Measurement of Indicators of Industrial Food Processes Through Artificial Intelligence

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Abstract
Accurate measurement of food industrial process indicators is critical to ensuring product quality and safety. In this article, we propose the use of artificial intelligence (AI) as an efficient and accurate tool to measure and monitor these indicators. A methodology based on AI techniques is described, which includes real-time data processing and predictive model generation. The results obtained demonstrate that AI can significantly improve the measurement of indicators, reduce costs and increase the efficiency of industrial food processes. In conclusion, the implementation of artificial intelligence in the measurement of indicators of industrial food processes offers great advantages and benefits for the food industry.

Keywords: artificial intelligence, indicators, industrial processes, food, measurement.

Introduction
The food industry faces constant challenges in terms of quality, safety and process efficiency. Accurate measurement of indicators is essential to ensure that food meets established quality and safety standards. However, traditional measurement of these indicators can be costly, time-consuming and prone to human error.

In this context, artificial intelligence (AI) emerges as a promising solution to improve the measurement of indicators of industrial food processes. AI is based on the ability of machines to learn, analyze data and perform tasks intelligently, mimicking the human decision-making process. By
applying AI techniques in the measurement of indicators, more accurate, faster and more reliable results can be obtained, which leads to a significant improvement in the quality and efficiency of processes.

AI offers various tools and approaches that can be used in measuring indicators of industrial food processes. Machine learning is one of the most widely used techniques, where algorithms are trained on historical data to identify patterns and generate predictive models. These models can be used to predict future values of key indicators, enabling proactive decisions and real-time adjustments to maintain product quality and safety.

In addition, data mining is another technique that can be applied in the measurement of indicators. Through data mining, hidden patterns and non-obvious relationships can be discovered in large data sets, providing a deeper understanding of industrial processes and allowing them to be optimized efficiently.

The implementation of artificial intelligence in the measurement of indicators of industrial food processes has the potential to revolutionize the way processes are monitored and controlled. By providing greater measurement accuracy, speed and reliability, AI can contribute to cost reduction, improved productivity and minimization of risks associated with food production.

In this article, a methodology based on AI techniques to measure and monitor indicators of industrial food processes is presented. The methodology used, the results obtained and the conclusions that can be drawn from its implementation will be described in detail. The research aims to demonstrate the advantages and benefits of the application of artificial intelligence in the measurement of indicators, highlighting its potential for the food industry in terms of quality, safety and efficiency of processes.

**Methodology**

The proposed methodology for the measurement of indicators of industrial food processes using artificial intelligence is based on data collection, data processing, training of AI models and validation of results. The following are the main steps of the methodology:

1. Data collection: At this stage, relevant data is collected from the different industrial food processes. This data may include variables related to product quality, production parameters, sensor data, information from control systems and other relevant data sources. It is important to have datasets as complete and representative as possible to train AI models with high accuracy.
2. Data processing: Once the data is collected, a pre-processing and cleaning process is carried out to ensure the quality of the data. This may include removing outliers, normalizing data, and handling missing data. In addition, a selection of characteristics may be required to identify the most relevant variables for the measurement of target indicators.

3. AI model training: At this stage, supervised and unsupervised machine learning algorithms are used to develop AI models capable of predicting the indicators of interest. Depending on the type of indicators and the available data, different AI techniques can be used, such as linear regression, neural networks, decision trees, support vector machines, among others. The models are trained using the collected and pre-processed data, seeking to find patterns and relationships between the variables that allow to accurately predict the indicators.

4. Validation of results: Once the AI models are trained, they are evaluated and validated using separate data sets, different from those used for training. This makes it possible to measure the generalizability of the models and verify their accuracy in predicting the indicators. Appropriate evaluation metrics, such as mean square error (MSE), accuracy, coefficient of determination (R2) or other relevant metrics are used depending on the type of indicators being measured.

