mentioned to us a similar study that made use of food in any capacity as a variable in the research. This article presents a succinct introduction to deep learning (DL), in addition to detailed descriptions of the building of a typical convolutional neural network (CNN), as well as the ways by which artificial intelligence and the internet of things convey information. We conducted a comprehensive literature review on the subject of deep learning as it relates to the identification of issues with computers that are related to food. Some of the topics that were covered in this review include, but are not limited to the following: food recognition; the calculation of calories; fruit; potato; meat; the safety of aquatic goods; the safety of the food supply chain; and food infection. Each inquiry assessed its own distinct set of problems, datasets, preparation techniques, network topologies, and system architectures to discover how well they functioned and how they stacked up against other possible solutions. This paper is an investigation into the use of big data to the issue of hunger, during which we discovered some fascinating trends. According to the findings of our research, DL is superior to more traditional methods of system analysis, such as guided attribute extractors and classical algorithms. They have the potential to become the subsequent generation of food safety regulators.

Keywords: *Artificial Intelligence (AI), convolutional neural network (CNN), Deep Learning, Food Safety, IOT and Big data.*

1. Introduction

According to the definition provided by the World Food Post, food security is "the condition in which all people, at all times, have physical access to sufficient, safe, and nutritious food to meet their dietary requirements and food preferences so that they can maintain or improve their health and an active and productive lifestyle." [1]. Food safety has developed into an essential component of the global food industry (FI) as it exists at the present day. In addition, it is crucial to human health in both developing nations and nations that are already developed. In the United States, each year there are approximately 600 million episodes of food poisoning and 420,000 deaths attributed to the illness [2,]. It is anticipated that the annual cost of treating people in the United States for viral illnesses that are spread by food will approach $10 billion. Because of increases in production, processing, shipping, and retail demand on a global scale, there has been a rise in the number of concerns regarding the safety of food across the whole food supply chain. This underscores the significance of ensuring food safety as well as the difficulty involved in doing so.

Because of the inherent intricacy of FI, there is always the potential for problems with the quality of the food. The preparation of food, which is covered in the first portion of the FI and is also an essential part of keeping food safe, is discussed here. Taking care of the crops and animals is a typical step in the process of preparing meals on a farm. As a consequence of this, guaranteeing the safety of food during the transformation of plants or animals into consumable items is an extremely important and difficult task. When it comes to the addition of the appropriate food additives, the system for processing food should never, under any circumstances, include an error. Both the distribution and storage of food are operations that grow more difficult to manage as the environment changes. Transportation of food involves both of these processes. The unintended overpurchasing of food is something that should be avoided via meal retailing. There are a total of four stages that make up a product's "life," and each one has a role in determining how secure the food is [3].

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The goal of the field of study known as artificial intelligence is to educate computers so that they can "understand" the significance of data. There have been several recent high-profile cases in the disciplines of computer vision [4, 5], language processing, and other areas. One of the most notable benefits of artificial intelligence is its capacity to autonomously learn from vast amounts of data. As a result, artificial intelligence needs access to a significant amount of data. Massive facts methods are often used for the purposes of data collection, storage, querying, and processing of large volumes of data. The acquired records include many occurrences of the same information in different formats. As a result, we are able to employ AI and big data in order to extract meaningful information from material that would otherwise be redundant.

The scientific community, particularly in the domains of food science and even statistics, has devoted a great deal of time and energy to the investigation of food safety because of the importance it holds in the FI. Over the course of the last ten years, there has been a significant rise in interest in blockchain technology, big data, and artificial intelligence, as seen in Figure 1. This exemplifies the growing relevance of taking precautions to ensure that the food we consume is safe. Many recent studies have been conducted to investigate the possible applications of blockchain technology, big data, and artificial intelligence in the field of food safety. The researchers conducted an assessment of the current state of big data in the food safety industry and produced illustrative case studies to demonstrate the challenges and opportunities that lie ahead. In the field of food manufacturing, artificial intelligence (AI) applications can take on a variety of forms, each with their own particular strengths and weaknesses. As opposed to the prior system, the method described in [5] utilised blockchain technology or its many implementations to ensure a safe food supply chain. This was accomplished by replacing the previous system. These publications provided an analysis of real-world applications of connected concepts in a variety of contexts. On the other hand, the infrastructures that ensure food safety are frequently complicated and reliant on artificial intelligence (AI), big data sets, and the technology of blockchain. As a result, the topic of the study calls for a comprehensive investigation into the many different methods of food safety that are now in use [6].

