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Machine learning-based intelligent result compilation RPA bot for higher education institutions

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ABSTRACT

Educators are essential for societal progress, and well-educated students are pivotal for a promising future. Higher education faces challenges such as budget constraints, limited time, and a shortage of trained personnel, leading to faculty stress. Emerging technologies such as artificial intelligence (AI), machine learning (ML), and block chain provide solutions, with robotic process automation (RPA) bots a notable advanced AI subfield-automating repetitive tasks, thereby freeing teachers to focus on more essential responsibilities. RPA bots automate various educational processes, including examinations, admissions, marks updating, student record management, result compilation, human resources, resume screening, and administration. This research examines robotic automation in higher education institutions (HEIs), selecting and prioritizing RPA tasks through a survey involving subject matter experts (SMEs) from different HEIs, including professors and RPA experts. The research aims to develop a "virtual software bot" for automating "result compilation" post-examination. Using tools like XPATH, Whisper, and the web-based automation program Selenium web in Python, the bot automates this process. The ML library "Whisper" addresses the reCAPTCHA problem. The automated bot generates comma separated values (CSV) files in specific formats, completing the task 58 times faster than humans and saving 43 man-hours by compiling results for 653 students in 45 minutes.

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1. INTRODUCTION

Robotic process automation (RPA) is experiencing rapid growth due to Industry 4.0, gaining increasing organizational attention in recent years [1]. RPA automates routine, rule-based processes, offering businesses unparalleled agility, efficiency, and adaptability [2], [3]. It provides virtual bots that mimic human interactions within digital systems [4], significantly impacting workforce dynamics by freeing human resources for strategic tasks while bots handle routine duties. RPA can automate tasks on platforms like power automate, Pega, WorkFusion, and UiPath [5], integrating seamlessly with various software without disrupting third-party tools or APIs. RPA bots, which include cognitive and artificial intelligence (AI) capabilities, are categorized into attended (collaborating with humans) and unattended (operating independently) [6], [7]. Despite its popularity in sectors such as manufacturing, healthcare, and finance, RPA's adoption in higher education is less documented. Researchers are exploring RPA for administrative

efficiency, student support, and academic operations, indicating a need for more studies to understand its potential in this sector. This paper is structured as follows. The problem statement and the most pertinent literary contributions are discussed in section 1. The further methods to solve the provided problem and obtain the desired outcomes are introduced in section 2. A portion of the results are displayed in section 3. Section 4 offers a critical analysis and recommendations for future work guidelines as it wraps up the research.

Literature review and research gaps: RPA is a software solution that enables the creation of software bots that communicate with different underlying systems to mimic human-computer interaction. RPA is beneficial for a wide range of domains, including security, monitoring, control, marketing, human resources, technical operations, customer care, healthcare and administration. The increasing significance of business process automation (BPA) in industry has led to a rise in the use of RPA in the educational sector as well [8]. Mora and Sanchez [9] propose a theoretical model for implementing digital transformation in higher education institutions (HEIs) through the use of BPM and RPA. Educators are realizing that RPA can increase operational efficiency in HEI by streamlining administrative procedures. Educational institutions can lower manual workloads and more efficiently deploy resources to enhance student success by implementing RPA technology. The RPA robots interact with students during the online teaching and learning process, thereby improving AI and autonomous systems [10]. RPA bots are also taught to deliver lectures to assist teachers in their lesson delivery [11]. An innovative question paper generator is developed using RPA technology with UIPath to streamline the process of creating question papers for student's assessment [12]. RPA bots can be integrated with the online learning management systems to minimize student's effort in managing their learning materials efficiently [13]. RPA bots are also used in assessing the low performance and monitoring the programming skills of students [14].

