WJCMS

Wasit Journal of Computer and Mathematics Science

Journal Homepage: https://wjcm.uowasit.edu.iq/index.php/WJCM

e-ISSN: 2788-5879 p-ISSN: 2788-5879

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

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DOI: https://doi.org/10.31185/wjcm.145
Received: April 2023; Accepted: June 2023; Available online: June 2023

ABSTRACT: In recent years, Deep Learning (DL) has developed as a powerful method for analyzing big datasets in several fields, such as computer vision, audio analysis, and pattern identification. Recently, DL has also been put to use in the cutting-edge discipline of food science and engineering. In this paper, we present a brief overview of DL and explore the structure of a standard Convolution Neural Network (CNN), as well as the methods used to train AI and IoT (Internet of Things) data. To this end, we conducted a systematic literature review of research that employed DL as a computational approach to address issues associated with food, including but not limited to: food recognition, calorie computation, and safety detection across a wide range of food types (including but not limited to fruits, potatoes, meats, and aquatic products), food supply chain management, and food borne illness detection. Each research project compared their findings to others' investigations of the same problem from other perspectives (datasets, preprocessing methods, network designs, evaluation measures, etc.). We also investigated the use of big data in food quality control and found some interesting tendencies. Our findings show that DL routinely outperforms the alternatives we considered, which included both human-operated feature extractors and more conventional machine learning algorithms. The results demonstrate that DL holds great promise as a technology for use in food safety inspections and related fields.

Keywords: AI, CNN, DL, Food Safety, IOT and Big data.

1. INTRODUCTION

The motive of food protection, consistent with the world food publish, is to ensure that everybody has get entry to secure, nutritious, and enough food to satisfy their nutritional wishes and choices in order to live a healthful and lively lifestyles [1]. In cutting-edge civilization, meals protection performs an important element in the trade and alternate of the food quarter (FI). Moreover, in each underdeveloped and developed country, it's miles critical to human health. According to [2] there are approximately six hundred million times of food-borne infections every 12 months, ensuing in 420,000 fatalities. In the us., it's miles predicted that infections due to food-borne viruses will cost extra than $10 billion every yr. furthermore, the global demand for food raises the risks of food protection throughout the food production, processing, transport, and retailing tactics. As a result, making sure meals safety is each crucial and difficult.

because FI is such an advanced method, meals protection issues might stand up at any time. The first section in the FI is meals manufacturing, which is also a important pastime for food safety. meals production in agriculture more often than not relates to crop cultivation and animal husbandry. As a end result, meals safety is especially critical and difficult to relaxed at this step of meals processing, which is the transformation of vegetation or animals into items for human consumption. for the duration of food processing, corresponding food additives are regularly delivered, and meals safety

ought to guarantee that this manner is blunders-unfastened. meals transportation refers to the delivery and storage of meals, which deteriorates over the years thanks to dynamic surroundings. The purpose of meals retail is to save you leftover food from it being bought through accident. these 4 degrees characterize a product's entire "life," and they can all have an effect on meals safety [3].

The goal of AI is to allow computers to "recognize" the meanings of records. Massive examples in laptop imaginative and prescient [4], language processing, and other fields have emerged in current years. most of the most apparent benefits of AI is it may robotically benefit statistics from a big amount of statistics. As a end result, large information is critical for AI. Huge facts approaches are primarily used for gathering, storing, querying, allowing primary processing of large amounts of information. The acquired records have numerous redundancies. As a result, AI and large facts can be used to extract relevant statistics from redundant records.

Due to the fact meals safety is so vital within the FI; it has gotten a number of attentions from the scientific network in meals science or even statistics technological know-how. As tested in discern 1, Google search traffic for the terms blockchain, large records, as well as AI has improved notably over the last decade, indicating that meals protection has gotten extra attention through the years. Many latest studies have centered on blockchain, massive statistics, and artificial intelligence (AI) and its programs in meals safety. The researchers examined the nation of big data in food safety, and they supplied diverse instances to aid destiny concerns and opportunities. AI applications for meals commerce are divided into several classes, such as vision, textual content, and practical-based answers. In contrast to the old supply chain gadget, the observe in [5] supplied blockchain generation or its programs inside the integrity of the food supply chain. those publications took a extensive observe the applications of associated subject matters. food safety structures, on the other hand, are commonly complicated structures that use AI, huge data, with blockchain era. As a result, the look at topic calls for a holistic assessment that presents numerous technology utilized in meals safety [6].

