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Generative AI Enabled Robotic Process Automation: A Practical Case Study

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***Abstract*— Robotic Process Automation (RPA) can be used to automate highly repeatable business processes. However, it might struggle in non-deterministic situations where some sort of understanding is required. For example, it can automatically load all the students' answers from an online examination, but it cannot mark them without the help of some kind of AI. This significantly limits its capabilities. Generative AI and applications such as ChatGPT have many potential applications as they can generate and understand natural language text, making them ideal candidates for addressing the limitations of RPA. In this paper, we propose a practical way of enhancing Robotic Process Automation using Generative AI. This work also includes a practical case study that uses Visual Studio C#, Selenium, and ChatGPT for automatically grading students' examination attempts in the Moodle Learning Management System. The results show that the application managed to grade the students with minimal human input.

Keywords—Artificial Intelligence, Generative artificial Intelligence, Robotic Process Automation, Business Process Automation

Introduction

Industry 4.0 and AI have revolutionized the way business operates these days with the automation of different business processes by introducing disruptive technologies to break the long-held business rules [1]. Modern-day enterprise applications and requirements call for swift and higher degrees of automation with less human involvement and intervention. Robotic Process Automation (RPA) is a concept aimed at automating such repetitive tasks [2]. RPA can access different parts of the system and perform actions like clicking buttons, filling fields with text, reading text from applications, and, in general, using applications like a user. However, by default, at the conceptual level, it does not include a specific AI module for dealing with the understanding of text or generating text. This is an essential part of office automation, as in many cases, human users must understand the request or instructions within a given workflow before they can reply accordingly. Consider, for example, online exam marking. RPA can use the Learning Management System to access student attempts, but it cannot grade them as it has not understood how to do so. This is also true in many other cases where understanding or generating text is required, forcing RPA to rely on humans to fill the gap.

Generative AI, on the other hand, is capable of both understanding and generating text and images, making it an ideal candidate for filling this gap. RPA can use the application, and once it reaches parts that require understanding or generation of text, it can delegate this task to a generative AI application, use the results, and continue with the process. This will increase automation and significantly decrease the need for human input.

In this paper, we demonstrate that this is possible and propose a four-component approach for integrating the two technologies. We also tested the proposed approach by developing a C# application that uses the Selenium WebDriver [3] to grade some exams in the Moodle Learning Management System [4] using ChatGPT [5].

This paper is structured in the following way: The next section presents related work. Section III presents an overview of the technologies used in this work. Section IV introduces the general framework and explains how Robotic Process Automation and Generative AI can be used together. Section V, with a practical case study, demonstrates the proposed framework. Finally, Section VI concludes this article.

Related Work

Robotic Process Automation (RPA) can automate and transform processes involving repetitive human tasks. This is due to RPA's capability to automate and transform such specific processes. Technologies like Artificial Intelligence (AI), and specifically Generative Artificial Intelligence (GAI), play a key role in generating content and processing data, in so doing minimizing dependency on the human workforce. This creates new opportunities for researchers and industry experts to explore the combination of RPA and GAI to take advantage of the strengths of both technologies and achieve a more accurate and better level of automation. The related work in this section of the article investigates research in the domain of GAI-enabled RPA along with other similar work in the domain.

The most challenging part in automation of operational processes is the dynamic nature of decision-making during the process execution in an automated manner. This is due to the reason where either the workflows are open-ended or entirely dependent on human input and thought process of taking the actions in a manner suited with that specific scenario. Studies show how GAI and RPA can be integrated to address these challenges [2] and to enhance the predictive capabilities of GAI beyond content generation and data processing. AI models can be trained on similar use cases and scenarios to predict and provide accurate input and improve the efficiency of RPA automation. This study has established the idea that the use of GAI and RPA results in increased efficiency and has provided evidence in the form of assessments of several use cases.

Apart from theoretical frameworks and concepts, studies [6] have used real-world datasets to showcase and prove the capabilities of GAI-enabled RPA in improving efficiency and flexibility in handling different nature of processes for automation. Based on these evidences and established results, to manage adaptive workflows and decision-making, a framework is also provided for GAI-enabled RPA.