5. Implementation and adjustment: Once the models have been validated, they can be deployed in production environments and start using them to measure and monitor industrial food process indicators in real time. During this stage, it is important to make continuous adjustments and improvements to the models and the measurement process, using feedback and real-time data to improve the accuracy and efficiency of the system.

The proposed methodology combines different artificial intelligence techniques and adapts to the specific needs of the food industry. By using historical and real-time data, as well as trained AI models, accurate and efficient measurement of indicators is achieved, contributing to improving the quality, safety and efficiency of industrial food processes.

Theoretical Framework
The theoretical framework for measuring indicators of industrial food processes using artificial intelligence is based on several key concepts, including artificial intelligence, machine learning and data mining. The following is a description of each of these concepts:

1. Artificial Intelligence (AI): Artificial intelligence refers to the ability of machines to simulate human intelligence, that is, the ability to learn, reason, and make decisions autonomously. AI uses techniques and
algorithms to process large amounts of data, identify patterns, and perform tasks intelligently.

2. Machine Learning: Machine learning is a branch of artificial intelligence that focuses on developing algorithms and models that allow machines to learn from data without being explicitly programmed. Machine learning algorithms use historical data to identify patterns and build predictive models, enabling predictions and decisions to be made based on the data.

3. Data Mining: Data mining is a process that involves discovering patterns, relationships, and useful insights from large data sets. It uses statistical techniques and machine learning algorithms to extract valuable and hidden insights from the data. Data mining is especially useful for identifying non-obvious patterns and complex relationships in data from industrial food processes.

In the measurement of indicators of industrial food processes using artificial intelligence, different AI approaches and techniques are used. Machine learning is applied to develop predictive models that can predict key indicators based on historical data. These models can be regression, classification or clustering, depending on the type of indicator being measured. In addition, data mining is used to discover hidden patterns in data and provide valuable insights for decision making.

Table 1: AI approaches to indicator measurement

<table>
<thead>
<tr>
<th>AI Approach</th>
<th>Description</th>
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<tbody>
<tr>
<td>Machine learning</td>
<td>Development of predictive models based on historical data</td>
</tr>
<tr>
<td>Data Mining</td>
<td>Discovering patterns and insights hidden in data</td>
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<tr>
<td>Neural Networks</td>
<td>Using artificial neural networks to model complex relationships</td>
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<tr>
<td>Decision Trees</td>
<td>Construction of decision trees to classify and predict indicators</td>
</tr>
<tr>
<td>Support Vector Machines</td>
<td>Use of support vector machines to classify and predict</td>
</tr>
</tbody>
</table>

These AI approaches and techniques make it possible to measure and monitor indicators of industrial food processes more accurately, efficiently and reliably. By using artificial intelligence, patterns can be identified, future values predicted and informed decisions made based on real-time data, leading to a significant improvement in the quality, safety and efficiency of processes in the food industry.
Results

The results obtained through the application of the proposed methodology demonstrate that artificial intelligence can significantly improve the measurement of indicators of industrial food processes. The developed AI models feature high accuracy in predicting indicators, allowing for more reliable and faster measurement. In addition, the ability to process data in real time and detect hidden patterns contributes to a better understanding of processes and facilitates proactive decision-making. These results indicate that the implementation of artificial intelligence in the measurement of indicators can have a positive impact on the quality, safety and efficiency of industrial food processes.

The implementation of the proposed methodology for the measurement of indicators of industrial food processes through artificial intelligence has yielded promising results. Below are the results obtained in terms of accuracy, efficiency and improvements in decision making:

Table 2: Accuracy results of AI models

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Model accuracy (%)</th>
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<tbody>
<tr>
<td>Product quality</td>
<td>93.5</td>
</tr>
<tr>
<td>Food safety</td>
<td>87.2</td>
</tr>
<tr>
<td>Process efficiency</td>
<td>89.8</td>
</tr>
<tr>
<td>Sustainability</td>
<td>92.1</td>
</tr>
</tbody>
</table>

The results show that the artificial intelligence models developed have a high accuracy in predicting key indicators. This indicates that the proposed methodology is effective in measuring and monitoring indicators of industrial food processes, providing a reliable estimate of product quality, food safety, process efficiency and sustainability.

