TRƯỜNG ĐẠI HỌC FPT

The combination of robotic process automation (RPA) and chatbot for business applications

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Aknowlegement

We would like to express my deep and sincere gratitude to our research instructor, Dr. Phan Duy Hung for giving me the opportunity to do research and providing invaluable guidance throughout this research. His dynamism, vision, sincerity and motivation have deeply inspired us. He has taught me the methodology to carry out the research and to present the research works as clearly as possible. It was a great privilege and honor to work and study under his guidance. We would also like to thank him for his empathy, and immense knowledge.

Besides my instructor, we are extending our thanks to our friends in FPT University for their support, patience, and friendship. Our sincere gratefulness also goes to FPT University, which created the wonderful environment for our development during the four years we studied here.

Last but not least, we appreciate our caring, loving and supportive families. Their encouragement was a great comfort and relief for us during our hard times.

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Abstract

The digital transformation is going at break-neck speed in enterprises across all fields. Some of them have chosen to digitalize only essential processes or use ready-made solutions without thinking about system integration or developing application interfaces. Others set out to build a comprehensive digital infrastructure with management, administration, and production systems. However, for a large majority of them, digital transformation is an ever-going process as new business requirements, which will inevitably crop up. In this case, Robotic Process Automation (RPA) is a suitable solution. RPA is a concept in which software robots take over humans in automating iterative business processes with fixed logic that does not have an existing application programming interface (API). Recently, the combination of RPA and chatbots is considered an effective tool for handling many business processes. This research proposes a solution and procedure based on open platforms, which can be readily extended by enterprises as needed. This solution can also be improved with Artificial Intelligence (AI) algorithms. The result is demonstrated through a few selective business processes that have been implemented in an organization and proven effective. The work focuses on the flexibility, ease of deployment, and efficiency of an RPA-chatbot solution targeting business digitalization.

Keywords: Information System Integration, Chatbot, RPA, AI.

I. Introduction

1. Problem

Investing in technology in businesses has never been more appropriate when new technologies can deliver considerable productivity improvements compared to manual works at very reasonable prices. The year 2020 alone brought about more digital transformations than the whole previous decade combined. As companies do not want to fall behind in the competition, every digitization effort is being accelerated and implemented on a large scale because those who do will inevitably experience a remarkable breakthrough in every aspect [1].

However, there are no common pathways for every company, so each of them has to carve out their own rules regarding estimation of costs, prioritization of high-value works or new services, retraining and transferring redundant workers out of automated processes, etc. Hence, some businesses have chosen to digitalize only essential management activities while not paying enough attention to the integration process that must happen later. On the other hand, enterprises with large investment budgets can build a unified software solution for their entire digital infrastructure, including management systems and production systems. However, in order to digitize an entire organization, purchasing ready-made software will not be sufficient. In fact, during the operation of businesses, new processes will crop up and demand additional digitation. In these cases, RPA is a viable solution for software systems without proper application programming interfaces. Assigning RPA to tasks with fixed logic will eliminate trivial errors and idle tasks, thus employees will have more time to focus on more important jobs and improve business productivity.

2. Related works

The recent trend of integrating RPA with a chatbot and applying artificial intelligence algorithms has brought about magnificent efficiency gains for automating business activities. Various studies and products of this solution can be listed below:

- Object detection in software applications interfaces using an RPA system integrated with the TensorFlow CNN YOLO tool. This application provided an initial solution for robots to simulate human manipulation on frequently changed interfaces. The evaluation tests of this project analyzed and labeled a specific programming software - Eclipse IDE [2].
- The research of S. Sutipitakwon and P. Jamsri focused on the effectiveness of using RPA in repetitive tasks. In this case study, the test is performed on filling education workshops forms. The research introduced many supportive platforms of RPA such as Pega, BluePrism, WinAutomation, etc, hence they chose to use UiPath for its advantages. After implementing and testing, the research team got very high satisfaction results (100%) with linear or simple forms RPA and found deficiencies in testing with complex forms for this specific case [3].
- An application of RPA in supporting systems for government administrative management processes was presented by Raissa et al. This case study indicated the effectiveness of RPA in improving the performance and reducing costs of executing operations [4].
- A case study in communication tools for the elderly was introduced to emphasize the essential aspect of implementing RPA applications into consumer services [5].
- A method for software testing automation using RPA was provided by N. Yatskiv, S. Yatskiv, and A. Vasylyk. The

solution was improved by combining with computer vision for object detection [6].

- The development of chatbot technology recently proved its significant effect on various areas, such as in the research of deploying a chatbot in the airport to support customers. This research proposed a chatbot solution to enhance client experience in gathering information in the airport. The chatbot can answer users' questions immediately, and it supports multiple languages, which human employees can hardly do [7].
- The research of Gajra, Lakdawala, and Bhanushali focused on the integration of chatbots and RPA to automate multiple processes in the Student Information Management system. This research proved that the combination of a chatbot and RPA technology is possible, and it could bring significant advantages to the Student Information Management sector [8].
- Oza et al. not only implemented a chatbot along with RPA bots, but they also included AI modules in Insurance Claim Processing for automating the process, such as legitimating user claims and sending emails about claims amount [9].

The above research and solutions mainly focus on a specific application without consideration of the organizations' existing IT team or the cost of short-term development. This thesis proposes a flexible system based on open platforms that are easy to develop. It also has the ability to integrate AI applications quickly and easily.

The remainder of the thesis is organized as follows. Section 2 describes system architecture, analyzes the extensibility for business operations, and integration of AI applications. A concrete example is shown in Section 3. Then, conclusions and perspectives are illustrated in section 4.

3. Contribution

This solution proposes a system that integrates chatbot, RPA, and AI technologies with the base of open platforms that require a limited amount of effort to develop. These are some of the most attractive technologies in the modern world. The interaction of the three can compensate for each other's weaknesses and it can bring huge benefits to various areas.

RPA has no user interface, which makes it significantly difficult for non-developer users to interact. Therefore, in this thesis, the research team introduces the integration between chatbot and RPA technologies in order to create an user-friendly system.

RPA can automate mundane processes with significant low effort, which carry many advantages for enterprises. However, as the drawbacks mentioned above, RPA can only support basic operations, which do not require human understanding ability. However, this disadvantage can be solved with the help of AI technologies.

Furthermore, due to the base of open platforms, this solution only required a low budget and resource. Besides, it can be easily expanded according to operation needs.

4. Technology Overview

4.1 Chatbot

According to Rosruen and Samanchuen, the definition of chatbots is computer systems that can communicate with customers using verbal communication [13]. This technology is designed to communicate with users automatically without the intervention of humans. Each chatbot can interact with multiple users at the same time without any delay and it

brings various significant benefits for myriad domains such as online shopping, answering frequently asked questions, or customer services. Hence, in this solution, we propose a chatbot for RPA triggering purposes due to its undemanding for background knowledge to use a chatbot.

This chatbot is built based on Rasa open platform, which is an "*open-source machine learning framework for automated text and voice-based conversations*" [rasa doc]. Rasa has been widely used over the world by thousands of developers because its ease of implementation and performance is comparable to various closed-source solutions [14]. This platform supports multiple natural language processing (NLP) pre-trained models to process user input into structured information such as MitieNLP, SpacyNLP, and HFTranformersNPL.

