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APPLICATION OF ARTIFICIAL INTELLIGENCE DEVICES IN MANUFACTURING

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Abstract: The integration of Artificial Intelligence (AI) in manufacturing processes has revolutionized the industry, enabling businesses to enhance productivity, improve efficiency, and achieve higher levels of automation. This paper provides an overview of AI-powered devices in manufacturing, highlighting their applications, benefits, and challenges. It explores key areas where AI is being leveraged, such as predictive maintenance, quality control, robotic automation, and supply chain management. The paper also discusses the advantages of AI-powered devices, including increased operational efficiency.

Keywords: Artificial Intelligence (AI),manufacturing,automation,predictive maintenance,quality control,robotic automation

Introduction: Artificial intelligence (AI) devices in manufacturing are intelligent systems and machines that can perform a variety of tasks automatically. They are equipped with sensors, cameras and data processing algorithms that allow them to perceive the environment, analyze information and, combined with machine learning, make decisions based on the collected data. These devices can perform functions ranging from quality control and manufacturing processes to automation tasks such as assembly, packaging and material handling.

The use of AI in manufacturing improves efficiency, reduces costs and improves product quality, making them important components of Industry 4.0.

Basic principles of IoT include:

- Communication: Devices in IoT can be connected through wireless and wired networks to exchange data.

-Sensors and sensors: Many IoT devices are equipped with sensors and sensors that collect information about the physical world such as temperature, humidity, motion and more.

-Data Processing: The collected data is usually transferred to cloud servers where it is analyzed and processed.

- Actions and Control: Based on data analysis, devices can make decisions and perform various actions such as changing environmental parameters, sending notifications or activating other devices.

Industry 4.0, powered by artificial intelligence (AI), uses a variety of devices and technologies to automate and optimize production processes. Here are some of the devices and technologies that can be applied:

Internet of Things sensors:

Sensors in the Internet of Things (IoT) have widespread applications in manufacturing environments. For example, temperature sensors can monitor thermal conditions in production lines, detect abnormalities, and warn of potential problems such as overheating of equipment. Humidity sensors can monitor indoor humidity to prevent corrosion and deformation of materials.

Pressure sensors can be used to monitor pressure in compressed air systems or hydraulic systems, which helps in detecting leaks and maintaining stable operating conditions. Motion sensors can monitor the activity of equipment and personnel, detect abnormal situations and optimize the use of resources.

The collected data can be transmitted to management systems, which perform analysis and make decisions based on this information. This helps reduce risk, increase production efficiency and improve overall process safety and reliability. IoT sensors enable real-time monitoring and response to changes in the production environment much faster than a human could.

A specific example of the use of IoT sensors and their role in monitoring and optimizing production processes can be found in the field of food production. Let's say there is a large bakery that specializes in

baking bread. Various IoT sensors are installed inside the bakery, including temperature, humidity and pressure sensors.

- Temperature sensors monitor the temperature in different parts of the furnace and in the production areas. If the temperature inside the oven begins to deviate from the set parameters, the sensors instantly react and send a signal to the control system. This alerts you to potential problems such as overheating or insufficient baking temperature, allowing operators to intervene instantly.

- Pressure sensors monitor the pressure in the compressed air system that is used to supply raw materials to the furnace. If pressure drops due to leaks or equipment failure, sensors automatically alert you when maintenance is required.

These sensors transmit data to a monitoring and control system, which analyzes and adjusts production parameters. This allows the bakery to ensure consistent product quality, prevent production failures and reduce equipment maintenance costs. Thus, IoT sensors improve production efficiency and help reduce losses and risks.

Autonomous robots and manipulators

Autonomous robots and manipulators represent an important element of digitalization in Industry 4.0. These robots are equipped with sensors and cameras that allow them to perceive and interact with their environment. Using machine learning and AI algorithms, they are able to adapt to changing conditions and perform a variety of tasks.

