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A Review of Integration of Robotic Process Automation and Artificial Intelligence: Advancements, Applications and Challenges

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Abstract: Robotic Process Automation (RPA) is an important automation tool used in various business processes and other occasions where repetitive work in a computer system is needed. RPA execute designated processes with high precision for a long period of time continuously. In addition, it is easy to deploy RPA bots on devices and to design automation processes, making RPA the most popular choice for business process automation. The application of artificial intelligence (AI) technologies including machine learning (ML) and natural language processing (NLP) expands the function of RPA and enhances its capability. The synergy not only enables automation for more complex tasks involving optimization, but also improves the efficiency of business processes. This paper focuses on current advancements of RPA integrating with AI. The paper also analyzes some typical cases of application and discusses potential challenges. The case analysis involves processes that RPA+AI is already widely applied, while advantages of AI integration is discussed. The paper provides an insight into how AI technology can be used in RPA in future researches.

Keywords: Robotic process automation, Artificial Intelligence, Machine Learning.

1. Introduction

Robotic Process Automation (RPA) has become a crucial tool widely used in corporations and industries [1,2]. By mimicking human interactions with the system, RPA can complete processes including order entry and invoice processing [1]. RPA's ability to improve efficiency and reduce human workhours on repetitive tasks contribute to a higher Return on Investment (ROI) and allows for more human workforce to concentrate on productive work. Recent years have seen a sharp rise in both the range and complexity of business processes. This results in the need for a stronger, more capable tool of automation. That is why current advancements in the RPA field focus on integrating Artificial Intelligence (AI) techniques - including Machine Learning (ML) and Natural Language Processing (NLP) - with RPA [3]. AI-enhanced RPAs can now participate in more complicated tasks such as optimization and decision-making.

A study in 2021 discussed the advantages of applying cloud-native RPA and AI on automated data warehousing and intelligent data pipelines based on the architectural design of the process [4]. The process of data extraction, transformation and loading (ETL) can be automated by cloud-native RPA.

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Then AI technologies are in charge of improving data quality and further analytic work. The study provides a useful guideline for the application of RPA+AI in data science.

In another research, a case study from a Power Distribution Utility in Brazil is focused on to find out how is AI involved in RPA processes [5]. RPA robots participate in downloading data from emails, finding missing data and producing reports. AI models, including Autoregressive Integrated Moving Average (ARIMA) and Long Short-Term Memory Recurrent Neural Network (LSTM-RNN) is used to analyze history data and predict future trends.

This next paper analyzes the role of RPA and AI from the perspective of the development of financial technology (fintech) [6]. The development shows a paradigm shift from process-driven technologies including RPA and its early form, Robotic Desktop Automation (RDA), to data-driven AI technologies such as machine learning. RPA specializes in executing processes, whereas AI resembles the brain, learning from the environment and telling RPA what to do and how to do it.

This review focuses on the major advancements in RPA+AI, gathering papers on these topics and extracting typical cases of applications, discussing how AI techniques are used in these cases and the possible challenges while implementing these techniques.

2. Advancements of RPA/AI Techniques

Integrating with AI is undisputedly the major trend in the development of the RPA field. RPA is known to be rule-based, following a clear set of rules as instructions while executing automation processes [2]. This certainly makes RPA powerful when working on repetitive tasks for a long time with high accuracy and precision, but it also brings shortcomings. The most notable ones are:

1) Being incapable of complicated tasks that cannot be described by a simple set of rules;
2) Lack of robustness, which lowers performance under a sudden change of environment.

The following are the major advancements of RPA related to AI that target on solving the problems above: ML-Based-RPA, Cognitive RPA and Hyperautomation [1].

2.1. ML-Based RPA

ML leads RPA into constant self-improvement by learning from past processes that have been executed. ML algorithms can spot patterns from the dataset of automation processes and then be integrated into the RPA framework, enabling it to complete tasks like identifying document types and acquiring related data from unstructured sources – tasks that traditional rule-based RPA is uncapable of. The new ML-based RPA is more accurate, more efficient and smarter, and is very likely the future way of RPA.

2.2. Cognitive RPA

Cognitive RPA focuses on gathering and interpreting external information with the help of NLP, ML and computer vision (CV). Sources including emails, unstructured documents and social media posts contain natural language and visual information that can be extracted by NLP-and-CV-supported cognitive RPA. ML then helps cognitive RPA to understand that information. Examples of tasks cognitive RPA can accomplish are responding to customer requests and analyzing social media trends.

2.3. Hyperautomation

Hyperautomation uses a combination of the AI techniques, including the ones mentioned above, and the goal is to automate the whole business process as much as possible. This involves applications on decision-making in finance, human resources and supply chain management.