AI endeavors to reorganize and re-engineer educational and instructional procedures, expediting the transition of the entire educational system from information to intelligence. RPA bots can be utilized to efficiently generate additional reports every day that highlight student attendance, problems resolved, and other information categorized as mentors to the students [15]. Because robots can learn things by watching people, the use of machine learning (ML) and natural language processing (NLP) technologies can easily improve the cognitive skills of RPA bots [16]. An intelligent tutoring robot (ITR) helps the distance learning students to provide automatic response, and improve the academic performance [17]. The integration of RPA and AI in higher education is expanding to unprecedented levels [18]. The RPA bots support instructors in evaluating student performance and improving their academic study plans, in addition to assisting with admissions and registration [19]. Use of block chain with the RPA is also explored in an online school registration system to investigate how a block chain-based RPA mechanism can resolve the inherent challenges [20], [21]. RPA has the potential to automate a broader range of administrative duties, freeing up staff time for more strategic responsibilities like financial management, human resources, placements and compliance reporting [22]. As the prevalence of RPA grows, finding appropriate candidate processes for automation in an organization is a constant challenge for automation [23], [24]. Same applies for HEIs. Higher education systems, comprising universities, colleges and other academic institutions typically involve numerous processes and tasks as shown in Table 1 to confirm the smooth functioning of educational institutions. Therefore, a decision support tool is utilized to assess each HEI process in order to determine which process or subprocess is most appropriate for RPA implementations. This aids in selecting and prioritizing the candidate processes for RPA implementations. Following assessment, the examination and grading process's result compilation subprocess is selected for automation. Therefore, the goal of this research is to create an RPA bot for HEI result aggregation so that exam administrators may better evaluate students' performance within a given semester.

Table 1. Processes and sub tasks in a higher education system

S. No.	Processes	Tasks in processes
1	Examination and grading	Automatic grading, test creation, answer sheet scanning, result compilation, result reporting
2	Attendance tracking	Data collection, data verification, absentee identification, automated reporting, alert generation, attendance trends analysis, integration with student information system
3	Course planning and scheduling	Timetable generation, student enrollment, exam scheduling, and course evaluation surveys
4	Lesson plan creation	Content selection, content formatting, preparing lesson outlines, resource integration, quiz creation, and assignment creation
5	Identifying student progress gaps	Performance metrics calculation, performance comparison, subject-specific analysis, student progress reports
6	Admission process	Application status tracking, data extraction from forms, application fee processing, document gathering, follow-up emails
7	Placement process	Resume screening, job matching, application tracking, interview scheduling, candidate feedback, and offer letter generation

The problem: result declaration is indeed a crucial aspect of university operations. A crucial component of result declaration is result compilation, which entails transferring values from one spread sheet to multiple online portals. It is the responsibility of the exam administrators or controllers of certain departments in HEIs to prepare and record the results in their own spread sheets and ERP systems. The student's individual result is uploaded as a portable document format (PDF) document on the university's web portal. These PDF documents on web portal offers a secure, consistent, accessible, and convenient method for disseminating academic information to students. While students can benefit from having their individual results available as PDF documents on a web site, educational institutions may face difficulties when it comes to compiling and aggregating data for administrative needs. It is the duty of an academic staff or faculty member to gather and compile the data for result analysis. The members of the academic staff keep an excel file with pertinent student information, including their date of birth, admission number, and roll number as shown in Figure 1.

S.NO.	ADMISSION NO.	ROLL NO.	STUDENT NAME	SECTION	SIGNATURE
1	2022M0141139	2200320140068	HIMANI SINGH TOMER	B	31-Jul-01
2	2022M0141170	2200320140069	HIMANSHU	B	12-Aug-01
3	2022M0141131	2200320140070	HIMANSHU SINGH MAHLYAN	B	25-Feb-01
4	2022M0141028	2200320140071	HRIDAY SHANKAR TRIPATHI	B	07-Feb-00
5	2022M0141068	2200320140072	JAGAT RAJ SURAJ YADAV	B	16-Nov-01
6	2022M0141207	2200320140073	JATIN CHOUDHARY	B	15-May-02
7	2022M0141160	2200320140074	JATIN RAJPOOT	B	30-Sep-98
8	2022M0141013	2200320140075	JAY PRAKASH	B	10-Oct-00
9	2022M0141051	2200320140076	JEETWAR KATYAYAN	B	28-Jan-99
10	2022M0141106	2200320140077	JOTIKA GUPTA	B	06-Jun-02
11	2022M0141113	2200320140078	JUNAID AHMED	B	13-Nov-00
12	2022M0141119	2200320140079	JYOTI GANGWAR	B	12-Jan-98
13	2022M0141153	2200320140080	JYOTI KUMARI	B	25-Dec-02
14	2022M0141159	2200320140081	KAJAL SHARMA	B	24-Apr-02
15	2022M0141203	2200320140082	KALYANI	B	15-Mar-97
16	2022M0141180	2200320140083	KANIKA BANGA	B	13-Sep-01
17	2022M0141053	2200320140084	KAPIL CHANDRA	B	17-Apr-00
18	2022M0141191	2200320140085	KAPIL CHAUHAN	B	30-Mar-98
19	2022M0141014	2200320140086	KAUTILYA UTKARSH KUMAR JI MISHRA	B	30-Oct-02
20	2022M0141150	2200320140087	KETAN KUMAR SINGH	B	04-Jun-00
21	2022M0141186	2200320140088	KM BALA	B	11-Aug-03
22	2022M0141015	2200320140089	KM LEKHIKA MISHRA	B	25-Jul-99