4.2 RPA

RPA, which stands for Robotic Process Automation, is a technology application that allows users (organizations and businesses) to automate cumbersome, complex, and resource-consuming processes by defining those with existing rules into instruction sets. According to Sarah Burnett, Vice President of Research at the Everest Group,

> *"Robotic Process Automation is the next wave of innovation, which will change outsourcing. We already are seeing the beginnings of a race to become the top automation-enabled service provider in the industry. In time, we are likely to see an arms race for innovation in automation tools leading to new offerings and delivery models."* [15]

Generally, an RPA application system can be composed of one or more robots that handle different subprocesses. Thus, an RPA system is scalable and therefore can be used to replace a large amount of human

labor required for a process - which would greatly reduce the staffing costs of a company. Extending or upgrading an RPA system can be done in many different ways. Companies can expand their systems simply by adding robots that handle new processes, re-modeling, or even deleting old robots. Usually, this change has almost no effect on the system platform or related software due to the separated structure of the robots. In an RPA system, different robots handle different tasks, and even though they contain related tasks, the instructions that define how they work are completely independent. Therefore, the use of RPA in enterprise tasks can bring great efficiency while still saving labor costs.

With the rapid development of automation technology, nowadays it is not difficult to find platforms and frameworks that support the creation of a robot. For equivalent processes, the cost for RPA might be much cheaper than the cost for human labor. Popular platforms such as UI Path, BluePrism, Pega, ... are all open-source platforms, but can still be used in formal businesses because of their professionalism in applications. These platforms are either almost or completely free, which is extremely beneficial for businesses that want to automate their work. Besides, self-setting using available platforms, such as UI Path, is not only pretty straightforward but also allows users to customize the robot's flow to be more clear and suitable for their needs [3]. As well as that, the cost of setup and maintenance is negligible. As Clint Boulton referred in a 2018 article of Cio, by using 85 bots for 13 predefined processes, a bank had marked a significant achievement in productivity as it "*added capacity equivalent to more than 200 full-time employees at approximately 30 percent of the cost of recruiting more staff*" [16]. Therefore, using RPA brings many financial benefits, as well as saves workers time and effort.

Another reason for using RPA applications is that they can work with high speed, high volume, and error-free. Indeed, as with any other virtual software, "*Digital robots can work 24/7/365 without days off and vacations*" [4]. While humans still need to rest and spend time on other activities, robots can work continuously day and night. According to the

statistics of the *United States Department of Labor* (2020), the average number of working hours for workers in the US is approximately 8.15 hours per day, which is only equal to ⅓ of the continuously working time of a robot. This means that robots can handle larger workloads than humans. In addition, when dealing with repetitive or high-volume processes, humans can easily make mistakes, while robots won't. As a programming application that always follows the instruction set, RPA can ensure error-free processing [3]. Moreover, by eliminating human errors such as tiredness or lack of knowledge, RPA can reduce the rate of error [4]. Besides, depending on how fast the computer hardware is, robots surely can "*perform operations several times faster than humans*" [4].

Moreover, one of the outstanding features that could elevate RPA into the main workforce in the future is its ability to replace humans in several tasks that previously required human intelligence and discernment. To provide RPA with cognitive and decision-making capabilities, AI models can be embedded into systems [2] [6]. In the modern world, as science and technology rapidly develop, artificial intelligence is no longer an unfamiliar term. Many large organizations and enterprises have put intelligent applications into practice to aid in monitoring, controlling, or tasks that require meticulousness and the ability to analyze information at a level of extremely detailed. Especially in the medical field, computer vision - a branch of artificial intelligence - has been widely used to increase efficiency as well as the ability to diagnose disease [18]. The combination of RPA with AI also brings results beyond expectations [2]. Thus, former RPA systems which once were used to substitute people in repetitive, mundane tasks, can now do jobs that require human analysis and decision-making abilities. By simulating some human abilities, RPA can be used in almost any business processes including monitoring process, evaluation process, etc.

In conclusion, for processes that have specific predefined rules, RPA can certainly bring an enormous efficiency, maybe even higher than that of human workers.

4.3 Frameworks and Platforms

In this thesis, the solution we propose makes use of open-source frameworks in order to minimize setup costs for businesses. Therefore, among these popular frameworks and platforms for RPA such as UIPath, Pega, BluePrism, ect which of those all have their own advantages and promise positive results, we aim to use RPA Framework because of its high applicability and scalability, as well as versatility and ease of use.

"*RPA Framework is a collection of open-source libraries and tools for Robotic Process Automation (RPA), and it is designed to be used with both Robot Framework and Python. The goal is to offer well-documented and actively maintained core libraries for Software Robot Developers*." [20]

RPA Framework is built on a 100% open source project platform, therefore, users are free to use and contribute to this framework. Moreover, the fact that the framework is integrated with python makes it easier and more flexible to use. Users can choose to use python or the framework's own syntax to set up the automation system depending on their needs. In this thesis, we use robot syntax for case study of the problem to make tracking and controlling the operating sequence defined for the robot easier.

In this framework, the command setting for a robot usually has four parts

```
*** Settings ***
Library     RPA.Excel.Files
Library     RPA.Tables
Library     RPA.Email.ImapSmtp  smtp_server=smtp.gmail.com  smtp_port=587
```

Fig. 1. Setting section in RPA Framework

The Setting section is used to define the libraries and resources that the robot needs to use. Obviously, any libraries that are supported by RPA Framework can be added here, including robot framework and python built-in libraries.

```
*** Variables ***
${EXCEL_FILE}   ${CURDIR}/input/Report.xlsx
${USERNAME_GM}  INPUT_ACCOUNT
${PASSWORD_GM}  INPUT_PASSWORD
```

Fig. 2. Variables section in RPA Framework

The Variables section defines the global variables used during robot operations

```
*** Keywords ***
Get row count in the sheet
    [Arguments]     ${SHEET_NAME}
    ${sheet}=       Read Worksheet   ${SHEET_NAME}
    ${rows}=        Get Length  ${sheet}
    [Return]        ${rows}

Close All Application
    Close All Browsers
```

Fig. 3. Keywords section in RPA Framework

In Keyword section, functions which are needed for operating processes will be defined. Normally, these functions are non-basic, task-specific and therefore have not been pre-defined in the framework. The keywords defined here can only be used by this robot.

```
*** Test Cases ***
Read data frome excel

Processing operation

Save results

Close All Application
```

Fig. 4. Test Cases section in RPA Framework

Test Cases section is used to set up the robot's manipulation sequence. Here, the keywords defined above or available keywords in the framework will be called for use. This section allows the user to set up and control the robot's flow in the most obvious way.

By default, after each process the robot will return output files including log.html, report.html and output.xml that record all parameters and status from general to details during the robot processing operations. Thereby, users will find it easier to monitor the process as well as identify and fix if an error occurs.