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3. Cases of Application

3.1. Invoice Processing Using RPA & AI

This study analyzes the process of invoice processing with ML-supported RPA bots, comparing it to the traditional approach [7]. The study aims at improving performance both when creating invoices and when extracting information from invoices. The study uses the ML based IQ Bot of *Automation Anywhere* (the RPA platform used here, AA for short). It first specified the type of invoice that needs to be processed – General-Purpose Data Capture Invoice, and the algorithm it uses – Naïve Bayes Algorithm. First a definition of the Class Invoice is created, including the Invoice Creator, the data and a Validation Rule. This enables an automated training process, in which the extracted data are compared with desired results and accuracy is evaluated. The final "Invoice Download" bot after training has successfully converted all PDF invoices into CSV files, with an accuracy higher than the untrained bot in all of the 5 sample groups.

This study is a well example of how the involvement of ML training can improve the accuracy and efficiency of processes that traditional RPA are already capable of.

3.2. Using RPA+AI for Retail Pricing Optimization

A paper by Anderson O. in 2022 discussed this application in detail, giving an example of how AI empowers RPA for more complicated tasks, i.e. optimization problem [8]. Retail Pricing requires thorough consideration upon data from various sources, including social media trends, customer feedback and information from business competitors. The data needed can be extracted from those sources automatically and effectively by RPA. Regression models, neural network and reinforcement learning, and other AI techniques can be used to recognize patterns from the data collected and can predict the influence different pricing strategies have on sales revenue, thus making the optimal decision. RPA also allows for up-to-date data collection and the follow-up execution of AI pricing programs. This supports a dynamic pricing strategy to be well executed, making the optimal pricing decision at all times.

In another paper by Venigandla K. in 2023, feedback from some corporations that uses RPA+AI in retail pricing is viewed to analyze the influence of RPA+AI application on different pricing strategies, in terms of AI-RPA implementation rate, operational efficiency, market adaptability and customer satisfaction [9]. This gives an insight of the benefits of AI-RPA implementation that takes marginal effect into consideration.

3.3. Order Entry with RPA+AI

The study conducted by Salmen A. in 2022 involves a quantitative analysis of the benefits of RPA+AI implementation in terms of time economy [10]. For theoretical analysis, the processes of both the traditional process and the RPA+AI process of order entry are modeled step by step, giving a equation for time consumption on a factor of the number of repetitive processes based on the steps involved. The new RPA+AI process reduces the number of steps in the process, therefore decreases the theoretical time consumption. For empirical analysis, data from Small and Medium Enterprises (SMEs) that use RPA+AI in order entry processes are collected. These data include the time taken in the process, before and after RPA+AI implementation. The result is a notable 64.52% increase in time economy.

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4. Current Challenges

Current Challenges in the application of RPA+AI involve issues regarding artificial intelligence ethics [11]. One common challenge that comes with artificial intelligence is algorithmic bias. AI model training uses a vast amount of data from various sources, some of which might contain biased information that can lead to stereotypical judgement from AI decision-making. In the retail pricing application, for example, the AI gathers a good portion of data from social media sources. This can result in AI putting stereotypical (and most of the time wrong) labels on certain customer demography. The consequence involves not only inaccurate pricing strategies being established, but also possible social accusations of discrimination. Another challenge is about human irrationality that AI-RPA bot might catch while training decision-making tasks based on real human decisions. On the one hand, tasks that require absolute rational decision-making need to eliminate this possible factor of error. On the other hand, in some other tasks which, for example, have a strong correlation to customer feedback and satisfaction, it is still arguable whether to keep making rational decisions, or give the AI a more human-like preference while performing these tasks. Other ethical issues include data privacy and possible reallocation of labor and capital when RPA+AI gains a wider application and more human workforce is replaced.

5. Conclusion

This paper, through case analysis, discusses applications of the RPA+AI technique. The integration of AI technologies into RPA has significantly enhanced efficiency in various business processes including invoice processing and order entry. This synergy not only improves operational performance but also enables SMEs to increase their scale at a lower cost. In the foreseeable future, with the continuous development of more advanced AI techniques and more effort put into the RPA-AI integration, RPA+AI will further evolve into a smarter tool capable of handling more complex tasks. However, the idea of AI making decisions in business processes brings both technical and ethical challenges that need to be considered when developing and implementing AI-enhanced RPA. To overcome these challenges, the effort of both commercial RPA providers and individual developers using open-source RPAs is needed. Possible future trends in this field include the integration of RPA+AI with other technologies, such as the Internet of Things (IoT) and blockchain, which could further transform business operations and create new opportunities for innovation.

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