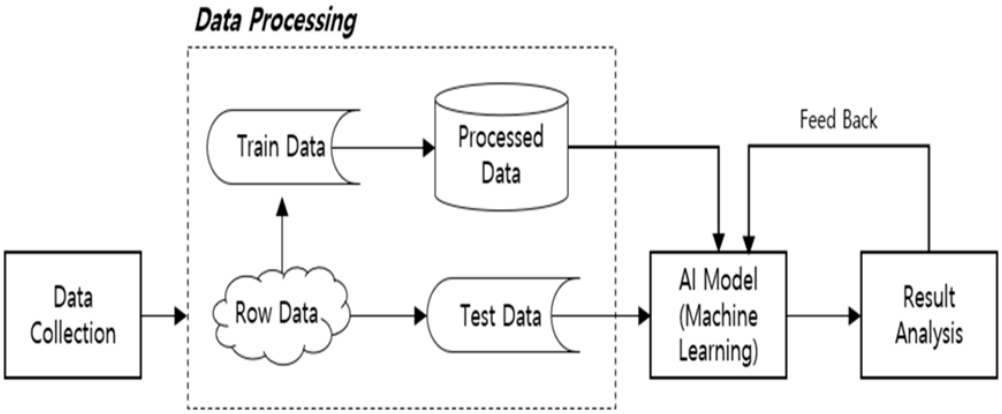

FIGURE 1. Proposed Model of this work

In this study, we investigate the importance of controlling learning data before applying machine learning techniques. We explore instances where faulty AI learning data were used and examine cybersecurity attack methods to enhance the reliability of AI systems (Figure 1). Additionally, we introduce a blockchain-based learning data ecosystem model, called the data-preserving AI system, to ensure the integrity of learning data [7].

The subsequent sections of this paper are structured as follows: Section 2 provides an overview of the most recent related research in this field. Section 3 outlines our proposed approach for controlling learning data. In Section 4, we present and compare the experiments we conducted to evaluate our system using various methods. Finally, Section 5 concludes the paper, summarizing our findings and discussing the implications of our research.

2. LITERATURE SURVEY

The usage of the technique given in this research to evaluate the cultured nice and differentiate the noise of the requirement can result in a totally correct rate, which have to have a advantageous have an impact on peanut output and industry increase, in keeping with [8]. within the desk, one hundred (ninety seven+2A+1P) denotes the presence of a hundred grains on this grade, 97 from which can be the same as the quantity obtained with the aid of hand, +2A denotes two computer virus-eaten grains categorized as D, and +1H denotes one regular seed categorized as P. The study examines the picture processing technique used to evaluate the satisfaction of peanut kernels; a couple of the amplitudes of the output designs are advancing the use of countrywide widespread records.

The records in [9] might come from agriculture, meals production, supply chain, traceability, and consumers. Sensors are information gathering places on the internet of things, however, consumer perspectives expressed on social media websites are the supply of data. Records processing is now commonly finished from far flung locations using high-performance computer systems, a practice known as "cloud computing." The facts obtained about the manner can be applied to make selections approximately how to decorate the performance of the activities or to provide relevant recommendations.

In have a look at [10], neural networks, skilled with acoustic frequency responses are used to stumble on dairy products that contain or do now not include nondairy additives (NDA), as well as to differentiate natural from non-natural meals items. Although the hypothesis is tested the use of butter samples, the approach might be prolonged to different dairy products as nicely. While trial and blunders could take a long term to attain a preference, a synthetic intelligence (AI) algorithm is probably used to extract high-stage capabilities of a fabric's conduct to a diffusion of frequencies and compare them across different substances.

The studies [11] make a specialty of the application of four.0 industrial revolution technologies, including laptop imaginative and prescient and artificial intelligence, in agriculture and the meals enterprise. The modern-day observe, especially, gives a comprehensive draw close of computer imaginative and prescient and intelligence approaches utilized in a wide variety of agricultural applications, which includes food production, agriculture-based totally apps, farming, plant information evaluation, clever irrigation, and so on. Furthermore, the document emphasizes the vital importance of utilizing environmentally friendly four IR technology to make certain that humanity has enough meals by means of 2050. The importance of the Agriculture enterprise, and additionally investments in AI other imaginative and prescient technologies, had been addressed thru relevant resources and use cases.