Besides, for chatbot, the research team made use of Rasa Open Source Framework, which is an “open source machine learning framework for automated text and voice-based conversations”. This Framework includes three crucial parts, which are Rasa Natural Language Understanding, Rasa Core Dialogue Engine and Rasa SDK Action Server. Rasa NLU (Natural Language Understanding) is the part of Rasa Open Source that generates intent classification, entity extraction, and other structured data from user input, which will be used for selecting and predicting appropriate actions and response to users in Rasa Core. Rasa SDK Action server is a server provided by Rasa for writing custom actions and API calls.

4.4 Challenges

In this solution, the integration of chatbot and RPA has been proposed. Normally, chatbots are used for communication purposes, which mention previously and do not cause too many problems if the chatbot makes incorrect responses or detects user intents inaccurate. However, because the target of this chatbot is for triggering RPA processes, chatbot intent detection and classification should not make wrong action predictions or classify wrong intentions since it might call out to the incorrect RPA process, which causes waste of system resources and could lead to unwanted consequences. Therefore, the high accuracy of this chatbot must be sufficient.

This thesis offers a solution to combine RPA with AI by using open source frameworks and platforms in order to simplify the process as well as minimize costs for businesses. However, one of the challenges posed with RPA is that its capabilities and applicability are heavily dependent on these open platforms. In fact, with the rapid growth of today's automation industry, frameworks and platforms already have tools to cover nearly all of the basic tasks for RPA. However, for non-basic, task-specific processes, the system setter will have to define the specific keywords and functions for that operation. Fortunately, one of the most popular and popular frameworks of RPA - RPA Framework, now allows the integration of robot framework as well as python platform into the application, making it more convenient if the user needs to define a specific manipulation.

In addition, similar to the challenge posed when combining chatbot and RPA, the automation system when integrated with cognitive capabilities will be affected by the accuracy of the AI model. That leads to the risk of reducing the efficiency of the RPA if the integrated AI model is ineffective or has large deviations in practice. As well M.Romao claimed in his article, "*the fact that immature or not well-trained models can eventually decrease productivity and increase errors*

from unsupported or even wrong decisions" [19]. Therefore, solving this challenge depends on the ability to choose cognitive models.

II. System Architecture and Extensibility

1. Architecture overview

1.1 Chatbot Flow

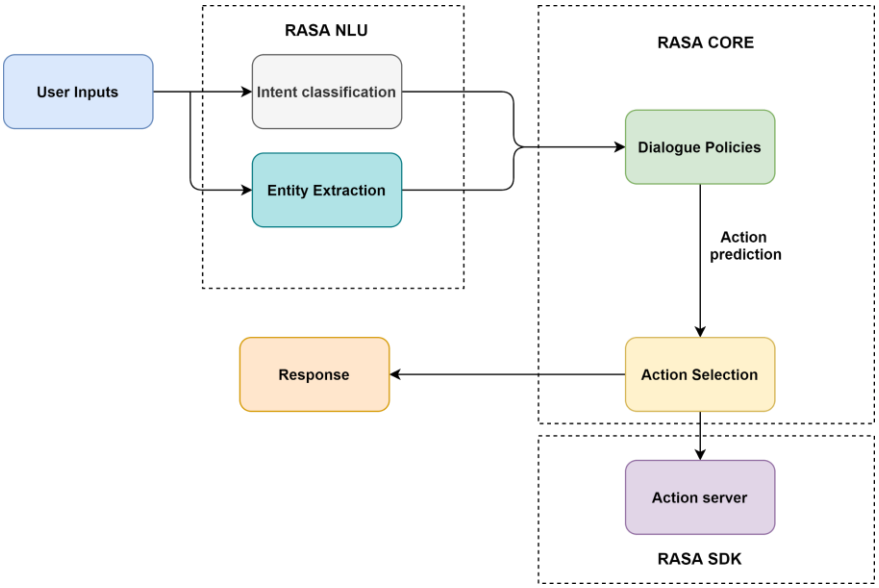


Fig. 5. Design of chatbot flow.

Fig. 5 shows the design process of chatbot flow using Rasa Framework. As can be seen from the figure, the first part that will handle the user's input is Rasa NLU (Nature language understanding). In this stage, Rasa NLU will extract essential knowledge such as the user's intents, entities, and other structured information (Fig. 6) [10]. The

intents, entities, and other data are predefined in a specific file; Rasa NLU will classify user input according to this file. In order to obtain this knowledge, the Rasa pipeline comprises different components, which are defined by developers, for instance, language models, tokenizers, and intent classifiers. By using the pipeline, Rasa NLU will classify data as the one with the highest confidence score. For example, in Fig. 6, the sentence "I am looking for Chinese food" is recognized as a restaurant_search intent because of its highest confidence score, which is more than 0.64. Then, the extracted information will be fed to the dialogue policy to predict appropriate actions to perform from a predefined list of actions in the same way with intents classification (Fig. 7). An action could be a direct response to the user, an executable function, or API calls from the action server. For the purpose of writing custom actions or API callings, rasa provides an action server, which is Rasa SDK Action Server.


```
{
    "text": "I am looking for Chinese food",
    "entities": [
        {
            "start": 8,
            "end": 15,
            "value": "chinese",
            "entity": "cuisine",
            "extractor": "DIETClassifier",
            "confidence": 0.864
        }
    ],
    "intent": {"confidence": 0.6485910906220309, "name": "restaurant_search"},
    "intent_ranking": [
        {"confidence": 0.6485910906220309, "name": "restaurant_search"},
        {"confidence": 0.1416153159565678, "name": "affirm"}
    ]
}
```


Fig. 6. Intents classification and entities extraction output

```
{
    "response_selector": {
      "faq": {
        "response": {
          "id": 1388783286124361986,
          "confidence": 0.7,
          "intent_response_key": "chitchat/ask_weather",
          "responses": [
            {
              "text": "It's sunny in Berlin today",
              "image": "https://i.imgur.com/nGF1K8f.jpg"
            },
            {
              "text": "I think it's about to rain."
            }
          ],
          "utter_action": "utter_chitchat/ask_weather"
        },
        "ranking": [
          {
            "id": 1388783286124361986,
            "confidence": 0.7,
            "intent_response_key": "chitchat/ask_weather"
          },
          {
            "id": 1388783286124361986,
            "confidence": 0.3,
            "intent_response_key": "chitchat/ask_name"
          }
        ]
      }
    }
}
```


Fig. 7. Response selection output

1.2 RPA Flow

What is RPA and how to implement it? "*RPA is a form of business process automation that allows anyone to define a set of instructions for a robot or 'bot' to perform*", says Aaron Bultman, director of product at Nintex [11]. Thus, to set up an automation process, we first need to specify the process steps, the desired input and obtained results. The complete and detailed scenario will be given to robots as an instruction set. The size of the indicator set will depend on the size of the automated process. However, with support from open source frameworks like the RPA framework and built-in (mostly code-free) platforms such as UIPath, Blue Prism, or Pega, the procedure of creating these sets will become straightforward [10]. Fig. 8 shows the general flow of the RPA system. As can be seen from it, after fully setting up the process and providing input (if any), the robot activated by the user will follow the scenario with a guarantee of low error rate, before returning the results to the user.

