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Procedia Computer Science 181 (2021) 51–58

Procedia Computer Science

www.elsevier.com/locate/procedia

CENTERIS - International Conference on ENTERprise Information Systems / ProjMAN - International Conference on Project MANagement / HCist - International Conference on Health and Social Care Information Systems and Technologies 2020

Robotic Process Automation and Artificial Intelligence in Industry 4.0 – A Literature review

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Abstract

Taking into account the technological evolution of the last decades and the proliferation of information systems in society, today we see the vast majority of services provided by companies and institutions as digital services. Industry 4.0 is the fourth industrial revolution where technologies and automation are asserting themselves as major changes. Robotic Process Automation (RPA) has numerous advantages in terms of automating organizational and business processes. Allied to these advantages, the complementary use of Artificial Intelligence (AI) algorithms and techniques allows to improve the accuracy and execution of RPA processes in the extraction of information, in the recognition, classification, forecasting and optimization of processes. In this context, this paper aims to present a study of the RPA tools associated with AI that can contribute to the improvement of the organizational processes associated with Industry 4.0. It appears that the RPA tools enhance their functionality with the objectives of AI being extended with the use of Artificial Neural Network algorithms, Text Mining techniques and Natural Language Processing techniques for the extraction of information and consequent process of optimization and of forecasting scenarios in improving the operational and business processes of organizations.

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1877-0509
10.1016/j.procs.2021.01.104

Keywords: Robotic Process Automation, Artificial Intelligence, Industry 4.0.

1. Introduction

The availability of digital services is seen as a growing trend at a company-level, taking into account the greater use of the proliferation of information systems in society and the technological evolution that we are witnessing at various levels. The form of communication between citizens, companies and institutions started to be mostly through the exchange of digital information. In view of the high volume of information and digital documentation exchanged between entities, in general, it is humanly impossible to respond in a timely manner to the processing of all information and to follow up on processes internally. In this sense, we highlight the importance of Robotic Process Automation (RPA), which can be defined as a "technique that results in the automatic execution of administrative, scientific or industrial tasks" [1] which uses robotics as a "set of techniques concerning the operation and use of automata (robots) in the execution of multiple tasks in place of man" [1] for "how to do a thing; standard; method; system" [1]. In this context and in a nutshell, the RPA tools correspond to a set of techniques that aim to improve the work by reducing the number of repetitive tasks, automating them [2]. In addition to the use of RPA, the complement with Artificial Intelligence (AI) - algorithms and techniques - allows to improve the precision of the execution of automated processes. Industry 4.0 reviews a set of technologies and sensors that allows an even greater advance in the processes and applications of automation of AI applications for organizational processes, contributing to a better performance and presenting new opportunities.

The main contribution of this paper is essentially in providing a review of AI and RPA contributions to Industry 4.0 as well as in the analysis and comparison of several proprietary and opensource tools regarding their functionalities. This document is structured as follows. In chapter two the general concept about Robotic Process Automation is presented and in section 3 the general concept of Artificial Intelligence and Industry 4.0. In chapter 4, several proprietary and open source tools are presented and their main characteristics so that in chapter 5 a discussion about the tools is made. In chapter 6 the conclusions are presented and then the references that support this work are presented.

2. Robotic Process Automation

Robotic Process Automation (RPA) is the automation of services tasks that reproduce the work that humans do [3]. The automation is done with the help of software robots or AI workers that are able to perform, accurately, repetitive tasks. The task instructions are set by the developer using some form of screen recording and defining variables. These tasks include actions like logging into applications, copying and pasting data, opening emails, filling forms, among others [4]. Van der Aalst et al. [3] state that "RPA is an umbrella term for tools that operate on the user interface of other computer systems". Although traditional forms of process automation (like screen recording, scraping and macros) also rely on the computer's user interface, RPA's core function is via element identification and not by screen coordinates [4] or XPath selections. This, in most cases, provides a more intelligent interaction with the user interface. Commercial vendors of RPA tools report a surge in demand since 2016 [3], and we see some research where these tools are used for automating digital forensics [4], auditing [5] and industry [6]. The advent of the fourth industrial revolution (Industry 4.0) is paving the way for new ways to automate mundane rules-based business processes, using RPA tools on information obtained from smart devices [6]. For business processes, RPA is the extrapolation of a human worker's repetitive tasks by a robot (where those tasks are done quickly and profitably). This aims to replace people by automation in an outside-in manner. Unlike traditional methods, RPA is not part of the information infrastructure but rather sits on top of it, implying a low level of intrusiveness [7] possibly reducing costs. Some reports present a 30% to 50% decrease in operational costs of transactional activities within shared services with the use of RPA technologies [8].