Learning can be accomplished by machines through the use of DL, which is a group of methods that includes the following: In order to acquire data and keep it under control, they use a wide variety of non-linear processing equipment.

• They might study in front of a teacher (for activities such as categorization) or in private (for activities such as sample analysis).

• They study the several stages of play, each of which requires a different way of thinking than the one before it. At each of these stages, the progression of thoughts can be observed.

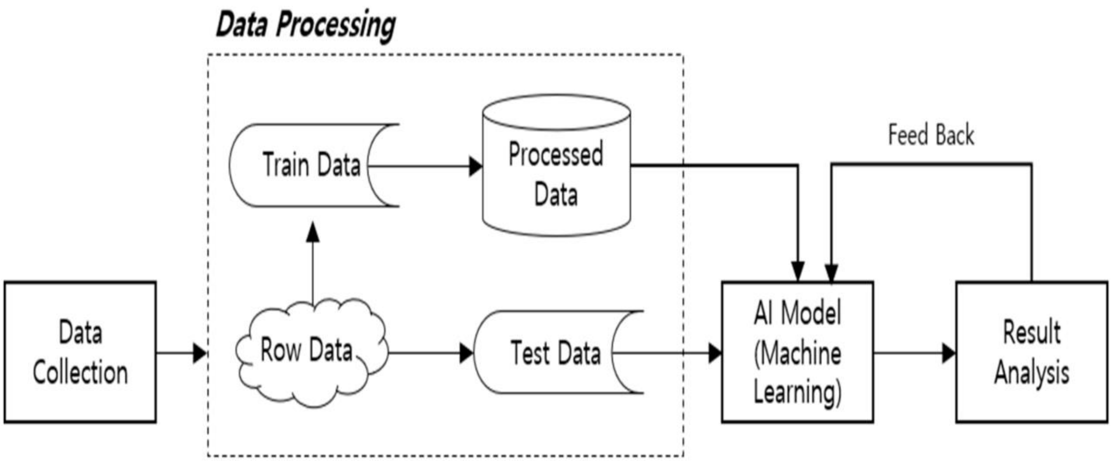

Fig 1. Proposed Model of this work

The significance of having complete control over one's training data before putting it to use in a learning system is investigated in this body of work. In order to accomplish this, it investigates examples of unsafe AI learning data taken from the actual world, as well as the ways in which cybersecurity concerns might be used to improve the accuracy of AI. We also need to work on developing an AI system that is capable of statistical analysis. A model for a learning environment that is based on blockchain technology and validates the reliability of learning data is an illustration of such a system [7].

The following constitutes the remaining components of this paper: Recent work that is still relevant is provided in Section 2, and Section 3 provides an overview of the methodology that is going to be used. In Section 4, we explain and contrast the studies that we normally do to test our system in a range of settings. These studies are described below. In the fifth and last part, we put an end to everything once and for all.

2. Literature Survey

According to [8], this should be advantageous for peanut ouTcut and industry growth if the method presented in this study is used to evaluate the crop quality and isolate it from the noise of the demand. Additionally, this should be the case if the approach used to evaluate the crop quality and isolate it from the noise of the demand is employed. If the total number of grains in a particular grade is 100, then 97 of those grains correspond to the count that was collected manually, two of the grains have been infected by a computer virus, and one of the grains is a healthy seed. This means that the total number of grains in that grade is 100 (97+2A+1P). The purpose of this study is to investigate the image processing method that was utilised to determine how satisfied peanut-kernel consumers were. Some of the outcome designs are contributing to an increase in the utilisation of national standard records.

There is a possibility that data pertaining to agriculture, food, production, supply chain, tracking, and consumers are all reflected in [9]. The Internet of Things (IoT) includes sites known as sensors that collect data, with the data typically coming from social media posts. The practise of using remote, powerful computers to process data in a remote location is referred to as "cloud computing." The information that was gathered can either be used to make well-informed judgements or to provide useful advice about how to make the process run more efficiently.

In the paper [10], neural networks are utilised to distinguish natural and artificial foods based on the acoustic frequency responses of the items, as well as to locate dairy products with or without nondairy additives (NDA). The method is demonstrated by applying it to butter samples in order to conduct tests, while it is adaptable enough to be used with any kind of dairy product. Finding the appropriate material could need a significant amount of time spent experimenting with different options. In its place, a system employing artificial intelligence (AI) might be used to evaluate and contrast the overall behaviour of a number of different materials across a variety of frequency ranges.