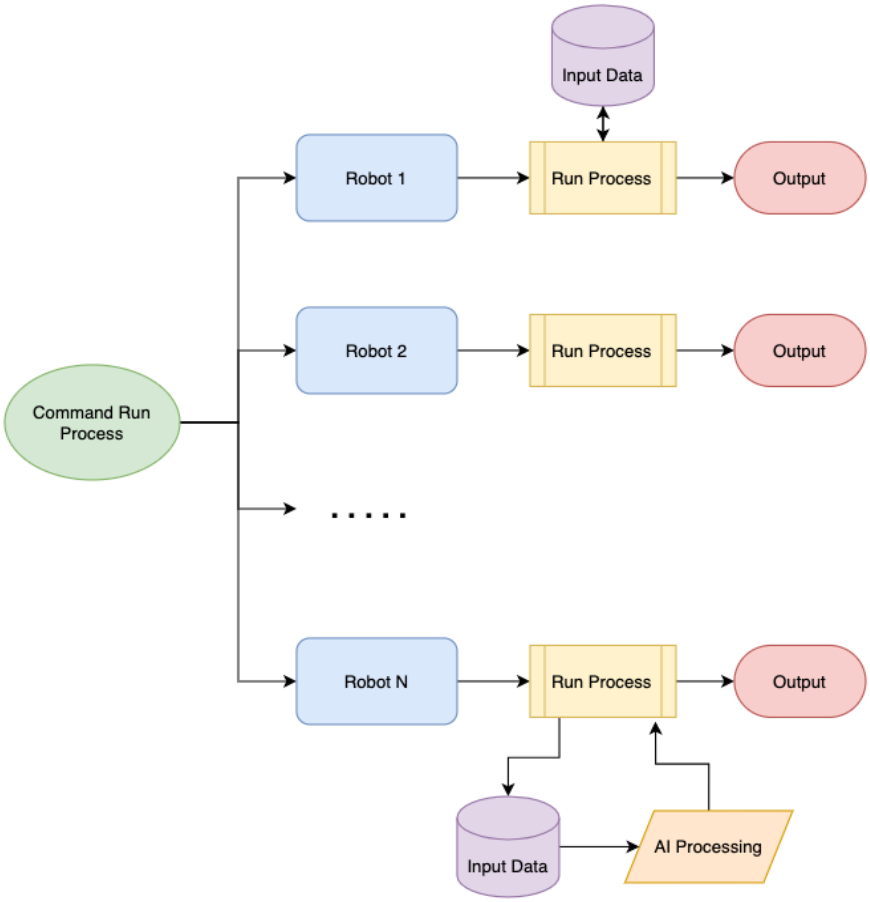


Fig. 8. Design of RPA flow.

RPA typically focuses on automating individual operations that perform repetitive mundane tasks, so rule-specific business actions are excellent candidates for RPA [8]. An RPA system can consist of many automated robots that perform various operations with predefined process rules. Besides, the incorporation and expansion of the RPA system are often affordable. An enterprise can effortlessly refactor and expand its RPA system without having to replace the old one completely.

Moreover, since the robots in a system are separated from each other, adding, removing, or re-modeling robots can be done without causing any disruptions to other existing systems. Fig. 8 shows a simple overview of an RPA system, consisting of robots of the same level that perform separate tasks, which may or may not require input (depending on the requirements of the process).

Moreover, for upgrading, RPA can be integrated with high-consciousness recognition (AI) technologies for tasks that require knowledge and decision-making. AI applications can be embedded into process flows and handled by robots as part of themselves. These combinations make it simpler to incorporate AI technology into practical applications, yet achieving high efficiency in processes that require awareness and decision-making abilities that are not inferior to using human resources [2].

1.3 Chatbot and RPA integration flow with AI embedding

Fig.9 shows the flow of chatbot integrated with the RPA system and embedded with AI processing. At the first step, the chatbot will receive the input sentences from users and extract their intents. If the chatbot classifies users' intent as triggering an RPA process, it will check the required information for the process and request additional information from the user if needed. After ensuring that the given information is sufficient, the chatbot will utter a response sentence of confirmation to users and activate the RPA process as a fire-and-forget request by using system commands. When the RPA process is activated, it will access input files to get the necessary data for the process. In some cases, the RPA robots might input this data into an embedded AI model and run this model as a part of the RPA process. When the process finishes, the task's status and output will be logged into a specific folder for reviewing and further activities.

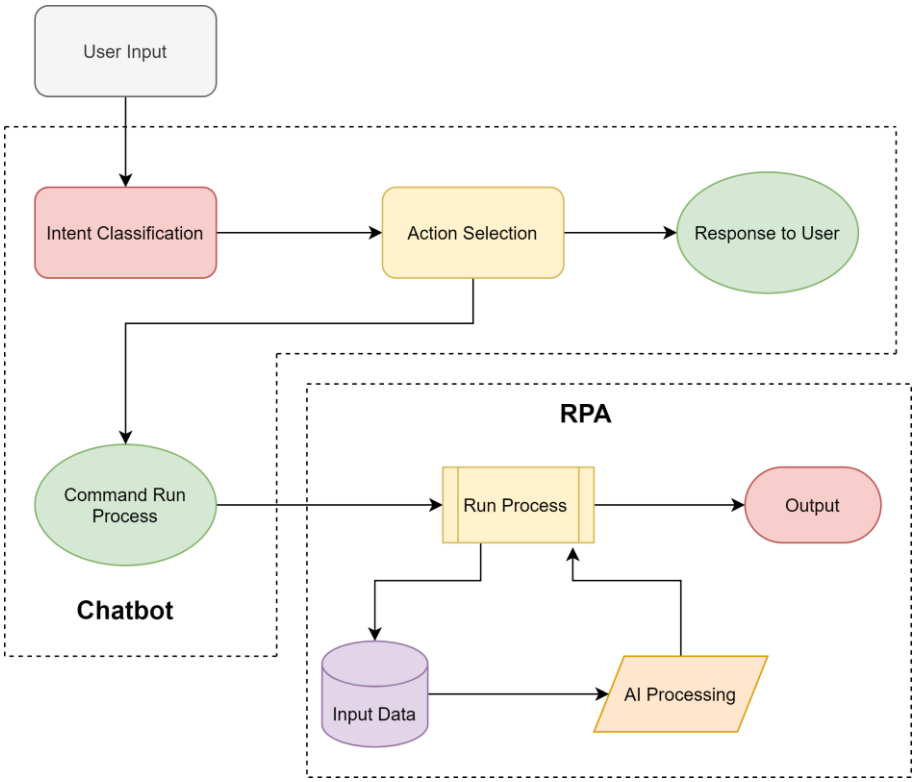


Fig. 9. Design of integrated flow.