3. Artificial Intelligence and Industry 4.0

At one time AI was a concept divided into major fields of application. Some of those fields where natural language processing, automatic programming, robotics, computer vision, automatic theorem proving, intelligent data retrieval, etc. Nowadays these application areas are so extensive that each could be considered a field in and of itself. AI is now best described as a group of core ideas that underline many of these applications [9]. The use of AI by machines to complete complex tasks, reduce costs and improve the quality of goods and services is the core principle of smart factories and industry 4.0 [10]. AI technologies are permeating the manufacturing industry and merging the physical and virtual worlds with the help of cyber-physical systems. The use of AI makes the manufacturing industry smart and capable of addressing modern challenges like customizable requirements, reduced time to reach the market and increasing number of sensors used in equipment [11]. The use of flexible robots combined with AI allows for easier manufacturing of different products. AI methods (like data mining) are capable of analyzing large volumes of real-time data gathered from various sensors [12].

4. RPA Tools with IA support

In recent years, AI algorithms [13] and Machine Learning (ML) approaches have been successfully applied in real-world scenarios, such as commerce, industry and digital services. ML [14] is used to “teach” machines how to deal with data more efficiently, simulating the learning concept of rational beings and can be implemented with AI algorithms (or techniques), reflecting the paradigms / approaches of rational characteristics such as connectionist, genetics, statistics and probabilities, based on cases, etc. With the AI algorithms and based on the ML approach, it is possible to explore and extract information to classify, associate, optimize, group, predict, identify patterns, etc. Given the scope of the applicability of AI, RPA has gradually been adding, to its automation features, implementations of algorithms or AI techniques applied in certain contexts (e.g.: Enterprise Resource Planning, Accounting, Human Resources) to classify, recognize, categorize, etc. In recent years, some academic studies have been published as challenges and potential, as well as case studies of the applicability of RPA and AI, as are the cases of articles [15] in the field of automatic discovery and data transformation, in the audit area, [17] in the application of Business Process Management and in productivity optimization processes [18]. Other studies on the intelligent automation of processes using RPA have been published, such as that of the consultancy Delloite [19], which presents the potentialities of the applicability of AI algorithms and techniques, but it should be applied in well-defined, stabilized and mature processes, like in strategic areas focused on customer tasks, increasing employee productivity (optimizing routine tasks), improving accuracy in categorizing and routing processes, improving the experience with customers and employees, enhancing the analytical data analysis, reduce fraud and payment of “fines” processes for non-compliance with dates or procedures defined by government institutions. In this context, and based on the above, if on the one hand there are challenges and potentialities of the concept of automation using RPA, these may be further enhanced with the application of algorithms and AI techniques. The following sections present commercial and open source tools that we consider representative of the recent applicability of RPA (ideally with the application and some AI techniques or algorithms).