In [12] proposes a virtualization technique for the meals production method, that's supported with the aid of a cloud platform. The coronary heart of virtualization is a set of wise algorithms (ANNs) that assess organoleptic attributes the usage of NIR spectrometry statistics from samples. As an example, the virtualization generation turned into used to the cheese production technique. The use of the cloud ICatador platform, the critical retailers (satisfactory supervisor, tasters, tasting organizers, and quality inspector) cooperate and proportion records from multiple factors, and instrumental facts is systematically included.

In [13] use a computer vision-primarily based device that includes both hardware and software to assess first-rate of the product to replace manual grading. Based totally on the goods we grade, hardware consisting of a digicam, conveyor device belt, sensing devices, and variable pace sensors are required. The properties of the collected pix are retrieved, and photo processing strategies are used to pre-process the pictures. a number of sectors are progressively growing grading techniques for assessing product nice. Finally, to categorize and compare best detection, the appropriate synthetic Intelligence method is established. Synthetic intelligence is maximum typically used in agriculture.

3. PROPOSED METHODOLOGY

In a selection of sectors, system learning has been employed as a precious technique for statistics analysis. Traditional machine mastering strategies regularly contain a manual characteristic extraction step because of the issue to analyze uncooked natural data. A computer may additionally make use of representation gaining knowledge of to create capabilities from raw statistics for recognition, grouping, or regression. The primary idea underlying convolutional neural networks (CNN) is convolution, and the way it's far implemented is a key component in network performance. The convolution layer is the initial level, and it uses numerous kernels to extract new traits from the photo. The range of absolutely linked layers is likewise decided by using the user. The convolution layer is the initial degree, and it uses several kernels to extract new capabilities from the photograph [14]. The Max pooling system follows, which reduces the dimensions and amount of community parameters. After being transformed to a one-dimensional vector, the output of this layer is transferred to the whole connection network layer. not unusual neural network strategies are employed at this accretion. The convolution layer (convolution + max-pooling) may be repeated a couple of times to create a deeper community. The quantity of fully linked layers is likewise determined with the aid of the consumer. CNNs are a form of DNN this is typically employed in device learning for visual or speech analysis. 2. indicates a typical CNN structure for picture categorization.

For its functioning, the smart refrigeration is integrated into the growing old algorithm, voice indication, and photo processor (Figure 2). The input represents the fabric this is processed and inspected the use of the statistics inputs, and the output is shown in the form of alerts with the aid of the microprocessor. The age quantity and the age of the items are displayed in the result (primarily used for veggies). For a most of 30 days, the shelf life depend is saved. Clever refrigeration has a dependability of as much as 96.fifty five percent [15]. Intensive sorting of fruits and greens includes sorting and grading them according to their ripeness, weight, size, density flaws, and other factors. The fundamental device is automated visual exam (Figure 3). It changed into meant to sort 10 belts of culmination at duration of 15 end result in keeping with 2d utilizing infrared colorations and ultraviolet pix. (1) Middle control unit; (2) interfaces panel & garage middle; (three) weight sensor; (four) light sensors; (five) output unit are the primary additives of automatic visible