2. System extensibility analysis according to source code architecture

2.1 Chatbot

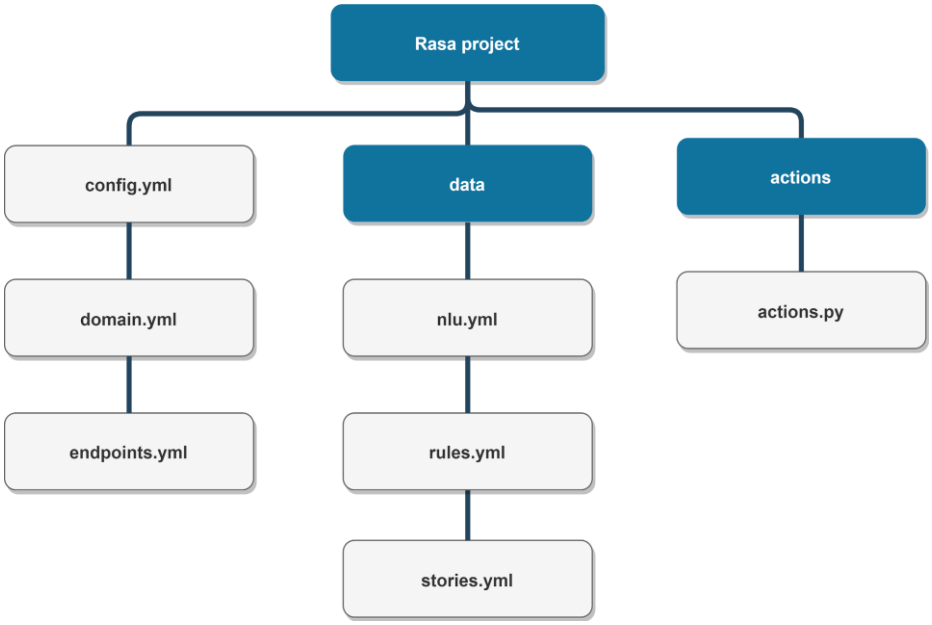


Fig. 10. Chatbot system tree.

The chatbot code system contains main components below (Fig. 10):

- *config.yml*: Defining pipeline components and policies to make NLU predictions and predict the following actions. There are myriad pipelines that rasa already supports for entity extraction, intent classification, or response selection. Besides, rasa also supports many pre-trained language models such as Mitie, Spacy, and HF Transformers NLP. Furthermore, developers can write their custom components.
- *domain.yml*: Including every name of definitions, which the chatbot will use. This file contains labels of all user's intents, custom action names, and several configurations for sessions and slots. Besides, the domain file is also where developers define their entities, slots, and response sentences.

- *endpoints.yml*: Containing different endpoints which the chatbot will use, such as action server endpoints or conversation history store (tracker store).
- *nlu.yml*: Consisting of data of user sentences as examples for training data. Training examples are defined as intents, and each intent has myriad examples, which can contain entities. The entity extraction is also trained in this file by defining examples. Besides, developers can define other training data for natural language processing like synonyms or regular expressions.
- *rules.yml*: Defining how the chatbot responds to short conversations, which will always follow the same path.
- *stories.yml*: Composing examples of conversation paths to train models for predicting which actions to do next to respond to the user.
- *actions.py*: Including custom actions written in python for various purposes such as data querying and API callings. This file helps rasa projects to communicate with other technologies.

According to the architecture of the chatbot's source code, the rasa project could be extended by adding more definitions of intentions, stories, or actions. Therefore, Rasa chatbots are very flexible in scaling, which would significantly benefit enterprise demand to extend the system gradually. Besides, the custom action file makes Rasa chatbot extremely simple to interact with other technologies. For example, in this project, the research team utilizes this function to integrate the Rasa chatbot with RPA technology.

2.2 RPA

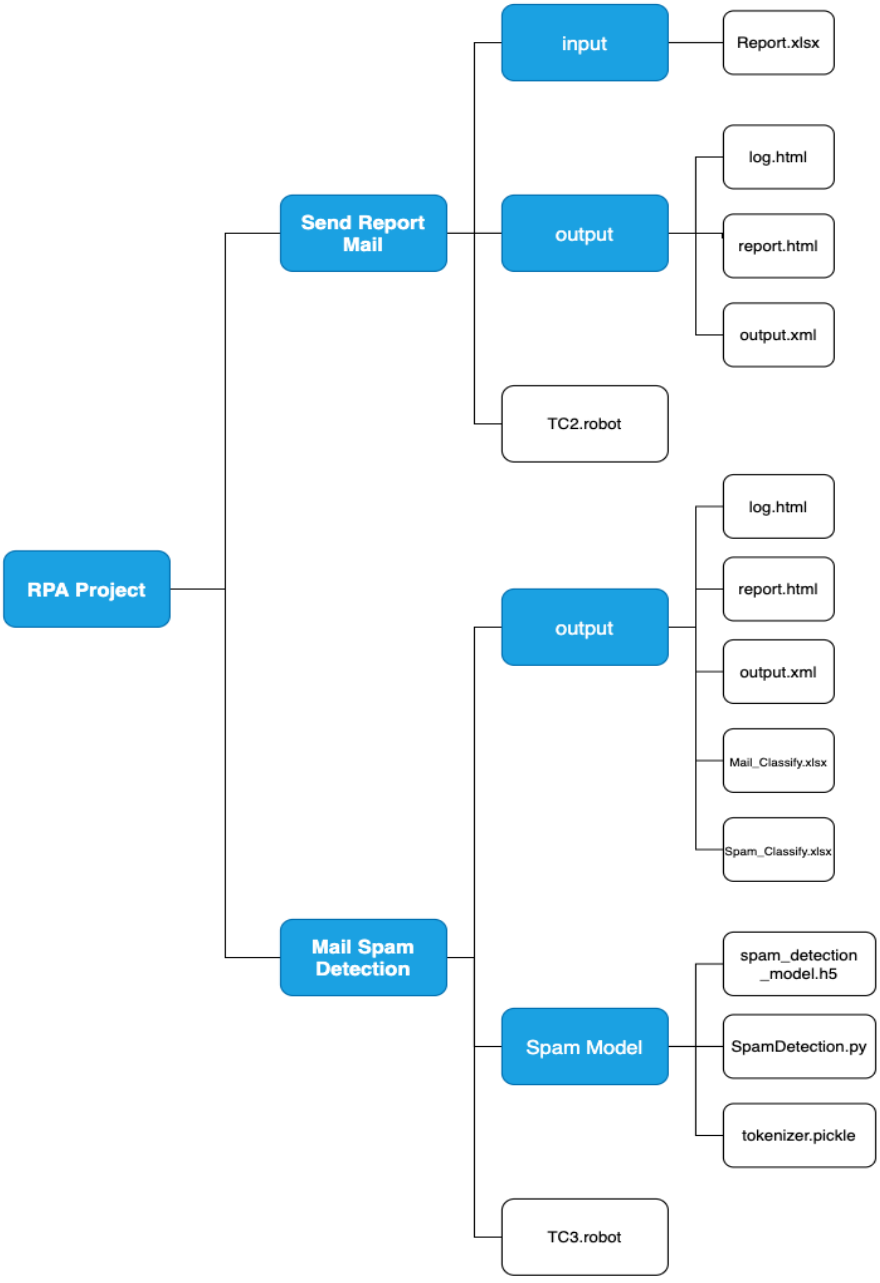


Fig. 11. RPA system.

