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METHODS AND TECHNOLOGIES OF AUTOMATION AND DATA STRUCTURING IN AGRICULTURE

Khusein Pakhaev (a)*, Timur Aygumov (b), Elmira Amirova (c)
*Corresponding author

(a) Kadyrov Chechen State University, Grozny, Russia, pakhaev01@gmail.com
(b) Dagestan State Technical University, Makhachkala, Russia, 915533@mail.ru
(c) Kazan State Agrarian University, Kazan, Russia, elmira.failovna@gmail.com

Abstract

This research aimed to enhance agricultural efficiency through the integration of cutting-edge technologies for crop yield prediction and resource optimization. The agricultural sector faces a pressing challenge in the quest for efficient and cost-effective data collection and processing methods to enhance decision-making and overall productivity. The current reliance on manual data collection and analysis proves to be time-consuming and susceptible to errors, potentially resulting in inaccurate outcomes. The study employed IoT sensors for real-time monitoring of soil, climate, and plant conditions, coupled with machine learning algorithms for data analysis and precise crop yield predictions. Additionally, GPS technology was utilized for field mapping, and autonomous systems, including unmanned tractors and drones, were implemented for automated farm operations. The results demonstrated a significant increase in crop yield accompanied by a notable reduction in resource usage. Accurate predictions of optimal intervals for irrigation, fertilizer application, and harvest were achieved through machine learning models. This allowed farmers to streamline processes, minimize water and fertilizer usage, and ultimately enhance overall agricultural productivity. The study concludes by emphasizing the pivotal role of integrating modern technologies into agriculture for achieving sustainability, efficiency, and increased output.

Keywords: Automation, agriculture, data analysis, data structure, information technology

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1. Introduction

The potential of the green project (Environmental sustainability) on a global scale is limitless, with the ability to endlessly maintain healthy habitats and socioeconomic systems on a local and global scale. The environment is necessary for the economy and communities to exist (Magomedov et al., 2020). Communities are completely reliant on the conditions of their surroundings. Sustainability refers to a concept that refers to the ability and possibility of future generations to meet their needs. Also, in general, people should have an understanding that healthy ecosystems and environments are necessary for the survival of people and other organisms (Volkov et al., 2020). According to research by various scientists, the ability of human society to achieve environmental sustainability has been and continues to be questioned. The reasons for this are phenomena such as example, climate resilience can be broken due to environmental degradation, climate change, overconsumption, population growth, and the desire for unlimited economic growth (Novikov et al., 2019). There's no denying that population increase puts a strain on existing resources. This explosion is hastening the loss of resources. States may be experiencing a fall in economic growth as a result of air pollution, deforestation, water pollution, soil erosion, and natural resource extraction. Green projects are helpful in being implemented to assist quickly developing countries with resource depletion challenges. Some developing countries have recently been blamed for significant resource depletion (A. U. Mentsiev, Amirova, et al., 2020). Projects with an environmental focus are now being developed (Grout & Mullin, 2018; Lyko et al., 2016)

Data Collection Automation now plays a significant role in a variety of industries. Traditional methodologies in numerous fields have been transformed by a mix of algorithms, robots, and software. In some competitions, Artificial Intelligence (AI) and Machine Learning (ML) can defeat champions. The construction industry, as expected, has benefited enormously from the growing automation movement. The Internet of things (IoT) is playing an important role in data collection automation. To put it another way, the Internet of Things is the modern energy industry's enabler. IoT technology allows one to combine all strategies and steps in power generation and consumption, acquire visibility into operations, and provide real control at every step of the energy flow, from exploitation to end-user supply. For data automation and record, this IOT collaboration boosts both renewable and hydrocarbon economies' efficiency (Mentsiev & Gatina, 2021a).

2. Problem Statement

The agricultural sector faces a pressing challenge in the quest for efficient and cost-effective data collection and processing methods to enhance decision-making and overall productivity. The current reliance on manual data collection and analysis proves to be time-consuming and susceptible to errors, potentially resulting in inaccurate outcomes. Consequently, there is an imperative demand for automated data collection methods capable of bolstering accuracy and efficiency, concurrently mitigating costs.

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3. Research Questions

This research aims to address the following key inquiries:

1) Current Data Collection and Analysis Methods:
   i. What are the prevalent methods employed for collecting and analyzing primary and secondary data in the agricultural sector?
   ii. How do surveys, interviews, focus group discussions, and other methodologies contribute to data gathering in agriculture?
   iii. What are the diverse techniques and tools used for processing agricultural data, encompassing statistical analysis software and data visualization tools?
2) Benefits of Automated Data Collection and Analysis:
   i. What potential advantages can be derived from automating data collection and analysis in agriculture?
   ii. How does automation contribute to improved efficiency, accuracy, and cost-effectiveness in the agricultural data domain?
   iii. What challenges might be associated with the automated processes of data collection and analysis in the agricultural sector?
3) Tools and Technologies for Automation in Agriculture:
   i. Which tools and technologies exhibit promise for automated data collection and analysis in the agricultural sector?
   ii. How can sensor technology, machine learning algorithms, and data analytics platforms be effectively utilized in automating agricultural data processes?
   iii. What considerations should be taken into account when implementing these tools and technologies in the agricultural context?