The potential of combining GAI with RPA has been discussed by many studies as mentioned in this section, study in [7] addresses challenges along with the capabilities in combining GAI with RPA. In order to leverage the true strengths of GAI-enabled RPA, this study discusses the hurdles and critical aspects of integrating these technologies. The nature of data, nature of process and its complexity is key in designing the right automation mechanism. Apart from understanding of process, data and its complexity; the clarity of the model to be used is an essential player for succeeding in getting the desired outcome for a high level of automation. This study also discussed blockers and challenges in automation using GAI-enabled RPA and provides strategies and techniques to overcome these challenges.

Study in [8] discusses the domain of supply chain management and the requirements of automation in such a dynamic and continuously changing domain, and how this domain benefits from the GAI-enabled RPA processes automation. This study proves and establishes the fact that the combination of GAI and RPA can improve the efficiency and performance of operations in real-life use cases, such as supply chain management.

GAI-enabled RPA has the potential to achieve a high degree of automation, however the selection of the right model and techniques [9] for the target process and the accuracy of training of that model on relevant data is key to success. This study also explores several models and their benefits and shortcomings. It also advises on using these models in the kind of scenarios where it can provide better results in automation.

Several studies discuss the potential of GAI and RPA combination, however choosing the right model and techniques based on the nature of target scenario is a key to success. [9] discusses the pros and cons of various GAI models and techniques and advise on where it can be used for better results.

TABLE I. SUMMARY OF RELATED WORK WITH NOVELTY OF OUR RESEARCH

No.	***Paper Title***	***Similarities***	***Novelty of research***
1	Leveraging Generative Artificial Intelligence for Adaptive Workflow Automation.	Use of AI in Adaptive/open workflow automation	Generative AI implementation in the form of Input for intelligent AI automation tool rather than only prediction of the next step. To address the challenges like User Acceptance and Integration complexities a generalized prototype will be created for the selected scenario to ensure the acceptability of such novel approach.
2	Enabling Open Workflow Processes through RPA and AI Integration: Opportunities and Challenges.	Automation of Open workflow process using RPA and AI.	Utilizing Generative AI based on a custom-made training data set will address the challenges mentioned in the study like process ambiguity.
3	Predictive Process Monitoring Based on LSTM Neural Networks	Prediction of next action within a process using AI	The LTSM interpretability is complex and with generative AI usage this study will create a prompt that instead of a human agent an intelligent AI automation agent will execute.
4	Integrating RPA with Generative AI: A Case Study of Enhanced Workflow Automation in Banking Sector	Integrated use of RPA and Generative AI	Instead of focusing on a specific sector, this research generalizes the approach with a prototype.
5	Adaptive Robotic Process Automation with Generative Artificial Intelligence	Using generative AI along with RPA	The integrated use of generative AI is for customer interaction and RPA for automation. This research however uses the Generative AI for generation of input prompt based on AI prediction of the next action in the process and utilizes the intelligent AI tools to execute an implement it.

Concluding the related work indicates that combination of Generative Artificial Intelligence and Robotic Process Automation shows promising potential in enhancement of operational efficiency and improvement in the automation and transformation of processes. Choosing the right model and integration technique is the key to success.

TECHNOLOGY OVERVIEW

A. Generative Aritifical Intelligence

In 1960's Generative AI (GAI) was mainly known for Chatbots. The real enhancement to GAI began in 2014 with the introduction of a machine learning algorithm i.e. Generative adversarial network (GAN) for creating precise audio, video and images of real people [10]. Brynjolfsson et al, [11] found out that Generative AI has improved customer sentiments and employee's retention while helping to increase productivity. Generative AI is multidisciplinary and has many applications in different domains such as computer vision, Natural Language Processing and creative arts [12]. GAI is also used for content generation such as simulations and code. Among the most popular applications of GAI is ChatGPT (Generative pretrained transformer) emerged in the late 2022 as an implementation of the GAI. Since then, ChatGPT has seen iterative development of new tools almost every month with a growing concern among people for losing their job to technology [13]. That means that is capable of performing tasks that were usually completed by humans. Generative AI is inspired by the core principle of making the machines to learn the patterns and structures in a bigger dataset of high quality and then to use that knowledge to generate contents that have similar characteristics with the trained data [14]. GAI usage was considered a hectic and troublesome work with the API submission using python language but lately with the advancements a simple plain text requests are entertained. NVIDIA technologies lists some of the most important challenges faced by GAI which includes but are not limited to lack of high-quality data for training, latency and data licenses for using the data [15]. We predict that the future of Gen AI is quite bright for researchers and tools developers. Businesses may undergo a huge transformation with models impending human level performance by the use of advanced machine learning that powers GAI products and technologies.