Figure 1. Spread sheet containing student records

To obtain the result as a PDF file, the student must input their roll number, date of birth, and do the CAPTCHA verification on the web portal as shown in Figure 2. The roll no. and date of birth must be copied from an excel file and pasted into the appropriate text boxes on the website as depicted in Figure 2(a). A student must complete the CAPTCHA verification after making these entries in order to receive the PDF. A reCAPTCHA provides a test or puzzle on the screen, so that a human can easily solve it. The reCAPTCHA tests are in the form of an image, audio file, or a simple question that requires a response. The user is not allowed to access the website or service if it is determined that the response is automated. Though it is very difficult for a bot to solve the image reCAPTCHA's [25]. So, to solve this problem, the research here uses the audio file reCAPTCHA technique as seen in Figure 2(b). In this approach, a user has to listen to a series of numbers, letters or words and enter them in to a text box. These sound files typically contain some periodic and non-periodic noises that are hard for a computer to identify but not for a human listener.

(a) (b)

Figure 2. Web portal accepting (a) roll no. and date of birth and (b) audio reCAPTCHA

Figure 3 depicts the resulted PDF, which has semester-wise result of a student along with other information including total marks obtained; semester grade point average (SGPA), result status, total subjects and total marks obtained. The individual results are needed to answer several queries like, (i) subject-wise, average and overall pass percentage. (ii) Count of students not passed in the exam. (iii) Identifying students requiring additional support. (iv) Identifying trends or patterns in student performance and taking corrective actions. (v) Making decisions related to academic policies, such as grading criteria, promotion criteria, and course offerings. To analyze the performance of students there is a need to extract the result data of each enrolled student from the PDF and stored it into a comma separated values (CSV) file. This process needs to be repeated as depicted in Figure 4. in order to get the result of all the students of a particular semester. Manually transferring data for a large number of students can be extremely time-consuming and prone to errors. Here RPA comes to rescue. RPA bots are capable of accurately and efficiently extracting data from online portals using web scraping [26].

Figure 3. Student result on web portal

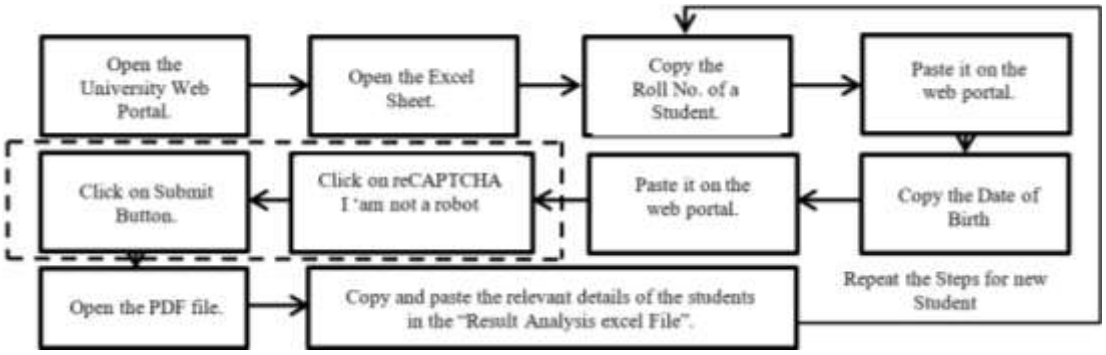

Figure 4. Manual approach for automation of result compilation subroutine

This work not only develops an automated RPA bot for 'result compilation bot', but also emphasizes how urgently automation is needed in the sector of HEIs. RPA is being utilized by practitioners and researchers to evaluate the automation possibilities of various processes employed in HEIs. RPA has been used by numerous financial and healthcare organizations; however the education sector is all set to explore it [27]. As a result, an increasing number of HEIs are exploring ways to use technology and automation to streamline a variety of operations such as attendance tracking, resume screening, interview scheduling, performance tracking, document verification, automated notifications, timetable scheduling, and others.