The study [11] investigates the possible uses of artificial intelligence and computer vision in agricultural contexts as well as in the food business. The current study, in particular, offers a complete review of the application of computer vision and intelligence in a variety of agricultural settings. These contexts include, but are not limited to, the production of food, agriculture-based apps, farming, plant data evaluation, smart irrigation, and a variety of other applications. The report also underlines the deployment of environmentally friendly four-IR technology as a means to guarantee that there will be sufficient food for everyone by the year 2050. The writers examine the significance of the Agricultural sector and investments in AI and other vision technologies, utilising useful resources and examples from the actual world as support for their arguments.

The author of the article [12] suggests that a virtualization strategy for the food manufacturing process might be provided by leveraging cloud computing. The foundation of virtualization is comprised of intelligent algorithms known as ANNs, which analyse organoleptic characteristics based on the NIR spectrometry data obtained from various materials. For example, the generation that was brought up with virtual reality has been acclimated to the conventional approach to the manufacture of cheese. ICatador is a platform that is hosted in the cloud and serves as a facilitator for collaboration and the sharing of information across various retail stakeholders. These stakeholders include the satisfactory supervisor, tasters, tasting organisers, and quality inspector. There is usually information regarding the instrumentation.

Table 1. Comparative analysis for Food Safety [13]

Fruits	Features	Technique	Accuracy
Harumani mangoes	Transition in image color	IR imaginative and prescient sensor and Gaussian Mixture Model	Not specified
Mango	Weight, color, and shape	Fourier separation model	90%
Cashew	Color, texture, size, and shape of cashews.	Multiresolution Wavelet remodel and AI (classifier)of SVM and BPNN	95%

Peanut	Color, texture, shape	SVM and KNN classifiers are synthetic intelligence strategies.	Not specified
Cherry tomato	Color, texture, shape	BPNN is an AI approach of BPNN.	Not specified
Mango	Color, texture	FN and SVM are AI approach of FN and SVM	89%
Apple	Size, shape, weight, and surface defects of mangoes	The AI strategies of SVR, MADM, and FIL	87%

Instead of manually grading the product's quality, use a gadget that is based on computer vision and has both hardware and software built in [14]. We require a camera, a conveyor belt, sensor devices, and monitors that are capable of measuring varied speeds, depending on what it is that we are rating. Analysing the photographs and processing them through a variety of photo editing techniques in order to extract the qualities that are intrinsic to them is what pre-processing includes. Several different industries are actively developing more accurate systems of ranking the quality of their products. At long last, the appropriate AI strategy has been developed in order to enable the most encouraging outcomes to be aggregated and compared. Agricultural settings are the ones that make the most frequent use of artificial intelligence.

3. Proposed Methodology

Several fields of study have recognised the value of system learning as a method for doing data analysis. Because it can be difficult to inspect raw natural data, feature extraction is typically done by hand in traditional machine learning techniques. The creation of recognition, grouping, and regression functions from raw data can also be accomplished by machines through the use of representation learning. The effectiveness of convolutional neural networks (CNN) is highly dependent on the efficient application of convolution, which serves as the network's guiding principle. The initial layer is referred to as the convolution layer, and it employs a number of different kernels to look for fresh content inside the image. The number of "fully connected layers" that are utilised can also be determined by the user. The initial layer is referred to as the convolution layer, and it makes use of a large number of kernels to look for novel visual features [15]. The subsequent step, which is called the Max pooling approach, brings about a reduction in the total size and number of community components. Before being passed on to the next layer, which is responsible for managing the entire connection network, the ouTcut of this layer is first transformed into a vector with a single dimension. At this point, the more traditional approaches for neural networks are put into use. It is possible to construct a more robust network by utilising many rounds of the convolution layer (which consists of convolution followed by max-pooling). In addition, the number of layers that are entirely connected to one another is established by discussion and agreement with the customer. Convolutional neural networks, also known as CNNs, are used rather commonly in the field of machine learning for the processing of visual or aural data. demonstrates a typical CNN architecture for the purpose of image classification, 2.