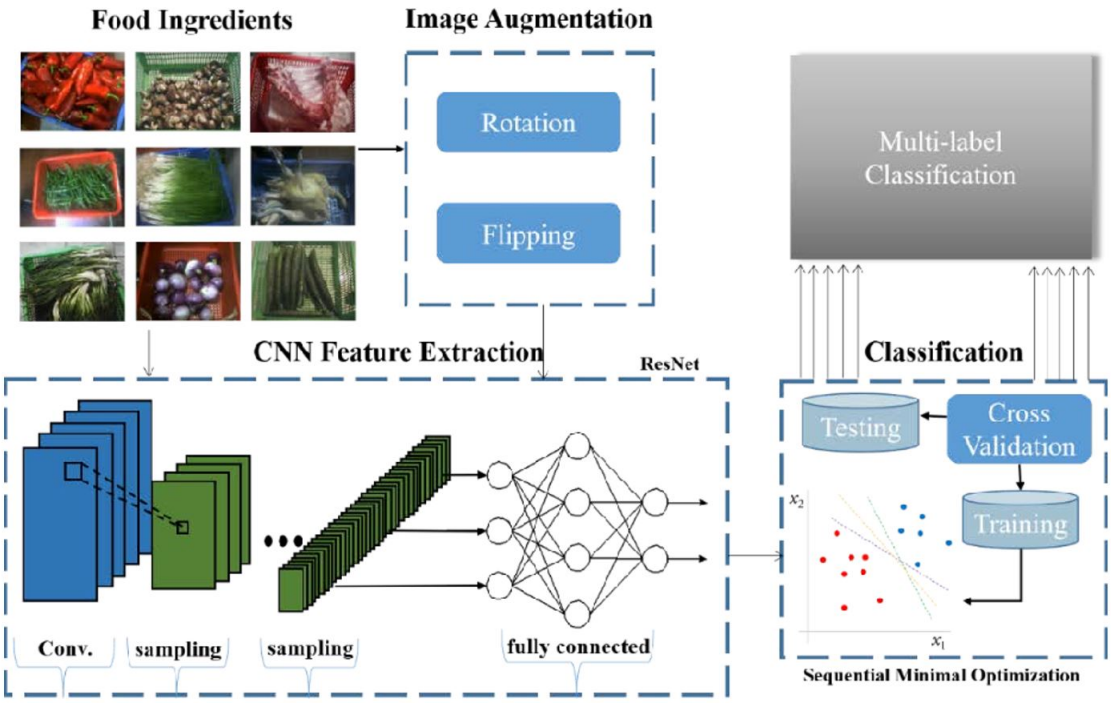

FIGURE 2. **Proposed model using CNN for Food safety**

inspection. The authors added a standing update on authentication inside the internet of factors. For effective grading, a file examined the grading technique of various farm items using AI, which used a device vision approach and comprised unbiased hardware and software additives.

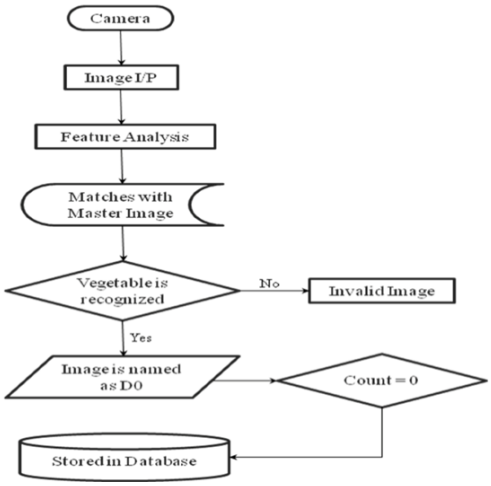

FIGURE 3. **Proposed flow chart**

4. RESULT AND DISCUSSION

To compare the classification efforts, we generated confusion matrices for each round of cross-validation. These matrices allowed us to extract the counts for true positive (TP), false positive (FP), true negative (TN), and false negative (FN) instances [16].

$$FP = \sum_{j-1}^{M} C_{ji} - C_{ii} \tag{1}$$

$$TP = C_{ii} \tag{2}$$

$$FN = \sum_{j-1}^{M} C_{ji} - C_{ii} \tag{3}$$

$$TN = \sum_{i=1}^{M} \sum_{j=1}^{M} C_{ij} - (FP + TP + FN) \tag{4}$$

We evaluated the effectiveness of each strategy by measuring three key performance metrics: (i) accuracy, (ii) sensitivity, and (iii) precision. These metrics are defined as follows:

$$Accuracy = \frac{TP}{TP + FN} X\ 100\% \tag{5}$$

$$Sensitivity = \frac{TP}{TP + FN} X100\% \tag{6}$$

$$Precision = \frac{TP}{TP + FP} X100\% \tag{7}$$

Table 1. Food Data's selected and descriptions

Sl.No.	Indicators	Data sources	Available countries	Time range	Data format
1	Raw milk [17]	India commodity dashboard	India	2015–2019	Linked open data
2	Feed barley [18]	India commodity dashboard	India	2015–2019	ZIP file
3	Feed wheat [19]	India commodity dashboard	India	2015–2019	PDF file
4	Feed Rice [20]	Food and Agriculture Organization	India	2015–2019	Linked open data
5	Feed Dhall [21]	Food and Agriculture Organization	India	2015–2019	Linked open data

From the extremely pictures, a total of one hundred twenty five features had been produced. In each manner, function choice techniques had been used to extract the functions. The table indicates the 119 characteristics acquired with the aid of combining three functional units (Table 1 and 2). It's worth noting that the function units handiest proportion seven factors, with the remainder of them being unique to that website.