B. *Robotic Process Automation*

RPA like Generative AI can use modified and fit for purpose AI algorithms, NLP and other data mining techniques to automate organizational processes [16]. RPA is also termed as "software robot" for businesses that enhances and automates governance structure, strategies for the organization and decision processes of the organization [17]. For any organization, Digital transformation and Business process Re-Engineering (BPR) are entirely dependent on automation of processes. The future of robotic process automation is seen as cognitive automation with unsupervised learning which Is seen a threat as well as a breakthrough achievement at the same time by researchers [18]. While in this paper we show how RPA can be combined with generative AI, it could also be combined in a very similar way with other AI approaches increasing both its capabilities and the degree of automation. We believe that the cognitive automation may end up combining many AI fields by making tools and applications that embeds expert systems, neural networks, robotics, fuzzy logic, computer vision, NLP and many more as depicted in figure 2.0.

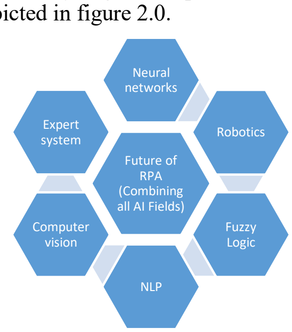

Fig. 1. Future of RPA - Combining different AI fields

Most of the RPA tools whether online or desktop applications, aim to automate repeated manual tasks. Enhancing RPA with the capability of delegating parts of the process to an inbuild or external (via API calls) AI solution would leverage its capabilities and allow it to remain relevant to the modern work environment.

Integration of Technologies Overview

The main idea behind using Generative AI (GAI) within Robotic Process Automation (RPA) is to achieve a higher level of automation, reducing the need for human input. During the automation of business processes using RPA, the steps involved sometimes require human input, data summarization, or content generation. All of these tasks can be achieved using Generative Artificial Intelligence (GAI). GAI can act as both a content generator and processor in processes automated via RPA. Thus, activities and work performed manually by humans can be replaced with mediators such as web services and APIs to achieve GAI-enabled RPA. Figure 1 shows a conceptual model of how these two key technologies can work together. With the integration of these technologies, introducing a concept of task distribution can improve performance and significantly reduce job completion time, depending on the task distribution mechanism and configuration.

In this paper, we propose integration of GAI within the normal flow of RPA. RPA can work as usual, accessing digital content, populating forms and in general being used to complete all the deterministic parts of the process. Once it reaches a task that requires some kind of "intelligence", either for "understanding" or generating some digital content, it can generate a prompt (in a deterministic way), pass it to a GAI solution and use the reply for completing the task. It can get the answer from GAI, process the reply, again in a deterministic way and use it without any actual understanding of the question or the answer. For example, consider that we wish to automate the process of booking hotel rooms. An RPA based application could login, put all the details to the search tab, such as location, room capacity, cost and so on. Once the results appear, it could check the reviews of certain hotels and rooms for wanted or unwanted features such as bad view, not clean and so on. These positive or negative features are not usually included in the search filters and the only way to detect them is by use of some kind of AI. To achieve the above task, as part of the RPA process the application must generate a prompt like "Does the following text imply that the room has a good view? Answer with a yes or no and nothing else." followed by the text of each comment. The application could then process the replies and use it to select the most appropriate hotel room.