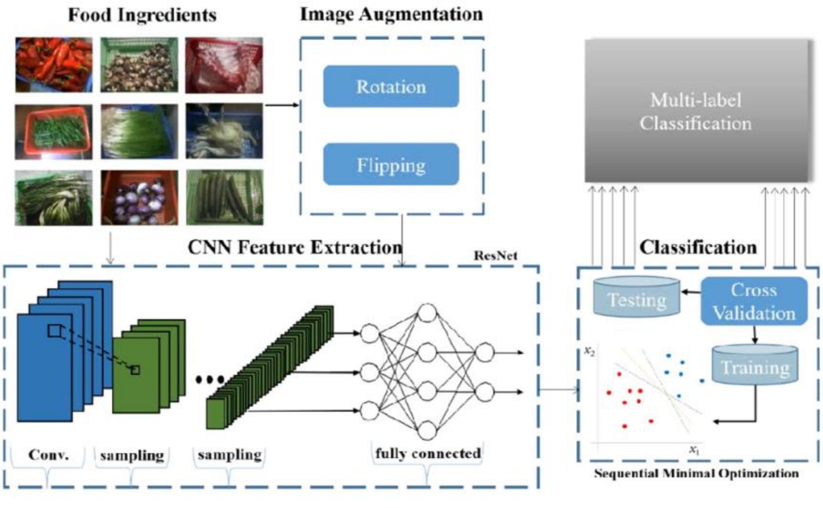

Fig 2. Proposed model using CNN for Food safety

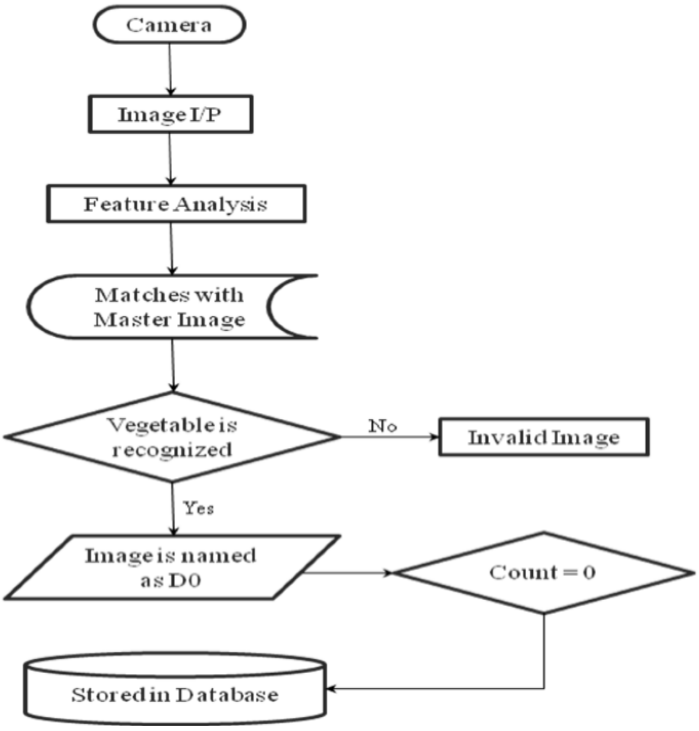

Fig 3. Proposed flow chart

The smart refrigerator is able to perform its functions because of an algorithm that can determine age, a speech indicator, and an image processor. Inputs of data are utilised in the processing and inspection of the input material, which is the substance that is being processed. The ouTcut is made up of the notifications that are presented by the microprocessor. In the end results, the item's numerical age as well as its real age are displayed for comparison. This is the recommended cooking method for vegetables. The maximum length of time for storage is thirty days. [16] Studies have shown that intelligent cooling systems have a dependability rate of up to 96.5%. Produce is sorted and graded based on a variety of criteria, including its degree of ripeness, size, weight, and density, to name just a few. The most important piece of equipment is the automatic visual examination. It turned into created to make use of infrared colours and ultraviolet photographs to sort 10 belts of outcomes at a rate of 15 results each second. The control hub, the interface panel and garage hub, the load cell, the illumination sensor, and the ouTcut unit are the five fundamental components that make up automated visual inspection. The authors have provided up-to-date information on where authentication of IoT devices now stands. A document investigated the application of artificial intelligence (AI) to rate a variety of farm items by employing a device discovery approach that comprised unique hardware and software components.