The basic structure of an RPA system will include many test cases, where each test case corresponds to a small process performed by a robot. Fig. 11 shows the source code architecture of the RPA system demonstrated in this work, including 2 test cases: Send Mail Report & Assemble Mail. In which, each test cases will include:

- *Input*: The *folder* contains the necessary input data for the robot to perform the process (may or may not concluded depends on the problem requirement)
- *Output*: The folder contains the output of the process, include:
  - *log.html* (default): contains details about the executed test cases in HTML format. They have a hierarchical structure showing test suites, test cases, and keyword details. Log files are needed nearly whenever test results are to be investigated in detail.
  - *report.html* (default): contains an overview of the test execution results in HTML format. They have statistics based on tags and executed test suites, as well as a list of all executed test cases
  - *output.xml* (default): contains all the test execution results in machine-readable XML format.
  - The output file corresponds to the process output. In test case 2, the additional output is 2 excel files: *Mail_Classify.xlsx* containing ham (not spam) mail information; *Spam_Classify.xlsx* containing spam mail information.
- *TC.robot*: The robot's run file consists of predefined rules that correspond to the regulations of the procedure. The called robot will activate this file and follow the available commands.

One of the outstanding features that could elevate RPA into the main workforce in the future is its ability to replace humans in several tasks

that previously required human intelligence and discernment. To provide RPA with cognitive and decision-making capabilities, AI models can be embedded into systems [2, 6]. For example, in test case 2 of this study, classifying spam emails requires human readability, however, integrating an appropriate NLP AI model for analyzing and classifying email content can also yield equivalent results. Besides, it is rather straightforward to integrate AI into the system to expand or upgrade it. As Fig. 11 shows, an AI model can be embedded directly into the RPA system without the support of any APIs. Robots can use predefined libraries via the RPA Framework to run the classifying process using the provided AI model. Especially in the above example, the Spam Model folder contains the necessary parameters of an AI model (*model.h5, tokenizer.pickle*) and the file to run the email classification. This folder can then be imported into the robot as a library, and the execution function will be called by the robot as part of the procedure. In the same way, it is indeed easy to extend and upgrade this RPA system. Depending on the quantity and requirements of the process, the system can be expanded by adding several robots or integrating with cognitive models. Also, as aforementioned, adding, removing, or modifying a robot script of any test cases will not affect the other because of their parallel and independent structure.

III. Case study

1. Problem introduction

In today's world, companies have to cope with an overwhelming number of manual tasks, which cost a considerable amount of time and budget to deal with. In this thesis, the research team tried to use RPA and chatbot technology to solve two common problems for most companies: sending attendance checking emails and checking mailbox to gather important information (Fig. 12).

Firstly, most companies have to send attendance checking emails to employees at the end of every month to confirm their attendance in that month. Tiresome and time-consuming as it is, but this email-sending task plays an indispensable role in almost every company. Therefore, to reduce the amount of work for the Human Resources Department of companies, the research team applied RPA technology to automate the process. This automation process can decrease the amount of time spent on idle works and help the Human Resources Department free up more time for other significant tasks. As a result, tedious operations such as sending attendance emails can be done with an even higher efficiency and accuracy.

Another such tedious and time-consuming task is reading through mailboxes and sorting out every important emails due to the immense number of emails companies receive every day. Emails often contain an enormous amount of information, and they are one of the best ways to communicate with other companies. However, various kinds of spam emails, advertisement emails, and other meaningless emails make managing important emails more complicated and time-consuming. Hence, the research team applied RPA technology to reduce the amount of work for companies' employees and employers by reducing the number of unimportant information of email they have to read. Even though most email service providers applied anti-spam solutions to their service, the number of spam emails remains excessive. Therefore, in this project, the research team implemented a machine-learning model for spam email detection to minimize junk and advertisement emails.

Moreover, to improve user experience, the research team created and trained a chatbot for convenient communication with the project system and RPA process. The chatbot will classify the intents and relevant data of users. Then, it will trigger the RPA process to complete the required tasks if the RPA triggering intents are detected. With the chatbot implementation, employees can access and activate the RPA process even when they work far from the office without any difficulty because

it is easy to use by nature language without any proper background knowledge. Besides, with the chatbot working as a front-layer of the process, users can have a more friendly experience and human-like conversation.

2. Test Cases

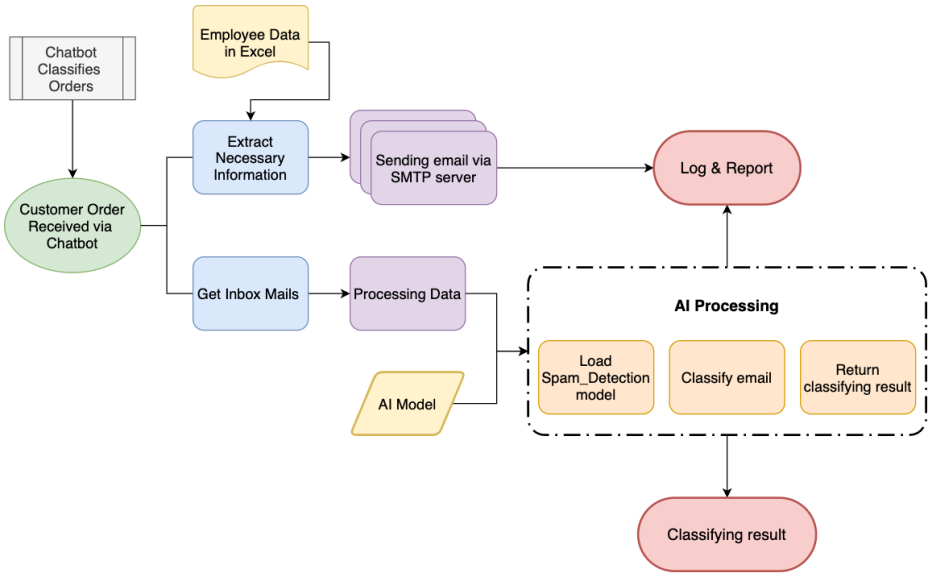
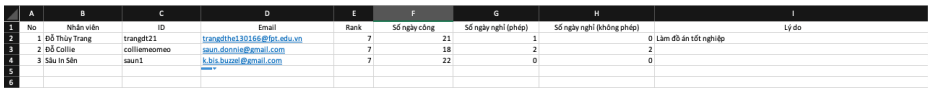


Fig. 12. Test cases flowchart.

2.1 Sending monthly attendance checking emails

This test case takes input as an excel file containing the content of the month's attendance report in a predefined format, including the employee's information such as employee's name, employee ID, email address, rank, the number of working days in the month, the number of days off and off, as well as the reason for taking leave, etc. When a user sends a request to trigger this process through the chatbot, the robot will be activated and start the process. First, the robot will achieve employee information through an excel file. Then it connects to Gmail Server via IMAP protocol with the default business (or personal) email account that

is approved. Next, the robot will compose an existing mail form with the information extracted from the excel file and send it to each employee via their email address. The results of the process can be checked as an overview through a report file including *output.xml*, *report.html*, and *log.html* files.