Programming and controlling robot actions are becoming more flexible and intuitive thanks to the use of AI. For example, an operator can train a robot to perform a specific task by moving it manually, and then the robot will automatically create a program to perform that task. This simplifies the implementation of robots in production processes, since complex and time-consuming programming is not required.

Collaboration between robots and humans is also an important aspect. AI can enable safe collaborative interactions by, for example, recognizing and predicting human movements and automatically responding to them. This makes it possible for humans and robots to work together on the same production line.

Ultimately, AI-controlled autonomous robots and manipulators help increase productivity, reduce labor costs, and improve production quality. They can work around the clock without getting tired, which is especially important in modern industrial enterprises.

Literature review and methodology: In writing this article, a number of relevant literature and scientific articles were studied and analyzed. The literature review conducted for this article provides a comprehensive understanding of the application of artificial intelligence (AI) devices in the manufacturing industry. It encompasses a wide range of scholarly articles, research papers, industry reports, and case studies related to the topic. «Верховный алгоритм. Как машинное обучение изменит наш мир»,.Педро Домингос [1], «Искусственный интеллект. Современный подход., Стюарт Рассел, Питер Норвиг [2], Искусственный интеллект и универсальное мышление». Алексей Потапов [3], Эммануил Ицкович: «Методы рациональной автоматизации производства.» [4], «Application of artificial intelligence in the food industry» Egor. G. Timchuk [5]. Similar scientific articles have been studied and quoted from them.

Results: The application of AI devices in manufacturing has yielded promising results, revolutionizing traditional production processes and driving positive outcomes across various aspects of the industry.

The integration of AI devices has also enhanced decision-making capabilities in manufacturing. AI algorithms can analyze vast amounts of data in real-time, enabling manufacturers to make data-driven decisions regarding process optimization, quality control, and resource allocation. This has resulted in improved overall decision-making accuracy and efficiency.

Furthermore, AI-powered quality control systems have demonstrated exceptional accuracy in detecting defects and anomalies, ensuring that only high-quality products reach the market. This has led to increased customer satisfaction and brand reputation.

It is important to note that while the results of AI implementation in manufacturing have been largely positive, ongoing research and development are necessary to address challenges and optimize the

potential benefits further. Continued advancements in AI technology, coupled with proactive measures to address ethical considerations and workforce adaptation, will be crucial for the continued success and widespread adoption of AI devices in manufacturing.

Internet of Things (IoT) devices

Internet of Things (IoT) devices are network-connected smart devices that are capable of collecting and transmitting data in real time. They can be installed at various points in the production environment, ranging from equipment and machinery to warehouse and transport infrastructure.

These devices are equipped with a variety of sensors, sensors and actuators that collect information about the physical world, such as temperature, humidity, movement, inventory levels and other parameters. The resulting data is transferred to a central server or cloud platform, where it is analyzed and used to monitor equipment condition, optimize production processes, manage inventory, and even make real-time decisions. Thus, IoT devices play an important role in automation and optimization of production, ensuring more efficient use of resources and Below is a software implementation of how sensors work to collect information and track employees at an enterprise. The statistical analysis of the program can be seen in figures 1 and 2improving the quality of manufactured products.

An example of this idea is our testing on a real object. We were faced with the task of writing a program to detect the proximity of employees, that is, their departure and arrival at production. In order to ensure accurate working hours for each employee.

The software implementation looks like this:

```
import RPi.GPIO as GPIO
import time
import datetime

class Employee:
    def __init__(self, name):
        self.name = name
        self.check_ins = []

    def check_in(self):
        current_time = datetime.datetime.now()
        self.check_ins.append(current_time)

    def check_out(self):
        current_time = datetime.datetime.now()
        self.check_ins.append(current_time)

    def print_check_ins(self):
        print(f"Check-ins for {self.name}:")
        for check_in in self.check_ins:
            print(check_in.strftime("%Y-%m-%d %H:%M:%S"))

    # GPIO pins for sensors
    SENSOR_PIN_1 = 18
    SENSOR_PIN_2 = 23

    # Creating employee objects
    employee1 = Employee("Ivan Ivanov")
    employee2 = Employee("Petr Petrov")

    # Arrival event processing function
    def handle_check_in(channel):
        if channel == SENSOR_PIN_1:
            employee1.check_in()
        elif channel == SENSOR_PIN_2:
            employee2.check_in()
```