2. METHOD

The RPA is the best suited solution for automating the repetitive and time-consuming tasks. In this study, an automated RPA bot is developed to automate the task of compiling results during the examination process. The manual approach for result compilation is shown in Figure 4. These steps need to perform repeatedly for each student to access their result in "result analysis excel sheet" for further analysis. RPA has proven to be quite effective for automating the boring and repetitive tasks. The result compilation bot consists of four primary components. These include the CSV generator, XPATH, OpenAI whisper model, and selenium web driver. Using their ID and class properties, items like textboxes and pictures can be found using the selenium web driver. The reCAPTCHA problem is fixed using the OpenAI whisper model. Selenium and XPATH are utilized for web scraping. The bot's output is returned as a '.csv' files via the CSV generator. Following the successful completion of the task or processes, all entries from PDF to excel are made automatically without the need for human interaction. The creation of bot consists of six steps.

- Step 1. Selecting and prioritizing a process in HEI's through survey and questionnaire: a survey questionnaire is used to select and prioritize specific processes or subtasks for automation. This questionnaire is distributed to subject matter experts (SMEs) in industry and academia. This questionnaire covers a variety of operations of HEIs such as examination, placement, admission, attendance tracking, course planning and scheduling, lesson plan construction, and so on. SMEs are highly skilled academicians (professors, associate professors, assistant professors, and research researchers) from HEIs and the corporate world (RPA specialists). SME responses to the survey questionnaire are gathered and evaluated to discover trends in process fit for RPA. Following review, only three procedures are identified as highly automatable. The most important processes are "examination and grading," "placement," and "admission process". In this study, the subroutine 'result compilation' was chosen for automation.
- Step 2. Preprocessing, cleaning, and generation of datasets: the dataset is an excel sheet with the student's roll. no, name, and date of birth (Signature). The 653 student records in the dataset have been cleared of any inaccurate or blank information. The dataset was gathered for various students from various sessions and stored in an excel file named 'roll_class.csv'.
- Step 3. Using selenium web driver for automation: Selenium web driver is used for browser automation [28] in Python script. This driver is used to locate specific elements in a web page, auto-fill the data in the web fields and extract data. This driver first open the web portal 'https://erp.aktu.ac.in/WebPages/OneView/Oneview.aspx' and then read the 'roll_class.csv' excel file. This excel file is repeatedly fetched by the bot, which then pastes "roll. no" and "signature" into the web site to obtain the results. Web driver scripts are used to search for and locate specified parts inside a web portal as well as to extract pertinent data, including text, links, photos, and more.
- Step 4. Using OpenAI whisper model to solve reCAPTCHA: OpenAI whisper is an ML-based model used to bypass the reCAPTCHA. It is an extremely powerful speech recognition system trained on 680,000 hours of multilingual and mutitask supervised data collected from web. Selenium script locate the audio icon button and request for the audio version of the reCAPTCHA [29]. The source of the reCAPTHA audio is identified and downloaded in our system. This audio is then transcribed by the whisper model. Whisper returns the text transcription of the reCAPTCHA solution. Selenium auto-fill the text version and solves the audio reCAPTCHAs as depicted in Figure 5.
- Step 5. Using XPATH: after bypassing the reCAPTHA, the bot retrieves the PDF. Selenium web driver again extract the PDF details using XPATH. It is Python library to web scraping. XPATH is a very powerful toolset for draversing the document object model (DOM) and extracts the text from hypertext markup language (HTML). All the details of the students like, 'name of students', 'Roll No.', 'SGPA', 'status', 'total marks', 'internal', 'external' are scrapped in a dataframe using XPATH and selenium web driver [30].
- Step 6. CSV generator: after web scraping the data from the web portal. The next step to is to create a CSV file with the required data. For this Python dataframe is used to retrieve the data and concatenate it in a table format. The to_csv method is used to create a CSV file from the dataframe. The output file is create with the name 'test_output.csv' file.

Compared to a typical human user, this "result compilation bot" operates 58x faster. The advantage of using RPA bots for online scraping is their ability to retrieve data from websites without requiring direct interaction with the underlying systems or applications. RPA bots can simulates human interaction with diverse applications, such as opening browsers, typing in, clicking the links. After accessing a websites the bot recognises the HTML elements including tags, classes, IDs, and attributes to find the pertinent data. The propsed "result compilation bot" is developed in Python programming language.