No	Nhân viên	ID	Email	Rank	Số ngày công	Số ngày nghỉ (phép)	Số ngày nghỉ (không phép)	Lý do
1	Đỗ Thùy Trang	trangdt21	trangdthe130166@fpt.edu.vn	7	21	1	0	Làm đồ án tốt nghiệp
2	Đỗ Collie	colliemeomeo	saun.donnie@gmail.com	7	18	2	2	
3	Sâu In Sân	saun1	k.bis.buzzel@gmail.com	7	22	0	0	

Fig. 13. Input file excel with predefined format

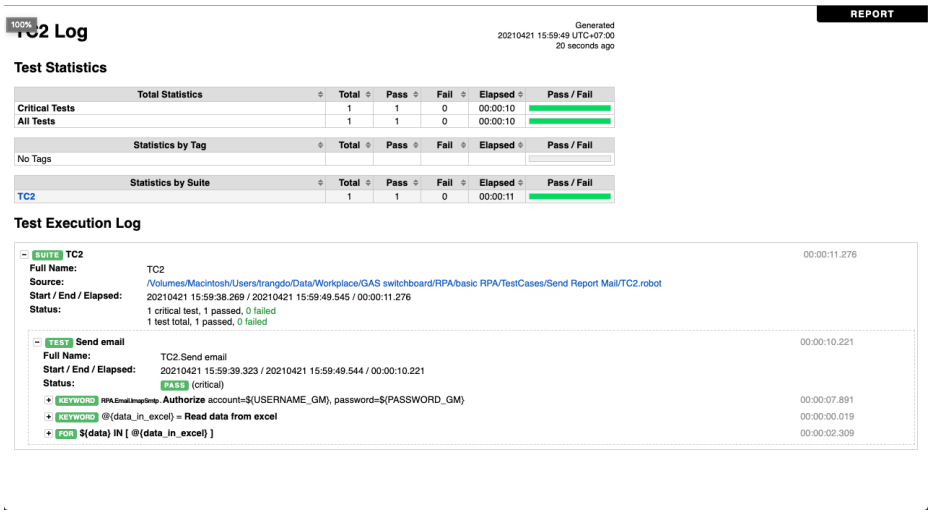


Fig. 14. Log output of send checking attendance test case

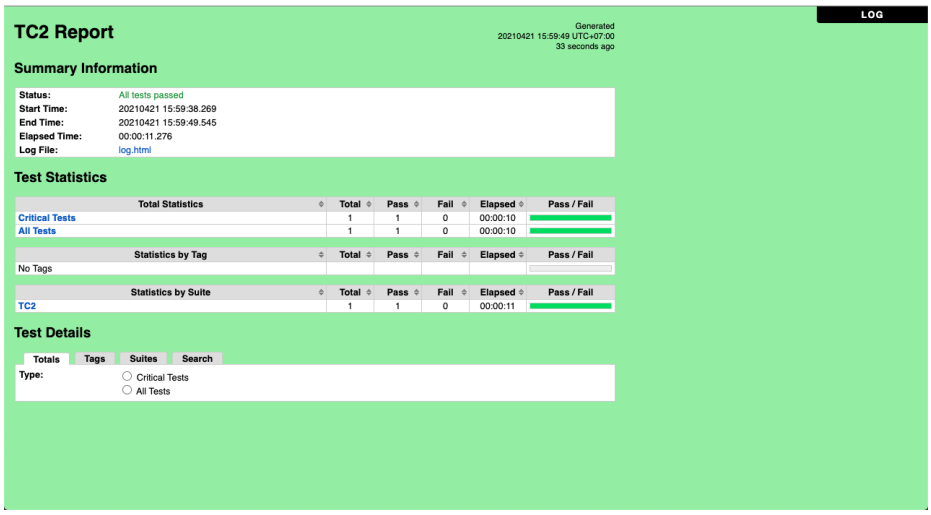


Fig. 15. Report output of send checking attendance test case

This case demonstrated the effectiveness of RPA in reducing manpower requirements, increasing the accuracy of the process. For many predefined rule processes (such as sending attendance mails), RPA can work smoothly with no monitoring required. Also, by merely following indicator sets, RPA applications can reduce manual errors [3]. Besides, for many basic functions, RPA Framework supports a handful deployment methods, which simplify the setting up of the process.

2.2 Email classifying

In order to improve business performance, automated processes can be integrated with AI models. In this case, an NLP model will be combined with the RPA application to classify spam emails. The purpose of this operation is to "clean" the mailbox and help users achieve important information faster and easier.

In this test case, a model for email spam classification will be integrated as an RPA library. When activated by the user's request

through the chatbot, the robot will access the user's email address (or the default email address of the business) and retrieve data of unread emails. The data is then preprocessed and fed into the AI model for categorization. After the classification is complete, RPA will use the collected data to aggregate it through two excel files named *Mail_Classify.xlsx* and *Spam_Classify.xlsx* consecutively. Both of them contain email information such as title, content, sender information, and send date. Therein, *Mail_Classify.xlsx* contains information of all ham (not spam) emails, and *Spam_Classify.xlsx* includes details of spam mails. Besides these outputs, the process will export three detailed report files as *output.xml*, *report.html*, and *log.html*.

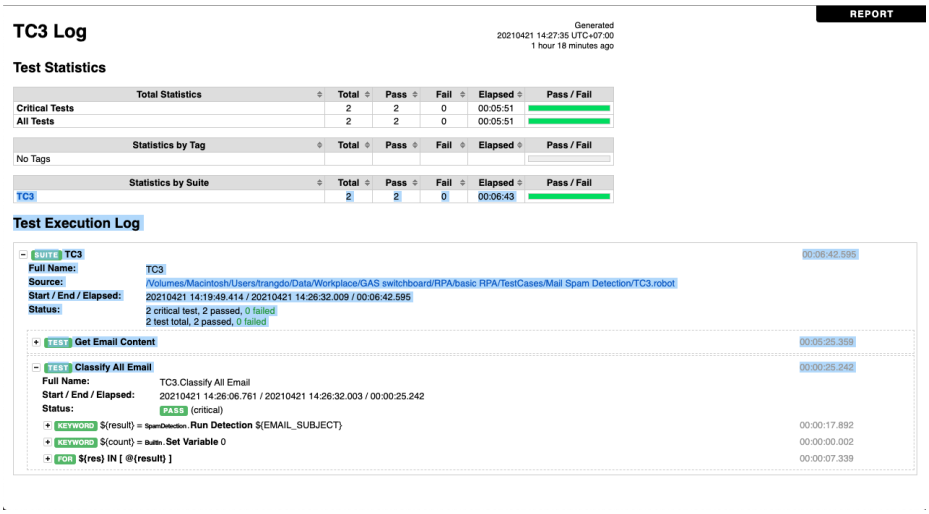


Fig. 16. Log output of mail classifying test case

TC3 Report

Generated
20210421 14:27:35 UTC+07:00
1 hour 19 minutes ago

LOG

Summary Information

Status:	All tests passed
Start Time:	20210421 14:19:49.414
End Time:	20210421 14:26:32.009
Elapsed Time:	00:06:42.595
Log File:	log.html

Test Statistics

Total Statistics	Total	Pass	Fail	Elapsed	Pass / Fail
Critical Tests	2	2	0	00:05:51	
All Tests	2	2	0	00:05:51	