4. Result And Discussion

To compare these categorization efforts, we extracted the counts of cases and placed them into a confusion matrix [17] for each round of cross validation.

$$\mathrm{Fc} = \sum_{j-1}^{M} C_{ji} - C_{ii} \quad (1)$$

$$\mathrm{Tc} = C_{ii} \quad (2)$$

$$\mathrm{Fn} = \sum_{j-1}^{M} C_{ji} - C_{ii} \quad (3)$$

$$\mathrm{TN} = \sum_{i=1}^{M} \sum_{j=1}^{M} C_{ij} - (\mathrm{Fc} + \mathrm{Tc} + \mathrm{Fn}) \quad (4)$$

We assessed the concert of each strategy using the subsequent three metrics: I accuracy, (ii) sensitivity, and (iii) precision, which are defined as follows.

$$\mathrm{Accuracy} = \frac{\mathrm{TC}}{\mathrm{TC+Fn}} \mathrm{X}\ 100\% \quad (5)$$

$$\mathrm{Sensitivity} = \frac{\mathrm{TC}}{\mathrm{TC+Fn}} \mathrm{X}100\% \quad (6)$$

$$\mathrm{Precision} = \frac{\mathrm{TC}}{\mathrm{TC+FC}} \mathrm{X}100\% \quad (7)$$

Table 2. Selected and Descriptions of Food Data's

Sl.No.	Indicators	Data sources	Available countries	Time range	Data format
1	Raw milk [18]	India commodity dashboard	India	2015–2019	Linked open data
2	Feed barley [19]	India commodity dashboard	India	2015–2019	ZIP file
3	Feed wheat [20]	India commodity dashboard	India	2015–2019	PDF file
4	Feed Rice [21]	Food and Agriculture Organization	India	2015–2019	Linked open data
5	Feed Dhall [22]	Food and Agriculture Organization	India	2015–2019	Linked open data

Table 3. The Result analysis of existing and proposed algorithms

Sl.No.	Indicators	Algorithms	Accuracy	Sensitivity	Precision
1	Raw milk [23]	KNN [29]	85%	84%	83%
		ANN [30]	89%	88%	87%
		SVM [31]	90%	89%	88%
		Proposed CNN 2	98%	97%	96%
2	Feed barley [24]	KNN [29]	88%	87%	86%
		ANN [30]	92%	91%	90%
		SVM [31]	94%	93%	92%
		Proposed CNN	97%	96%	95%
3	Feed wheat [25]	KNN [29]	70%	69%	68%
		ANN [30]	82%	81%	80%
		SVM [31]	90%	89%	88%
		Proposed CNN	98%	97%	96%
4	Feed Rice [26]	KNN [29]	86%	85%	84%
		ANN [30]	91%	90%	89%
		SVM [31]	95%	94%	93%
		Proposed CNN	98%	97%	96%
5	Feed Dhall [27]	KNN [29]	79%	78%	77%
		ANN [30]	85%	84%	83%
		SVM [31]	90%	89%	88%
		Proposed CNN	97%	96%	95%
6	Feed barley [28]	KNN [29]	84%	83%	82%