4.1. UiPath

UiPath [20-26] is a tool that allows the development of RPA functionalities in its framework to create and execute programming scripts, allowing it to be programmed with an interface of blocks and multiple plugins for the business process customizations. The RPA UiPath platform is currently structured in three modules, UiPath Studio, UiPath Robot and UiPath Orchestrator, in which the latter allows the possible orchestration of robots [20]. The UiPath Studio module corresponds to a tool that allows to design, model and execute workflows [21] and help in the creation and maintenance of the connection between robots, as well as to ensure the transfer of packages, management of queues. In turn, with the storage of log records and linked with Microsoft's Information Services Server and SQL Server, as well as with Elasticsearch (which is open source and built on the Apache License search engine) with a Kibana data visualization plugin also allows to potentiate the view of analytical information associated with the execution of RPA processes. These features can be found in more detail in [22-24]. Some Artificial Intelligence techniques or algorithms

are currently available through the UiPath tool through its UIAutomation module [25] and which are disclosed on its official page [26], of which the following stand out: recognition, optimization, classification and information extraction. In terms of AI algorithms, for the information consulted they use image and character recognition, optimization, classification.

4.2. Kofax

Kofax [27-33] is a company that develops process automation software in companies and organizations. The tool offers a set of modules oriented to RPA, business process orchestration through procedural flows of software activities, document recognition (through Optical Character Recognition - OCR processes) and advanced data analysis. Being a proprietary tool and not having been able to obtain a test version to this study, several sources of information were consulted [27-34] in order to collect as much information about the tool. As RPA automation processes, this tool makes it possible to extract data from documents, other sources (web, e-mail, local files) in various formats and design and allows the execution of procedural flows between computer applications to optimize tasks associated with Enterprise Resource Planning (ERP) information systems. As with other tools, it also provides modules associated with the implementation of techniques or algorithms associated with AI. Being able to be more or less profound in terms of the application of these techniques, the tool allows for example to recognize the content and context of a document [28], or through the classification and recognition of information in emails, web portals and paper [34]. The use of ML approaches combined with the recognition and classification of OCR documents and the analysis of the contents of e-mails or web pages can be considered as forms of supervised learning since a set of prior information is required to classify and validate the contents. On the other hand, the application of natural language processing, depending on the technique or algorithms, can be used in supervised learning for classification or unsupervised learning to analyze content through information clustering ("clustering") or density extraction. In this sense, it appears that some AI techniques or algorithms are currently available through the Kofax tool through the Intelligent Automation platform [32] and its Cognitive Document Automation module [33].

5.3 *Automation Anywhere*

Automation Anywhere [35-41] is another tool oriented towards RPA processes with the particularity of also providing information on the applicability of AI techniques / algorithms. As an RPA tool applied to ERP contexts and like other tools previously described, it covers several areas of applicability such as human resources, Customer Relationship Management, Supply Chain, being especially liable to be integrated or interconnected with ERPs from SAP and Oracle, and can be interconnected with other ERP's from other companies. Allied to the RPA is the most automatic or intelligent process called "Digital Workers". The RPA tool incorporates a module called cognitive automation and analytical data analysis tools applied to RPA processes. Being an application with numerous functionalities, it provides a set of information that allows the configuration, operation and implementation of RPA processes [35-41]. The Automation Anywhere tool through its Bot tool [40], internally provides the execution of some Artificial Intelligence techniques and algorithms such as fuzzy logic, Artificial Neural Networks, and natural language processing for the extraction of information from documents and consequently improve efficiency in document validation. In this sense, it appears that some AI techniques or algorithms are currently available by the Automation Anywhere intelligent word processing tool through the IQ Bot platform [40].

4.3. WinAutomation

The WinAutomation tool [42] provides a set of features associated with automation processes that are incorporated in the RPA processes, namely, automation of emails, files in various formats (eg PDF and Excel), OCR and other features associated with the post employees' work environment (desktop or web). In turn, softomotive is an RPA solutions company that created WinAutomation. WinAutomation is aimed at desktop environments that have built-in process design, desktop automation, web automation, macro recording, multitasking, automatic task execution, mouse and keyboard automation, User Interface designer, email automation, excel automation, file and folder automation, system monitoring and triggering, auto-login, security, File Transfer Protocol automation, exception handling, repository and

control images, command line control, web data extraction, PDF automation, scripting, OCR capabilities, computer vision, non-participatory and participatory automation, advanced synchronization, auditing and logs, web recorder, inactive and non-interactive execution, database and SQL, cognitive and terminal emulation [43]. In terms of RPA functionalities, the tool provides a set of modules through the "processrobot" module and through a partnership with the company CaptureFast allows to extend its RPA functionalities with information capture engines using AI, data extraction in documents and systems automatic and hybrid document classification. Based on the analyzed literature [42-45], the Cognitive module allows integrating the functionalities with the analytical information analysis engines from Microsoft, IBM and Google's Cognitive. However, it appears that at the level of availability of AI functionalities, the tools do not present evidence.