Statistics by Tag	Total	Pass	Fail	Elapsed	Pass / Fail
No Tags					

Statistics by Suite	Total	Pass	Fail	Elapsed	Pass / Fail
TC3	2	2	0	00:06:43	

Test Details

Totals | Tags | Suites | Search

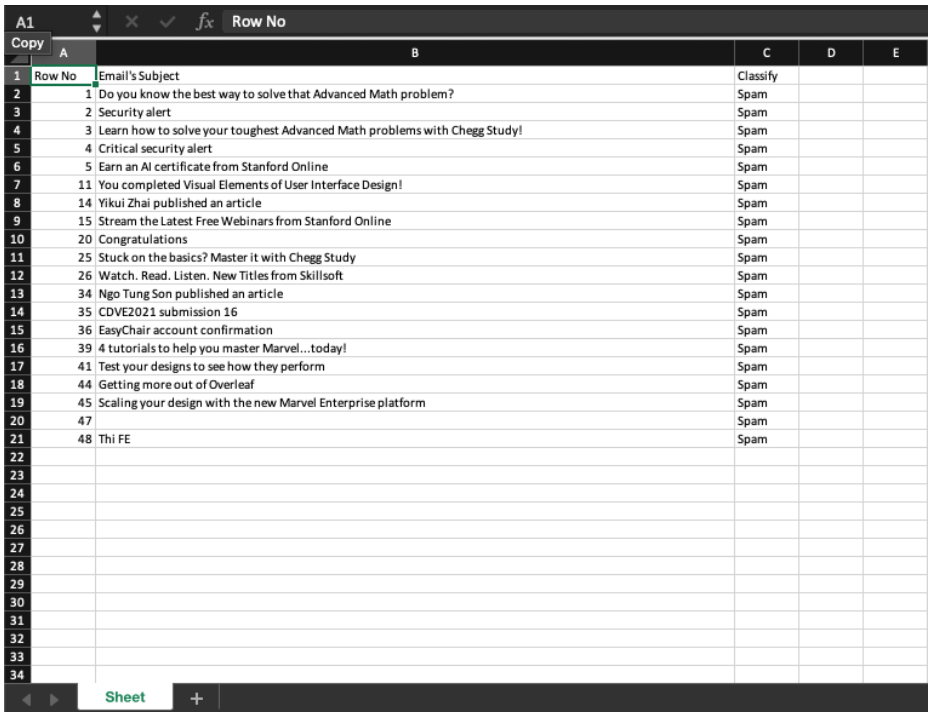
Type: ○ Critical Tests ○ All Tests

Fig. 17. Report output of mail classifying test case

	A	B	C	D
1	Row No	Email's Subject	Classify	
2	6	Welcome to the course	Ham	
3	7	Coursera Password Reset	Ham	
4	8	You have new or updated grade information for Defining the Look and Feel of Your Project	Ham	
5	9	You have new or updated grade information for Sketch Your Static Interface	Ham	
6	10	You have new or updated grade information for Create a Sample Pattern Library	Ham	
7	12	New feedback on your submission	Ham	
8	13	You have new or updated grade information for Map your App	Ham	
9	16	You have new or updated grade information for Journey to the Surface of the App	Ham	
10	17	Nguyen Minh Nhat mentioned you in a comment	Ham	
11	18	You have new or updated grade information for Create a clickable prototype	Ham	
12	19	You completed UX Design Fundamentals!	Ham	
13	21	You have new or updated grade information for Outline of Scope	Ham	
14	22	You have new or updated grade information for Sitemap	Ham	
15	23	You have new or updated grade information for Project Ideas	Ham	
16	24	You have new or updated grade information for Strategy Document	Ham	
17	27	Working report of February	Ham	
18	28	You have new or updated grade information for Wireframes	Ham	
19	29	You have new or updated grade information for Final Project Submission	Ham	
20	30	Become a change maker and start your civic journey	Ham	
21	31	Learning online on Thursday 18th, March	Ham	
22	32	Prep for the end of the semester with these tools	Ham	
23	33	Assignment 2	Ham	
24	37	Get to know your own mind, with writing help	Ham	
25	38	CDVE2021 submission 16 update	Ham	
26	40	Start inviting your team into Marvel	Ham	
27	42	Welcome to Overleaf	Ham	
28	43	The art of the error message	Ham	
29	46	Bring your Sketch prototypes to Marvel	Ham	
30	49	40 JavaScript project ideas so you can learn by doing	Ham	
31	50	What if you could tackle the largest problems facing your business?	Ham	
32				
33				
34				

Sheet +

Fig. 18. List of ham (not spam) emails after classifying



Row No	Email's Subject	Classify
1	Do you know the best way to solve that Advanced Math problem?	Spam
2	Security alert	Spam
3	Learn how to solve your toughest Advanced Math problems with Chegg Study!	Spam
4	Critical security alert	Spam
5	Earn an AI certificate from Stanford Online	Spam
11	You completed Visual Elements of User Interface Design!	Spam
14	Yikui Zhai published an article	Spam
15	Stream the Latest Free Webinars from Stanford Online	Spam
20	Congratulations	Spam
25	Stuck on the basics? Master it with Chegg Study	Spam
26	Watch. Read. Listen. New Titles from Skillsoft	Spam
34	Ngo Tung Son published an article	Spam
35	CDVE2021 submission 16	Spam
36	EasyChair account confirmation	Spam
39	4 tutorials to help you master Marvel...today!	Spam
41	Test your designs to see how they perform	Spam
44	Getting more out of Overleaf	Spam
45	Scaling your design with the new Marvel Enterprise platform	Spam
47		Spam
48	Thi FE	Spam

Fig. 19. List of spam emails after classifying

The practical significance of this case is speeding up the retrieval of user information (through the elimination of junk mail containing unhelpful information and aggregation of important emails) and increase productivity while also reducing staffing requirements. For other complex processes including flexible operations, the combination of RPA and AI will also yield many promising results [2]. Similar to the above case, the integration is suitable for jobs that require the human ability to make decisions before initiating the process, such as monitoring cameras, identifying dynamic conditions to perform specific operations, etc. Certain cognitive models will be used for the particular tasks. Hence the efficiency of an RPA system partly depends on the performance of the AI model [12]. Despite that, normally, this

integration can significantly reduce the need for human resources. Also, it can increase the speed of execution and the accuracy of the process.

IV. Conclusion and perspectives

The attraction of businesses worldwide in implementing RPA technology has increased considerably due to the significant advantages it offers, especially when the digital transformation process is occuring everywhere around the world. RPA can handle repetitive mundane tasks with ease, and it would be the perfect bridge between applications, which lack appropriate APIs to connect with others. The integration of a chatbot with RPA also helps improve user experience in using the system. Besides, the success of implementing AI applications in the system might provide myriad profits to businesses. Moreover, one of the most important benefits of this solution is that it is rather simple to deploy for companies that have their developer teams or a low budget. Furthermore, this work is not only available for enterprises to enlarge their project according to their demand, but it is also available for smaller scale companies because of its open platforms base.

The technology of automating mundane processes has a promising future, and because of the flexible cost of implementation, the RPA technology gains greater attention from the perspective of businesses. Additionally, with the ability to integrate with other technologies, it might have several effects on certain areas such as Banking, Medical, Economic Management, and many other sectors. Therefore, further research on this technology and its impacts on different sectors should be invested.

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