In order to generalize our approach, we propose a four components approach called "Robotic Process Automation", "Target System", "Mediator" and "Generative AI Agent ". We assume that the RPA aims to automate processes related to the "Target System". Within the RPA flow, any steps that require "cognitive" skills are to be passed to an external application, called the "Mediator". That will act as an intermediate between the "Generative AI Agent" and the application that uses the RPA. Different GAI solutions might be good in different things. For example, a GAI solution may be good for generating images while another could be for generating code. In theory, a single RPA could require making calls to different GAI agents either within the same run or at different times. This extra layer can allow the application(s) to always connect to the mediator so there is no need for changes in the application configuration or code. The mediator will be responsible for contacting the appropriate GAI agents, removing the complexity from the RPA as well as making it possible to change which GAI agent our applications are using by making the change only in the mediator. Reasons for change might include accuracy, speed, cost and so on. Figure 2 below shows an overview of the process. We included multiple lines (C1, C2, Cn) connecting the four components to illustrate that if required, multiple connections could be established in order to increase the performance, as multiple request could be made at the same time.

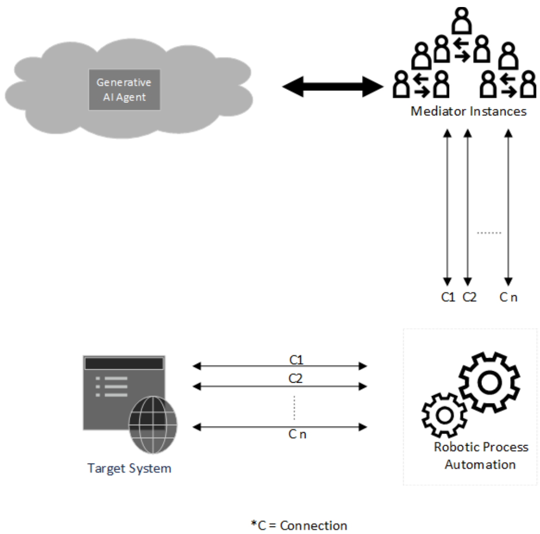

Fig. 2. General Framework

There are four major components as per figure 2:

- Target System: It is the target operational system where the actual business process resides and requires automation.
- Mediator(s): Mediator is the intermediary layer between the RPA and GAI to communicate necessary interactions. This layer can be scaled based on needs. The purpose of mediator(s) is to make sure that the solution or framework is not dependent upon a particular GAI platform and can be switched at any point of time without changes to the RPA enabled processes.
- Generative AI Agent (s): A generative AI solution/platform that is responsible for creation of content (text, images etc.) and processing of information. This can be a closed source or open-source solution tailored to specific use cases or generalized in nature.
- Robotic Process Automation: This component comprises automated processes that transform the target system's target processes and automate it to achieve desired results. It interacts with the GAI through the mediator instance(s) to automate the targeted services of the target system. According to the requirements multiple instances and communications can simultaneously be executed to achieve efficient outcomes.

The above components interact with each other in a general process as follow:

The target system's processes are partly or fully automated using RPA. At any given time, based on requirements, multiple communications can occur between RPA and the target system. RPA can either take input from the target system or provide output to it, or it can perform both functions, depending on the nature of the process.

RPA can also communicate with the GAI agent through mediators. The use of a single or multiple mediator depends entirely on the requirements and desired results. Once communication from the RPA component is passed through the mediator to the GAI component as a prompt, the required actions are performed, including content generation and data and information processing. The output from the GAI is communicated through the mediator(s) to the RPA component, where it can either be passed to the target system again or stored, depending on the requirements.

CASE STUDY

To support this paper, we developed a Visual Studio C# application that uses Selenium [3] to connect to the Moodle Learning Management System [4] website and automatically grade student attempts using ChatGPT [5]. It should be noted that the main aim of this paper is to practically demonstrate how Robotic Process Automation can be enhanced by the use of Generative Artificial Intelligence to offer a higher degree of automation. Hence, we did not focus on creating prompts for better grading or other academic matters. For this case study, Figure 2 from the previous section has been modified in figure 3 to include the specific components used in this study.