By addressing these research questions, the study aims to provide insights into the current landscape of data practices in agriculture, explore the potential benefits and challenges of automation, and identify effective tools and technologies for enhancing data collection and analysis in the agricultural sector.

4. Purpose of the Study

The primary objective of this study is to investigate the methods and technologies pertinent to the automation of primary and secondary data collection and processing within the agricultural sector. The study endeavors to discern the advantages associated with automated data collection and analysis, emphasizing enhancements in efficiency, accuracy, and cost-effectiveness. Furthermore, the research aspires to spotlight the array of tools and technologies available for the automation of data processes in agriculture.

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The specific aims of the study include:

1) Identification of Benefits:

i. Explore and articulate the benefits derived from automated data collection and analysis in agriculture.

ii. Assess how automation contributes to heightened efficiency, improved accuracy, and greater cost-effectiveness in the agricultural domain.

2) Evaluation of Tools and Technologies:

i. Scrutinize and elucidate potential tools and technologies that can be effectively employed for the automation of data collection and analysis in agriculture.

ii. Consider the practical applications of sensor technology, machine learning algorithms, and data analytics platforms in the agricultural context.

3) Insights for Decision-Making and Productivity:

i. Provide insights into how automated data collection and analysis can contribute to informed decision-making within the agricultural sector.

ii. Examine the potential impact of automation on overall productivity in agriculture.

By addressing these objectives, the study aims to offer a comprehensive understanding of the role and impact of automated data collection and analysis in agriculture, providing valuable insights for stakeholders, practitioners, and policymakers.

5. Research Methods

5.1. Methods

Green IoT, emphasizing environmental stewardship, not only conserves resources but also offers sustainable solutions for societal advancement. It addresses issues such as smart transportation, sustainable cities, and energy efficiency, fostering a green and long-term IoT environment. Online monitoring, facilitated by IoT technologies, allows data from various devices to be transmitted to an internet dashboard for user visualization (Thilakarathne et al., 2022).

Different Technologies Used in Green IoT:

i. Identification: The process of designating and linking services to their demand or obtaining data at a point of activity, collected by devices like appliances, wearables, or control panels.

ii. Sensory Data Collection: Involves collecting data from various "things" and transferring it to a database, data warehouse, or data center for structured organization. Analyzing this data aids decision-making, with sensors ranging from wearables to environmental sensors.

iii. Communication Technologies: Enable diverse elements to connect, utilizing protocols such as Wi-Fi, Bluetooth, IEEE 802.15.4, Z-wave, LTE-Advanced, NFC, and ultra-wide bandwidth (UWB).

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iv. Data Processing Units: Data collection and analysis involve hardware processing units (microcontrollers, microprocessors, SoCs, FPGAs) and software applications. Platforms like Arduino, Raspberry Pi, and specialized software solutions are commonly used in large agricultural enterprises.

v. IoT Cloud Technology: Essential for data acquisition, as it involves sending collected data to a cloud service. Integration with other cloud services and internet sources provides valuable information to end-users.

vi. Semantics and Knowledge Extraction: Intelligence in extracting knowledge for basic services, involving resource discovery, utilization, information modeling, data recognition, and evaluation. Semantic technologies like RDF, OWL, and EXI are commonly employed (Xiong et al., 2019).

This comprehensive array of technologies forms the backbone of the research methodology, aiming to explore the integration of these methods into the agricultural sector for efficient and sustainable data collection and analysis (Mentsiev & Gatina, 2021a, 2021b).

5.2. Literature Review

Green projects are used to maintain the environment at a sustainability level. There are different kinds of green projects. Carbon footprint is a measurement of a product's or service's total carbon dioxide (CO2) and other greenhouse gas emissions during its entire life cycle (Nair et al., 2021). All of these things add to global warming. Greenwashing is the practice of businesses portraying their products as ecologically friendly by packaging them in green packaging and stating that they are recyclable even when they're not. The waste stream is used for the flow or transportation of trash from its source (homes or businesses) to its eventual destination (landfill). Creating renewable energy sources, such as wind farms or hydroelectric power plants, is a green project for renewable energy resources (Amirova et al., 2022). This type of project also has the added benefit of generating electricity while lowering pollution. Forests are one of the most effective strategies for the reduction of carbon emissions since they absorb GHGs naturally (greenhouse gases). The process of developing a forest on land that has never been wooded or has been for a long time is known as afforestation. Alternatives to deforestation include reforestation and afforestation. Restocking is the process of replenishing depleted forests or woods. These types of projects also have the added benefit of protecting the habitats of hundreds of animal species that rely on forests and rainforests for survival (Van Loon et al., 2015). These are some examples of green projects.