4.4. AssistEdge

The AssistEdge tool, owned by EdgeVerve Systems (a subsidiary of Infosys), is a proprietary tool, but with an "opensource" version for the community [49]. Based on institutional information [46-49], its functionalities are OCR reading for processing documents based on the context associated with the type of document. Based on information from automation processes, it uses AI algorithms (e.g. Artificial Neural Networks) [49] for automatic data capture, data analysis through the analysis of process variations based on individual process monitoring and classification of information for recommendation processes.

4.5. Automagica

The Automagica tool [50] is proprietary with an opensource version (for non-commercial purposes), with its code being made available on GitHub [51]. Developed mainly in the Python language, it can be exploited by other implementations by the community (e.g. of AI techniques or algorithms). Among the basic features of RPA, such as reading OCR, extracting texts from PDF files, automating information in word files, excel, information collected via the browser and creating automation processes, it also allows interconnection with Google Tensorflow for image and text recognition.

5. Discussion

Based on the study of the most representative RPA tools described in this document, a comparative table of technologies is presented below, specifying which objectives of Artificial Intelligence and AI algorithms they use:

Table 1. Comparison of technologies and goals associated to IA

	Goals associated to IA				**Artificial Intelligence Techniques or Algorithms used**								
Tool	**Recognition**	**Optimization**	**Classification**	**Information extraction**	**Computer Vision (*)**	**Fuzzy Matching**	**Statistic methods**	**Artificial Neural Networks**	**Decision Trees**	**Fuzzy Logic**	**Natural Language Processing**	**Text Mining**	**Recomendation Systems**
UiPath	X	X	X	X	X	X	X	X					
Kofax	X	X	X	X				X			X		
Automation Anywhere	X	X	X	X				X		X	X		
WinAutomation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
AssistEdge	X	X	X	X			X	X					X
Automagica	X	X	X	X				X			X		X

(*) Computer vision - Considering the application of AI algorithms such as Artificial Neural Networks.
NA – Information Not Available.

Analyzing information on the web and in digital libraries, a set of tools were identified that implement automation processes associated with RPA. Those tools have the implementation of "smart" processes associated with automation routines but mainly are associated with the implementation of techniques and algorithms of AI. It appears that the proprietary tools have a greater set of information and RPA functionalities with AI. Open source tools depend on the community of developers, they are still under development or growing in the number of functionalities such are the tools TagUI [52, 53], TaskT [54], Robot Framework Foundation [55].

UiPath is a tool with a lot of features and a lot of documentation. It has several plugins that can be programmed allowing adaptability to other applications such as PowerShell, SAP ERP, Oracle and Microsoft Dynamics. The Kofax and Automation Anywhere tools implement several RPA processes with interconnection to ERP's mainly to ERP SAP. AssistEdge tool demonstrated the possibility of being integrated with Microsoft (Azure Machine Learning) and Google (cognitive Services) cognitive systems, which allows to enhance the usability of the implementations of these two large technological companies.

In the case of proprietary companies (where the largest number of RPA functionalities and information is more available) the adoption of RPA processes with AI or the interconnection with other ERPS will always be associated with a licensing cost. In the case of open source RPA tools, initiatives and implementations are still growing. However, in recent years, numerous implementations (at the academic level) of algorithms are used in free programming languages (such as R and python), and some initiatives of RPA may take advantage of implementations of Artificial Intelligence techniques and algorithms. On the other hand, as a result of the development and availability of Artificial Intelligence algorithms by Microsoft, the possibility of using the .NET framework from Azure's Machine Learning platform, allows for a direct way to explore RPA implementations.