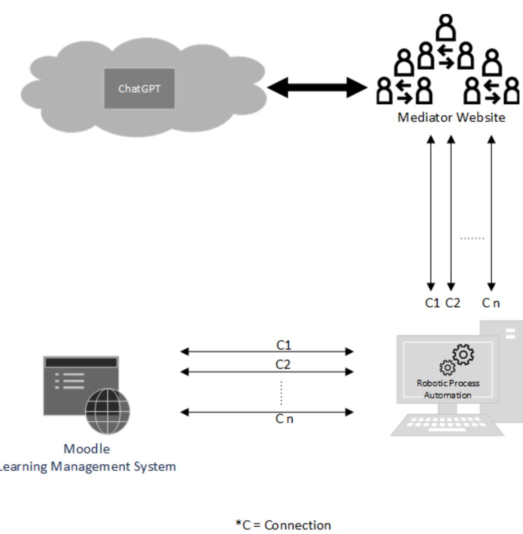

Fig. 3. Flow of the implemented Case Study

The Generative AI agent in this case is ChatGPT. The mediator is a website that we developed using PHP, which sends the questions to ChatGPT via its Application Programming Interface (API). The target system in our case is the Moodle Learning Management System. We developed a custom Visual Studio C# application that simulates Robotic Process Automation. Figure 4 shows the interface of the application.

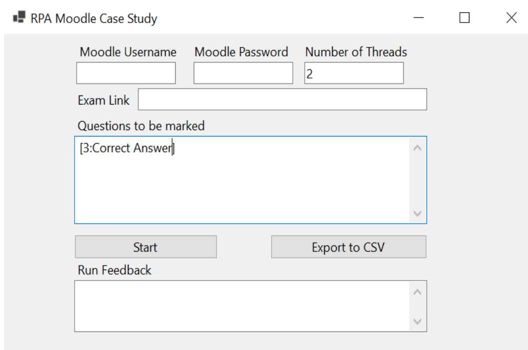

Fig. 4. The grading application.

As it can be seen in figure 4, the users have to supply the Moodle Username and Password as well as the link of the quiz results page. They also need to supply which questions are to be graded with their corresponding answers in the format [Question number: Correct Answer]. The number of threads is how many threads the application should open for sending data to the mediator.

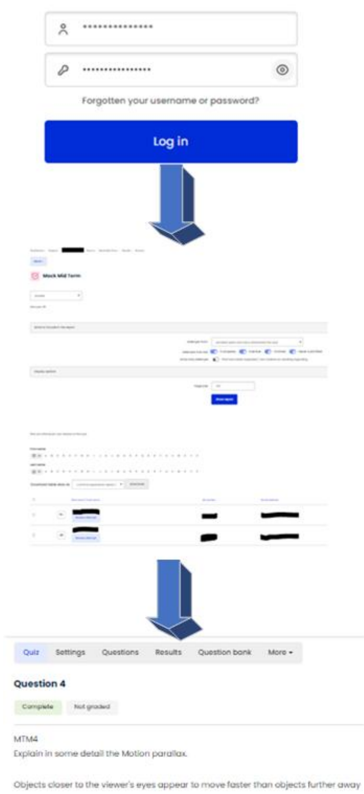

Fig. 5. Actual Flow of the developed case study

A mock quiz with three questions was developed in Moodle. The first two questions were auto-graded by Moodle while the third question required grading. The user has to provide the application with the questions that require the grading as well as the model answer. Figure 5 shows the sequence of the pages that were automatically visited by the application.

The application will access a mock quiz prepared for this experiment, download all the student answers that need manual grading, and automatically pass them one by one to ChatGPT via a modified prompt through a mediator.

During initialization, the Chrome WebDriver is set up to launch the browser. The Moodle login screen appears automatically by accessing the URL. The application checks the credential elements on the browser page, sends the credential values (i.e., username and password) to the respective fields via element IDs, and enters them. The application then identifies and finds the login button from the list of control element IDs on the page and clicks it. This results in a successful login to the Moodle Learning System by the authorized user, achieved automatically using the application.

Next, the application will visit the Quiz Results page to extract the students' attempts. A wait mechanism is incorporated to ensure that the page loads properly. In this page, Moodle displays the list of all student attempts with the student's name, id, hyperlinks that lead to each student attempt and some additional information. The application will extract the student ids and the hyperlinks that lead to each student attempt and store them in a list. To store the information, we created a class called "studentAttempt" that has a string called "Sid", a string called "attemptLink" that stored the hyperlink the leads to the attempt and a list of "question" objects. Each question class includes an integer called "questionNumber" a float "grade" and a string called "feedback" and a string called "studentAnswer".