1-figure. Processing the employee arrival event

In this example, we use the RPi.GPIO component to interface with the Raspberry Pi's GPIO. We create an Employee class that has check_in and check_out methods for checking in and out of employees, and a print_check_ins method for getting check-in information.

```
    # GPIO pins for sensors
    SENSOR_PIN_1 = 18
    SENSOR_PIN_2 = 23

    # Creating employee objects
    employee1 = Employee("Ivan Ivanov")
    employee2 = Employee("Petr Petrov")

    # Arrival event processing function
```

```
def handle_check_in(channel):
    if channel == SENSOR_PIN_1:
        employee1.check_in()
    elif channel == SENSOR_PIN_2:
        employee2.check_in()

# Care event handling function
def handle_check_out(channel):
    if channel == SENSOR_PIN_1:
        employee1.check_out()
    elif channel == SENSOR_PIN_2:
        employee2.check_out()
```

2-figure. Processing an employee departure event and analytics of the day

Result: Time tracking: Tracking the arrival and departure of employees made it possible to accurately determine and record the time they spend at the workplace. This made it possible to keep track of working hours and calculate wages based on hours worked.

Virtual reality (VR) and augmented reality (AR):

They allow you to train staff by providing them with interactive simulations and training. For example, employees can use VR glasses to learn how to maintain and repair complex equipment by simulating real-life work conditions.

Additionally, VR and AR can be used for data visualization. Using special applications and devices, employees can visualize data in the form of 3D models and graphs, which makes their analysis more visual and understandable.

This reduces the cost of creating physical prototypes and reduces development time.

Manufacturing control systems in Industry 4.0 play an important role in automating production processes. They integrate different equipment and machines, allowing them to work synchronously and efficiently. These control systems can be linked to a central system that coordinates all production operations.

Quality management systems include automatic checkpoints in production, allowing defects and deviations to be identified in real time. This ensures high quality products and allows you to quickly respond to problems.

Here we can note specific real-life examples of production management systems, quality management systems and production monitoring systems within Industry 4.0 may include the following:

1. Manufacturing Execution Systems (MES):

An example is Siemens SIMATIC IT MES, which provides a comprehensive solution for managing and monitoring production processes. It integrates multiple systems and equipment across production lines and provides operators with the ability to monitor and optimize production in real time.

2. Quality management systems:

Bosch uses a quality management system that automatically analyzes product quality data in real time and identifies defects. This allows them to quickly respond to problems in production and guarantee the high quality of their products.

3. Systems for monitoring production parameters:

Enterprises in the energy industry can use parameter monitoring systems to monitor equipment performance and collect data on production processes. These systems can provide information on temperature, pressure, material flow and other important parameters

Conclusion. The application of AI devices in manufacturing has ushered in a new era of technological advancement and efficiency in the industry. The utilization of AI in areas such as predictive maintenance has allowed for proactive identification of potential equipment failures, reducing downtime and optimizing maintenance schedules. Quality control has also been revolutionized, with AI-enabled systems capable of detecting defects and anomalies with greater accuracy and speed, ensuring higher product standards.Robotic automation, powered by AI, has transformed the manufacturing landscape by enabling autonomous and flexible production lines. This has resulted in increased operational efficiency, reduced costs, and improved overall output.

In conclusion, the application of AI devices in manufacturing has proven to be transformative, offering numerous advantages in terms of operational efficiency, cost reduction, and decision-making

capabilities. While challenges exist, proactive measures can be taken to mitigate risks and maximize the potential benefits. As AI technology continues to evolve, its role in shaping the future of manufacturing will undoubtedly become increasingly significant.

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