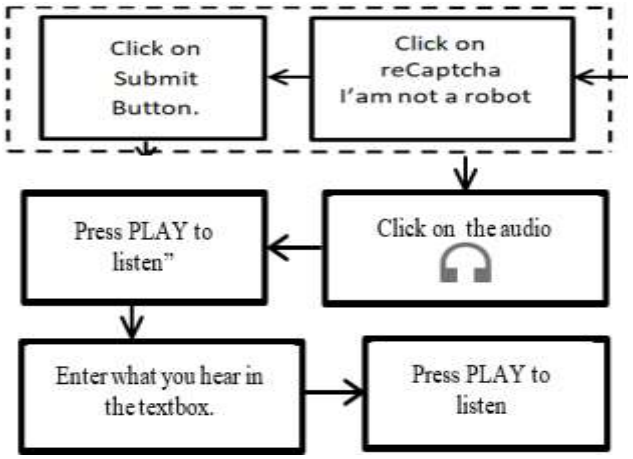

Figure 5. Bot's approach to solve the reCaptch issue using audio technique. Source: result compilation bot

3. RESULTS AND DISCUSSION

The "result compilation bot" is prepared to take over the repetitive chores, freeing up the administrative officer and other faculty members to work on other cognitive duties. The performance of a BOT implementation to compile results is discussed in this paper. The results of the students in a PDF copy from Dr. A.P.J. Abdul Kalam University is used as the sample input in this study. This result compilation task is automated by using Python scripts. This task has been perfectly automated by the RPA Bot as it is a highly repetitive, voluminous, manual, time consuming, structured and rule based tasks. All entries from PDF to excel is done automatically without human intervention.

The CSV file generated by the 'resultcompilation bot'as depicted in Figure 6 contains the status, SGPA, subject code, internal vs external marks of the different subjects of a particular semester. The dataset consists of 653 students details. Processing one record manually takes a maximum of four minutes. Thus, it requires 43 man-hours in total to collect the 653 students' results. As seen in Figure 7, our 'result compilation bot' finishes this operation in a mere 45 minutes. There were 7 out of 653 records with incorrect dates of birth, resulting in anamalies, which is approximately 1.07%. The exceptional anomalies are recorded in a different csv file named as 'left_std.csv'. Following the successful completion of the task or processes, all entries from PDF to excel are made automatically without the need for human interaction. Compared to a typical human user, this "result compilation bot" operates 58x faster. Earlier research utilize automation tools like UiPath, automation anywhere to automate the operations, however this study manually constructed a Python script which further utilizing selenium web driver, XPATH and whisper model to automate this tasks. Because these automation platforms have less support for AI and ML integrated technology. Furthermore, it is extremely tough to accommodate changes to their automotive tools.