6. Conclusions

This document presents an investigation on RPA with AI for ERP-related processes. It was based on the analysis of information researched in digital libraries on the web (corporate websites and tools, blogs, etc.), as well as in scientific digital libraries. A set of proprietary tools (UiPath, Kofax, Automation Anywhere and WinAutomation) and Opensource tools (AssistEdge and Automagica) were identified, and for each of them a characterization of their RPA features, their integration with ERPs and support for ERPs was made. We conclude that most of the proprietary tools implement algorithms associated with the objectives of AI, such as recognition, optimization, classification and extraction of knowledge from either RPA documents or processes. It also enhances their optimization and exploration of the information by the users of these applications. The AI techniques and algorithms that these tools implement, focus on computer vision (image recognition using for example Artificial Neural Networks), statistical methods, decision trees, neural networks for classification and prediction, fuzzy logic and implementation of techniques associated with text mining, natural language processing and recommendation systems.

On the other hand, Industry 4.0 - the revolution we are experiencing today - lives on the fusion of the Internet of Things, intelligent automation, intelligent devices and processes and cyber-physical systems. The combination of all these concepts and technologies brings a significant change in industrial processes, affecting the workflow of digital processes throughout the company. Nowadays, and to improve these processes, they are incorporating automation of some steps through robots (RPA). In addition, RPA nowadays incorporates, in many tools as we have shown in this paper, intelligent techniques and algorithms (AI), which allows to reach levels of intelligence in the automation of processes within a company.

References

[1] Infopédia (2020). Dicionário Infopédia da Língua Portuguesa, 2020. [Online]. Available from : https://www.infopedia.pt.

[2] Aguirre, Santiago & Rodriguez, Alejandro. (2017). Automation of a Business Process Using Robotic Process Automation (RPA): A Case Study. 65-71. DOI: 10.1007/978-3-319-66963-2_7. Available from: https://www.researchgate.net/publication/319343356_Automation_of_a_Business_Process_Using_Robotic_Process_Automation_RPA_A_Case_Study

[3] van der Aalst, W. M., Bichler, M., & Heinzl, A. (2018). Robotic Process Automation. Bus Inf Syst Eng 60, pp.269–272. https://doi.org/10.1007/s12599-018-0542-4

[4] Asquith, A., & Horsman, G. (2019). Let the robots do it!–Taking a look at Robotic Process Automation and its potential application in digital forensics. Forensic Science International: Reports, 1, 100007.

[5] Moffitt, K. C., Rozario, A. M., & Vasarhelyi, M. A. (2018). Robotic process automation for auditing. Journal of Emerging Technologies in Accounting, 15(1), 1-10.

[6] Madakam, S., Holmukhe, R. M., & Jaiswal, D. K. (2019). The future digital work force: robotic process automation (RPA). JISTEM-Journal of Information Systems and Technology Management, 16.

[7] Enríquez, J. G., Jiménez-Ramírez, A., Domínguez-Mayo, F. J., & García-García, J. A. (2020). Robotic Process Automation: A Scientific and Industrial Systematic Mapping Study. IEEE Access, 8, 39113-39129.

[8] Williams, D., & Allen, I. (2017). Using artificial intelligence to optimize the value of robotic process automation. Available from: https://www.ibm.com/downloads/cas/KDKAAK29

[9] Nilsson, N. J. (2014). Principles of artificial intelligence. Morgan Kaufmann Editors.

[10] Bahrin, M. A. K., Othman, M. F., Azli, N. N., & Talib, M. F. (2016). Industry 4.0: A review on industrial automation and robotic. Jurnal Teknologi, 78(6-13), pp:137-143.

[11] Zheng, P., Sang, Z., Zhong, R. Y., Liu, Y., Liu, C., Mubarok, K., ... & Xu, X. (2018). Smart manufacturing systems for Industry 4.0: Conceptual framework, scenarios, and future perspectives. Frontiers of Mechanical Engineering, 13(2), pp:137-150.