		ANN [30]	89%	87%	86%
		SVM [31]	93%	92%	91%
		Proposed CNN	98%	97%	96%

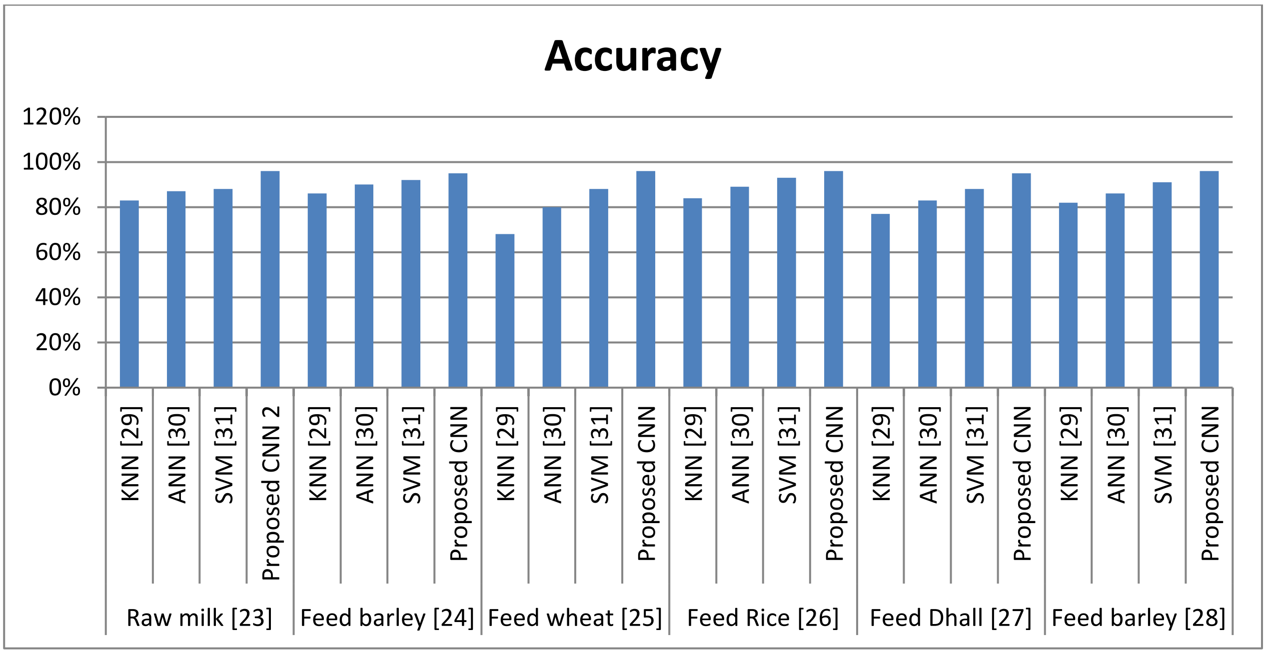

Fig 4. The parameter Accuracy has compared with existing algorithms and proposed algorithm.

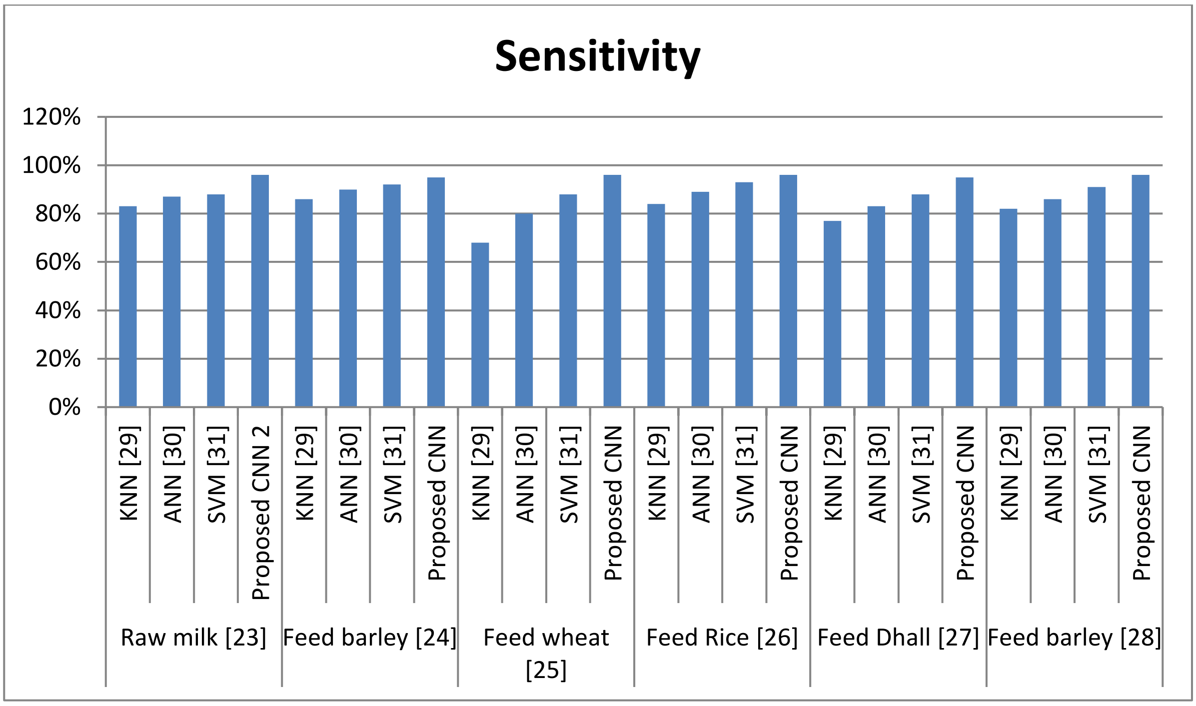

Fig 5. The parameter Sensitivity has compared with existing algorithms and proposed algorithm.