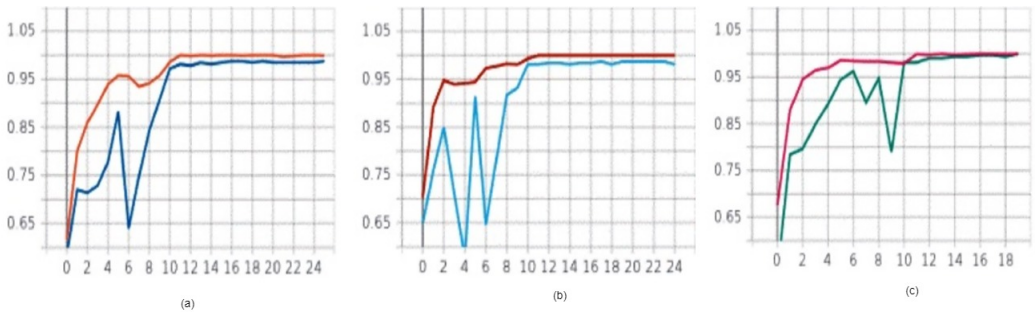

FIGURE 4. Accuracy graph for (a) KNN and ANN (b) ANN and CNN and (c) CNN and Proposed

This is probably as a result of the fact that the styles/capabilities at the elytra of beetles range substantially depending on the genus and/or species (Figure 4). Moreover, due to the fact some of the characteristics were rather correlated and redundant when they have been extracted, and we by no means intended to lead them to unrelated, statistical enrichment strategies might not usually emphasize the commonplace trends which are applicable.

Table 2. Shows the result analysis of existing and proposed algorithms

Sl.No.	Indicators	Algorithms	Accuracy	Sensitivity	Precision
1	Raw milk [25]	KNN [22]	85%	84%	83%
		ANN [23]	89%	88%	87%
		SVM [24]	90%	89%	88%
		Proposed CNN2	98%	97%	96%
2	Feed barley [26]	KNN [22]	88%	87%	86%
		ANN [23]	92%	91%	90%
		SVM [24]	94%	93%	92%
		Proposed CNN	97%	96%	95%
3	Feed wheat [27]	KNN [22]	70%	69%	68%
		ANN [23]	82%	81%	80%
		SVM [24]	90%	89%	88%
		Proposed CNN	98%	97%	96%
4	Feed Rice [28]	KNN [22]	86%	85%	84%
		ANN [23]	91%	90%	89%
		SVM [24]	95%	94%	93%
		Proposed CNN	98%	97%	96%
5	Feed Dhall [29]	KNN [22]	79%	78%	77%
		ANN [23]	85%	84%	83%
		SVM [24]	90%	89%	88%
		Proposed CNN	97%	96%	95%
6	Feed barley [30]	KNN [22]	84%	83%	82%
		ANN [23]	89%	87%	86%
		SVM [24]	93%	92%	91%
		Proposed CNN	98%	97%	96%

5. CONCLUSION

This article explains the way to shift from a traditional method to a more current and automated machine in the meals industry. At the same time as numerous technology has grown to deal with the difficulties that have emerged within the meals industry, AI and the BDA have built reliable systems for interacting with generation. to investigate great, shade, texture, basic consumer acceptability, and other traits, AI governs ANNs, machine studying, synthetic sensing, laptop vision, fuzzy good judgment method, robotics, in addition to other transdisciplinary systems.. This unique approach entailed reading records, patterns and converting workflows to provide results that is accurate, honest, takes less human sources, is efficient, and allows the person forecast destiny instances over time. These techniques could be regarded as a boon for picking up the slack within the food industry's developing disorder charge. Drone technology would gradually end up another watershed second in the meals deliver chain control. Sensors are another essential device for meals protection. Due to AI and large information, the food commercial enterprise has been capable of reaping better, extra optimized and real-time effects.

FUNDING

None

ACKNOWLEDGEMENT

None

CONFLICTS OF INTEREST

The author declares no conflict of interest.

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