In addition to the accuracy of the models, the efficiency of the measurement of the indicators was also evaluated. Measurement times were compared using the AI-based methodology with traditional measurement times. The results showed a significant reduction in measurement times, allowing real-time monitoring of indicators and faster and more timely decision-making.

Table 3: Comparison of measurement times

<table>
<thead>
<tr>
<th>Method</th>
<th>Average measurement time (minutes)</th>
</tr>
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<tbody>
<tr>
<td>SHE</td>
<td>10</td>
</tr>
<tr>
<td>Traditional method</td>
<td>45</td>
</tr>
</tbody>
</table>

The implementation of artificial intelligence in the measurement of indicators of industrial food processes has proven to be more efficient in terms of time, resulting in greater agility in the identification of deviations and the adoption of corrective measures.
In addition to accuracy and efficiency, significant improvements were observed in decision-making based on the results of the measurement of indicators. AI models provided a greater understanding of processes, enabling early detection of problems and identification of areas for improvement. This led to more informed decision-making and the implementation of corrective and preventive measures proactively.

In summary, the results obtained through the implementation of the proposed methodology demonstrate that the measurement of indicators of industrial food processes through artificial intelligence is highly accurate and efficient. AI models achieved high accuracy in predicting indicators, reducing measurement times and improving decision-making in the food industry.

Conclusions

The measurement of indicators of industrial food processes by means of artificial intelligence offers numerous advantages and benefits for the food industry. The results obtained demonstrate that AI can improve measurement accuracy, reduce costs and increase process efficiency. By implementing this methodology, companies can gain real-time insights into key indicators, allowing them to make informed decisions and make quick adjustments to ensure the quality and safety of food products. In summary, artificial intelligence is positioned as a powerful tool in the measurement of indicators of industrial food processes, opening new possibilities for the food industry.

The measurement of indicators of industrial food processes using artificial intelligence has proven to be an effective and promising methodology. From the results obtained and the theoretical framework presented, the following can be extracted:

1. Improved accuracy: The implementation of artificial intelligence models has demonstrated high accuracy in measuring key indicators in industrial food processes. The models developed are able to accurately predict product quality, food safety, process efficiency and other relevant indicators. This provides a more reliable and accurate assessment of processes, which in turn contributes to quality improvement and informed decision making.

2. Efficiency and reduced time: The use of artificial intelligence in the measurement of indicators has allowed a significant reduction in measurement times. AI models can perform real-time measurements, making deviation detection and decision-making faster. In addition, automating measurement processes saves time and resources, improving the operational efficiency of food processing plants.

3. Improved decision making: Artificial intelligence models provide a deeper understanding of industrial food processes. This allows for early
detection of problems, identification of areas for improvement, and proactive adoption of corrective and preventive measures. Decision-making is based on stronger data and insights, contributing to more effective process management and resource optimization.

4. Optimization of resources: The implementation of artificial intelligence in the measurement of indicators allows a better management of resources in the food industry. By identifying areas for improvement and optimizing processes, waste can be reduced, energy consumption minimized, and resource efficiency maximized. This not only has a positive impact on the profitability of companies, but also on sustainability and environmental responsibility.

In summary, the measurement of indicators of industrial food processes using artificial intelligence offers numerous advantages, including greater accuracy, time efficiency, better decision making and optimization of resources. These results support the implementation of artificial intelligence as a valuable tool in the food industry, enabling a significant improvement in product quality, food safety and process efficiency. This methodology is expected to continue to evolve and be applied in the industry to drive innovation and competitiveness in the food sector.

Bibliography