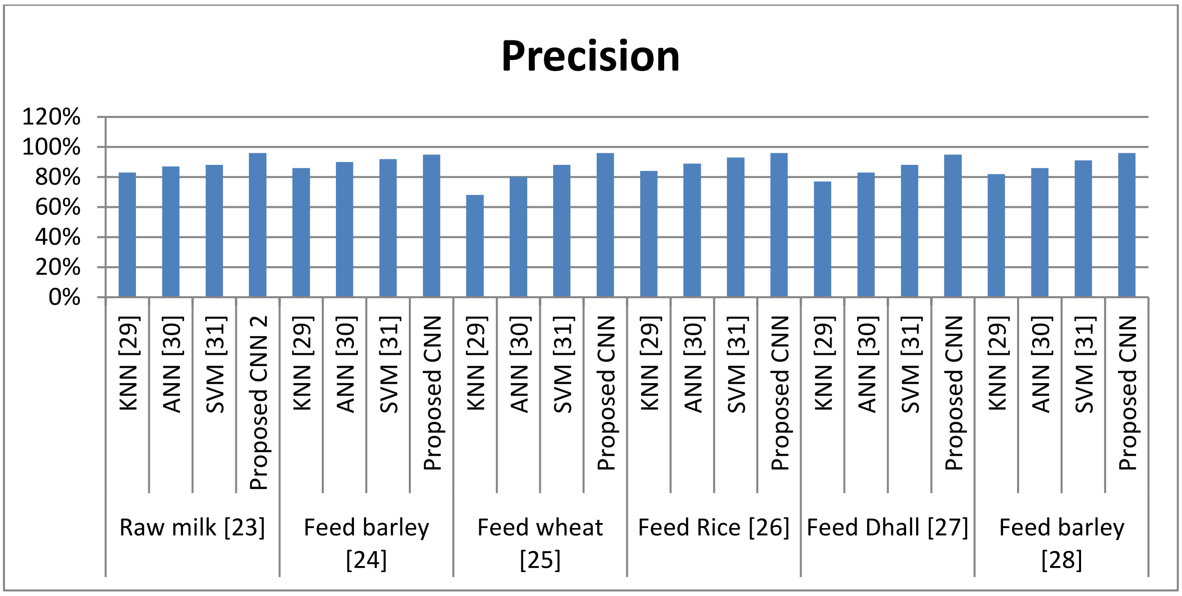

Fig 6. The parameter Precision has compared with existing algorithms and proposed algorithm.

The original photographs were utilised in the production of a total of 125 features. In both instances, the functions were eliminated through the application of function choice processes. In the table that follows, we can examine the 119 possible characteristics that emerge as a consequence of integrating three distinct foundational elements. There are just seven features that are shared by all of the function sets. The remaining ones are only available through the aforementioned internet service. This might be because different families of beetles have evolved elytra that look and behave very differently from one another. In addition, there is a possibility that statistically strengthened procedures will not always reveal the common tendencies that are essential. This is due to the fact that some of the features were connected to one another and additional when they were collected, and we did not wish to make them unattached to one another.

5. Conclusion

In the food industry, this article describes how to make the switch from utilising an antiquated method to utilising a brand-new, automated system. The transition will take place in the context of the food industry. Both the BDA and AI have had success in developing reliable means of communication with machines. This is due to the proliferation of various technologies that have been developed to solve problems that have arisen in the food sector. The term "artificial intelligence" (AI) refers to the management of complex computer systems that cover a variety of fields. This covers the use of artificial neural networks (ANNs), machine learning, synthetic sensing, computer vision, the fuzzy good judgement technique, robotics, and other related fields. These can be used to assess a wide range of features, including, but not limited to, quality, colour, and texture, as well as overall user approval. This forward-thinking strategy entails going through records, identifying trends, and making adjustments to procedures in order to achieve results that are more reliable, trustworthy, expeditious, competent, and capable of predicting the future. These strategies have the potential to be of substantial assistance in making up for the growing number of problems that have been identified in the food business. The business of delivering food would undergo a gradual transformation as a result of the use of drones. Sensors that evaluate the safety of food are yet another helpful equipment. The application of artificial intelligence (AI) and large amounts of data has enabled the food business to achieve results that are superior, more optimised, and more timely.

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