[12] Ustundag, A., & Cevikcan, E. (2017). Industry 4.0: managing the digital transformation. Springer Editors. Available from: https://www.springer.com/gp/book/9783319578699

[13] Haenlein, Michael & Kaplan, Andreas. (2019). A Brief History of Artificial Intelligence: On the Past, Present, and Future of Artificial Intelligence. California Management Review.

[14] Mitchell, T. M. (1997). Machine Learning. New York: McGraw-Hill. ISBN: 978-0-07-042807-2.

[15] Leno, V., Dumas, M., La Rosa, M., Maggi, F. M., & Polyvyanyy, A. (2020). *Automated Discovery of Data Transformations for Robotic Process Automation*. https://arxiv.org/abs/2001.01007

[16] Huang, F., & Vasarhelyi, M. A. (2019). Applying robotic process automation (RPA) in auditing: A framework. *INTERNATIONAL JOURNAL OF ACCOUNTING INFORMATION SYSTEMS*, *35*. https://doi.org/10.1016/j.accinf.2019.100433

[17] Agostinelli, S., Marrella, A., & Mecella, M. (2020). *Towards Intelligent Robotic Process Automation for BPMers*. Available from: https://www.researchgate.net/publication/338401505_Towards_Intelligent_Robotic_Process_Automation_for_BPMers

[18] FLUSS, D. (2018). Smarter Bots Mean Greater Innovation, Productivity, and Value: Robotic process automation is allowing companies to re-imagine and re-invest in all aspects of their businesses. *CRM Magazine*, *22*(10), 38–39.

[19] Delloite (2019). Automation with intelligence Reimagining the organisation in the 'Age of With'. Available from: https://www2.deloitte.com/content/dam/Deloitte/tw/Documents/strategy/tw-Automation-with-intelligence.pdf

[20] Tripathi, A. (2018). Learning robotic process automation: Create software robots and automate business processes with the leading RPA tool, UiPath. Packt Publishing Book Series.

[21] UiPath (2020a). UiPath Studio: introduction. [Online]. Available from: https://docs.uipath.com/studio/docs/introduction.

[22] GitHub (2020a). Open Source, Distributed, RESTful Search Engine. [Online]. Available from: https://github.com/elastic/elasticsearch.

[23] GitHub (2020b). Your window into the Elastic Stack. [Online]. Available from: https://github.com/elastic/kibana

[24] UiPath (2020b). Prerequisites for Installation. [Online]. Available from: https://docs.uipath.com/orchestrator/docs/prerequisites-for-installation.

[25] UiPath (2020c). About the UI automation activities pack. [Online]. Available from: https://docs.uipath.com/activities/docs/about-the-ui-automation-activities-pack

[26] UiPath (2020d). Artificial Intelligence RPA Capabilities. [Online]. Available from: https://www.uipath.com/product/ai-rpa-capabilities

[27] Kofax (2020a). Developer's Guide Version: 11.0.0 [Online]. Available from: https://docshield.kofax.com/RPA/en_US/11.0.0_qrvv5i5e1a/print/KofaxRPADevelopersGuide_EN.pdf

[28] Kofax (2019). Product summary Kofax RPA. [Online]. Available from: https://www.kofax.com/-/media/Files/Datasheets/EN/ps_kofax-rpa_en.pdf

[29] Kofax (2020b). Maximize Your ERP with Integrated Accounts Payable Automation. [Online]. Available from: https://www.kofax.com/Solutions/Cross-Industry/Financial-Process-Automation/AP-and-Invoice-Automation/ERP-Integration

[30] Kofax (2020c). Power your process. [Online]. Available from: https://www.kofax.com/-/media/Files/E-books/EN/eb_how-rpa-capture-empowers-customer-journey_en.pdf

[31] Kofax (2011). Kofax Capture (versão 10.0). [Online]. Available from: https://issues.alfresco.com/jira/secure/attachment/56073/KofaxCaptureDevelopersGuide_10.pdf