STUDENT NAME	ROLL NO	SGPA	Status	Total Marks	KCA101 Internal	KCA101 External	KCA102 Internal	KCA102 External	KCA103 Internal	KCA103 External	KCA104 Internal	KCA104 External	KCA105 Internal	KCA105 External	KCA151 Internal	KCA151 External	KCA152 Internal	KCA152 External	KCA153 Internal	KCA153 External
HIMANSHU SINGH MAHLYAN	2200120140070	7.78	CP(0)	774	40	61	43	54	37	61	36	58	38	58	47	49	45	49	48	50
HIMANI SINGH TOMER	2200120140068	8.26	CP(0)	826	41	70	41	78	40	64	36	64	38	71	46	47	45	47	50	50
HIMANSHU	2200120140069	8.17	CP(0)	811	40	57	47	78	43	62	41	48	40	68	47	49	44	49	50	50
JAGAT RAJ SURAJ YADAV	2200120140072	7.39	CP(0)	719	39	57	38	60	38	36	31	54	35	60	42	40	42	40	49	49
JATIN CHOUDHARY	2200120140073	8	CP(0)	791	41	70	38	75	41	72	34	32	38	71	44	47	45	45	50	50
JATIN RAJPOOT	2200120140074	6.74	CP(0)	680	34	58	33	53	31	55	31	55	29	62	38	40	46	41	44	50
JAY PRAKASH	2200120140075	8.83	CP(0)	892	46	67	46	80	48	61	41	74	42	74	47	50	42	50	50	50
JEETWAR KATYAYAN	2200120140076	6.52	CP(0)	665	39	53	32	52	30	60	28	38	32	32	41	42	41	41	50	50
JOTIKA GUPTA	2200120140077	6.43	CP(0)	677	40	62	30	31	42	57	31	51	32	34	40	43	42	45	50	47
JUNAID AHMED	2200120140078	6.04	CP(1)	639	40	54	34	63	43	42	22	14	31	34	41	40	41	40	50	50
JYOTI GANGWAR	2200120140079	8.17	CP(0)	814	40	75	41	75	47	65	40	67	37	45	45	46	46	47	50	50
JYOTI KUMARI	2200120140080	8.3	CP(0)	827	44	62	48	66	47	76	41	70	38	51	43	48	47	48	50	50
KAJAL SHARMA	2200120140081	7.74	CP(0)	773	41	60	34	61	44	67	33	61	35	46	45	49	48	49	50	50
KALYANI	2200120140082	7.57	CP(0)	754	38	59	35	71	41	62	34	54	35	45	41	48	48	48	49	50
KANIKA BANGA	2200120140083	8.78	CP(0)	850	43	77	44	81	46	76	42	70	38	52	43	47	47	46	49	49
KAPIL CHANDRA	2200120140084	8.04	CP(0)	800	40	70	44	64	40	55	40	78	36	52	44	48	42	49	50	48
KAPIL CHAUHAN	2200120000000	6.35	CP(0)	639	33	42	28	57	37	51	28	34	28	46	42	40	41	38	48	46
KAUTILYA UTKARSH KUMAR	2200120000000	6.83	CP(0)	675	35	44	28	65	38	53	29	53	29	36	42	41	43	43	48	50
KETAN KUMAR SINGH	2200320000000	7.91	CP(0)	794	42	72	41	78	41	68	33	42	33	56	47	49	44	48	50	50
KM BALA	2200120000000	8.17	CP(0)	793	31	60	37	76	35	78	32	59	38	72	45	45	45	44	48	48
KM LEKHIKA MISHRA	2200120000000	5.57	CP(1)	603	28	19	23	65	32	50	22	42	27	44	40	40	41	38	46	46
KM MANSHI SRIVASTAVA	2200120000000	6.91	CP(0)	701	37	60	33	39	41	59	37	59	33	35	43	42	42	42	50	49
KRITIKA MAURYA	2200120000000	8.57	CP(0)	855	41	63	49	80	39	56	48	78	39	69	49	50	50	50	47	49

Figure 6. Compiled result 'test_output.csv' generated by RPA bot, source: RPA bot

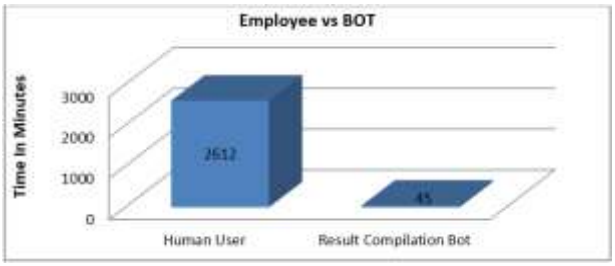

Figure 7. Graph for employee's manual work vs BOT

4. CONCLUSION

The goal of this research project is to create an RPA bot for the result compilation subroutine of any HEI. A significant reduction of man-hours has been achieved by this automated "result compilation bot". This bot is 58x faster than a normal human user. This study offered a comprehensive application of RPA and AI tools, such as XPATH, whisper OpenAI model, and selenium web driver, which is used to automate the laborious processes involved in the process of compiling results and improve the effectiveness of teaching and learning. This research paper presented three possible outcomes using ML and RPA within an HEI: (i) identification and prioritization of the candidate routines in HEIs for RPA; (ii) RPA's 'result compilation' bot to assist the HEI's exam administrators in result compilation after result declaration; and (iii) resolving the reCAPTCHA issue using ML whisper model. As of right now, the whisper OpenAI model performs best with more training audio recordings to solve the reCAPTCHA issue, which is the sole technological limitation identified.

Future work focuses on increasing the cognitive capability of the RPA bots. Additional research directions include giving the RPA more sophisticated intelligence, such as helping placement officers automatically filter resumes and compose emails based on job descriptions, curriculum development, and chatbots for administrative tasks, academic queries and student services. Software bot's cognitive capacity can be increased through the right extension of the technique, integration of RPA into broader automation frameworks, and use of AI, optical character recognition (OCR), and other technologies. AI and RPA can be used to create more tailored learning plans for students, adapting in real-time to their progress and learning styles. Examining how these technologies can be scaled to fit different educational environments and cultural norms could contribute to the globalization of education by opening up access to excellent resources for a wider audience.

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