In the next step, the application iterates through the full studentAttempt list that were storing the hyperlinks and visit each student attempt. In our example only one essay type of questions required grading, while the "matching" types were already marked by Moodle. For each question that required grading (as specified by the user in the application) the tool extracted the student answer and stored it in the list of student attempts. By the end of this step, the system had stored in the list all the student answers that required grading.

In general, this step should be implemented using multi-threading instead of sequential programming to speed up processing time. However, due to the limited number of attempts (i.e., 29 students in our case) and also to show that it is possible, we implemented it using a single thread. Our approach leaves it up to the developers to decide the implementation details.

Next, the marking of the student's attempts is performed. The application, will create a prompt for the GAI to perform the grading using the following formula.

$P = C + A + S$

P is prompt

C is constant instructions for grading

A is the correct answer, provided by the instructor manually to the application

S is the student answer

For example,

Prompt = "Mark the following question based on the given answer. The answer should be in the given format. Total Mark Out of 5 and up to 5 words feedback." + Correct Answer + Student Answer

The prompt is posted to the URL through the mediator in the following way.

https://URL? q=Prompt

where URL is the page of the mediator and q is a URL parameter

The application posted one by one the prompts to the mediator page and waited for the response in a string format that included the grade and the feedback. This process is very time-consuming if executed sequentially because the application must access the mediator website and wait for a response from ChatGPT. Additionally, the application must wait a few seconds for the page to fully load. Therefore, we are using multiple threads to distribute the collected list of attempts for grading.

To reduce the overall wait time and job completion time, we are creating multiple threads by dividing the collected list of attempts into T parts, where T is manually entered by the user. In this use case, we set the value to 2. Consequently, the total wait time for this step is theoretically reduced by half. This criterion can be adjusted based on requirements and needs. All threads add their results to the list of student attempts after splitting the string into two substrings, where one was containing the mark and the other the feedback.

Finally, the results can be extracted to a CSV file with three columns: the first column for the student ID, the second column for the mark out of 5, and the third column for the feedback.

The case study used the proposed approach for intergrading GAI within RPA for increasing the automation of marking student attempts. The user had to supply some initial information to the system once, and then the system started marking the students, without requiring additional information from the human user. The aim of this case study was to prove that it is possible to implement the proposed approach as well as to demonstrate how the approach could be implemented and not to develop a reliable application for grading students. The proposed process is not limited to this case study. We believe, that it can be used for any similar task, assuming that the GAI Agent used can perform the task.

Conclusions And Future Work

This research demonstrates, through an example, how Robotic Process Automation (RPA) can benefit from the use of Generative Artificial Intelligence (GAI). GAI-enabled RPA provides enhanced automation with less human intervention. In this study, we proposed a four-component approach for integrating Generative AI and RPA. The four components are the Target System, Mediator, Robotic Process Automation, and Generative AI. The Target System is the component that requires automation and enhancements in its processes. The RPA component automates these processes based on communication with the Generative AI component through the Mediator. This research also includes a case study where we developed a Visual Studio C# application demonstrating the proposed framework by using Selenium WebDriver to connect to the Moodle Learning Management System and automatically grade student attempts using ChatGPT. The application was able to perform the task with minimal human input. The aim of this case study was not to build a reliable student grading system but to prove that the proposed approach can be implemented and how.

This work has several limitations; mainly related to the selected case study. For instance, we did not use any specific grading methods as we were focusing on the integration of technologies and potential challenges rather than the academic aspects of grading. Also including multiple case studies from different sectors could possible had increased the clarity of the proposed approach.

In the future, we plan to address the above by extending this work. We plan developing multiple more complex applications for different industries such as tourism, finance, education and so on. We will also utilize more than one GAI agents within the same RPA to demonstrate the importance of having the mediator as a separate component. Finally, we will attempt to generalize the approach even further by replacing the GAI Agent with a generic Artificial Intelligence agent. This is because, as mentioned earlier in this paper, RPA could theoretically benefit from different types of Artificial Intelligence and Machine Learning approaches and not just from GAI. However, despite its limitations, this work has the benefit of presenting a clear case of how GAI could be practically utilized within RPA and automate business processes that require "cognitive" skills as long as the GAI can do the task.

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