[32] Kofax (2020e). Kofax intelligent automation platform. [Online]. Available from: https://www.kofax.com/Products/intelligent-automation-platform

[33] Kofax (2020d). Cognitive Document Automation. [Online]. Available from: https://www.kofax.com/Blog/Categories/Cognitive-Document-Automation

[34] Schmidt, D. (2018). RPA and AI. [Online]. Available from: https://www.kofax.com/Blog/2018/september/rpa-and-ai-the-new-intelligent-digital-workforce

[35] Automation Anywhere (2020a). Robotic process automation to ERP. [Online]. Available from: https://www.automationanywhere.com/solutions/robotic-process-automation-to-erp

[36] Automation Anywhere (2020b). Automate any ERP process with RPA. [Online]. Available from: https://www.automationanywhere.com/lp/automate-any-erp-process-with-rpa

[37] Automation Anywhere (2020c). Actions in the Workbench. [Online]. Available from: https://docs.automationanywhere.com/bundle/enterprise-v11.3/page/enterprise/topics/aae-client/metabots/getting-started/selecting-actions-in-the-logic-editor.html

[38] Automation Anywhere (2020d). Bot Execution Orchestrator API. [Online]. Available from: https://docs.automationanywhere.com/bundle/enterprise-v11.3/page/enterprise/topics/control-room/control-room-api/api-deploy-and-monitor-bot-progress.html

[39] Automation Anywhere (2020e). Automation Management API. [Online]. Available from: https://docs.automationanywhere.com/bundle/enterprise-v11.3/page/enterprise/topics/control-room/control-room-api/api-bot-deployment.html

[40] Automation Anywhere (2020f). IQBot – Intelligent Document Processing. [Online]. Available from: https://www.automationanywhere.com/products/iq-bot

[41] E. Global (2017). Automating Content-Centric Processes with Artificial Intelligence. [Online]. Available from: https://www.automationanywhere.com/images/lp/pdf/everest-group-automating-content-centric-processes-with-ai.pdf

[42] WinAutomation (2020a) Desktop automation https://www.winautomation.com/product/all-features/desktop-automation

[43] WinAutomation (2020b) About Softomotive. Available on: https://www.winautomation.com/about-softomotive/

[44] WinAutomation (2020c) Installation Requirements. Available from: https://support.softomotive.com/support/solutions/articles/35000081666-winautomation-installation-requirements

[45] WinAutomation (2020d) Softomotive RPA Review. Available from: https://www.rpa-star.com/softomotive-vs-winautomation-rpa-review/

[46] AssistEdge (2020a). RPA. Available from: https://www.edgeverve.com/assistedge/robotic-process-automation/

[47] AssistEdge (2020b). AssistEdge RPA Brochure. Available from: https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RE42s9D

[48] AssistEdge (2020b). Uso das Redes Neuronais Artificiais para análise de variações dos processos. Available from: https://www.edgeverve.com/assistedge/assistedge-discover/ and from: https://www.infosys.com/newsroom/press-releases/2019/launches-assistedge-discover-true-value-automation.html

[49] AssistEdge (2020c). AssistEdge RPA OpenSource Community. Available from: https://www.edgeverve.com/assistedge/community/

[50] Automagica (2020a). Automagica GitHub Repository. Available from: https://github.com/automagica/automagica

[51] Automagica (2020b). Automagica Documentação. Available from: https://automagica.readthedocs.io/index.html and https://github.com/automagica/automagica/wiki/Documentation

[52] TagUI (2020a). TagUI – AI Singapure Platforma – National institute. Available from: https://makerspace.aisingapore.org/do-ai/tagui/

[53] TagUI (2020b). TagUI – GitHub Repository Available from: https://github.com/kelaberetiv/TagUI/tree/pre_v6

[54] TaskT (2020a). TaskT RPA .NET Platform. Available from: https://github.com/saucepleez/taskt/wiki/Automation-Commands

[55] Robocorp (2020). Robocorp hub. Available from: https://hub.robocorp.com/new-to-robocorp-suite/get-started/quickstart-guide/