For the data collection and data automation, different programming languages and applications can be used to detect the ecological changes in specific regions and according to the environmental conditions and changes sustainability can be obtained through some environment-friendly strategies as already discussed above. For example, an application can be developed by using IoT techniques that can detect Plants’ PH, temperature, water level, nutrient requirement, soil conditions, etc. According to these environmental conditions, we can grow the plants in suitable soil, water, and nutrition requirement can be fulfilled by detecting these conditions. There are still clever alternatives for communities if they are not

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ready for a major overhaul. The WattTime system is an IoT solution that makes green energy accessible to everyone. Simply put the system on a gadget, charger, battery, or thermostat, and WattTime will automatically switch to the cleanest power source available at the time (Maltseva & Tkachuk, 2020).

Wind turbines, as simple as they appear, are incredibly sophisticated structures that are frequently installed in harsh environments such as open seas and far pastures. Wind farms must be able to quickly adapt to changing conditions in order to remain efficient and perform to their full potential. Not to mention the need of maintaining your equipment on a regular basis. Sensor-based technology, analytics for critical data on weather and environmental conditions, and turbine health are all examples of IoT and energy solutions that assist automate wind farm management, optimizing maintenance, and reducing costs considerably (Mentsiev & Mutaev, 2019).

6. Findings

Data collection and automation play a pivotal role in promoting environmental sustainability and human health. The automation of data collection, particularly in green projects, facilitates intelligent adjustments in environmentally friendly settings. For example, the use of artificial intelligence and IoT-based tools to collect data on plants' temperature, pH, soil condition, and nutritional requirements enables the detection of changes. Strategies can then be adopted to maintain an environment conducive to proper plant growth, including implementing changes in soil conditions to enhance fertility (Khudyakova et al., 2020).

The global recognition of the devastating consequences of environmental damage, such as droughts, fires, and ocean pollution, has led to increased attention to environmental issues. The rise in the carbon footprint due to technological advances necessitates new solutions. The emerging field of "Green IoT" is a focus area for scientists and specialists in agricultural and geological data collection. Green IoT is anticipated to have a substantial impact on daily lives, contributing to the concept of green ambient intelligence that connects the physical environment through eco-friendly networks (Magomadov, 2020). Green IoT networks aim to reduce emissions, control pollution, and preserve the environment while minimizing operational costs and energy consumption (Ohwo & Olujimi, 2020).

Devices designed to detect green energy consumption, such as trackers and sensors, can be attached to various appliances and surfaces to monitor electricity consumption in homes, offices, and entire buildings. Implementing IoT smart energy detectors, like Ecobee or Nest, allows for environment-friendly initiatives that cut down energy usage and mitigate the greenhouse effect resulting from electricity production. These technologies are particularly relevant for smart cities employing green energy solutions at a larger scale (A. U. Mentsiev, Engel, et al., 2020b).

Historical and real-time data on electricity consumption collected by these technologies are invaluable for environmentalists, researchers, and conservation strategists. Properly cleaned and analyzed data can inform decision-making, benefitting the energy sector through profitable initiatives that simultaneously benefit people and the environment. Stakeholder collaboration, diverse technological stacks, and emphasizing end-user benefits are integral aspects of such initiatives. Homeowners also find these tools helpful for tracking electrical usage, analyzing utility costs, and ensuring appliance safety. Utility companies and suppliers utilize these methods to control energy supply and determine demand-

based pricing (Magomadov, 2019). Researchers leverage the data for insights into electricity usage and storage habits, enabling the development of data-driven conservation methods.

7. Conclusion

As the demand for clean energy continues to grow, and environmental consciousness becomes integral, the emergence of new Internet of Things (IoT) energy management solutions is evident. In the contemporary landscape, IoT plays a crucial role in advancing green energy initiatives by enabling businesses to leverage data, enhance operational efficiency, and prioritize workplace safety. The clean energy revolution is still in its early stages, and the impact of IoT on the industry is expected to be substantial, shaping the future of green energy. The automation of data collection for green projects proves highly beneficial, as it enables the development of energy-efficient and eco-friendly tools and devices, minimizing potential harm to human and other organisms' health. As we navigate the intersection of IoT and clean energy, the potential for innovative solutions and sustainable practices remains significant, paving the way for a greener and more efficient future.

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