Design and Implementation of RPA Based ChatMES System Architecture for Smart Manufacturing

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Abstract- Today, with the generation of a lot of data in the manufacturing field, research is being actively conducted on how data is processed. But we're building more complex screens to process and show a lot of data. However, there are many times when manufacturing sites want fast, concise data. It is possible through Chatbot with Robot Process Automation (RPA) for checking and processing concise data regardless of time and place. Provides an architecture that can handle complex system screen queries and complex processes.

Keywords- RPA, Chatbot, Smart Manufacturing, MES

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1. Introduction

THERE'S a variety of data coming from the manufacturing site today. Along with the development of the way various data are processed, we have also been concerned about the way various data are displayed. The Manufacturing Execution System (MES) has created multiple screens that combine data to show data from different perspectives. This phenomenon has not necessarily changed to an advanced form. It can be useful for users who want to see and analyze a variety of data combinations, but there are many inconveniences for simple information. You need to go to the PC where the system can be connected and access it. In addition, even though you can see it on your mobile device, you need to find a menu of many categories and access screens in subcategories to see the data you want. And to see simple data, various data are viewed together on the connected screen, so the viewing speed is delayed, and the view can be dispersed because it shows data that I don't need. To compensate for these points, ChatMES, a simple manufacturing bot using Chatbot, was studied.

Chatbot is an application that mimics conversations with people and allows them to interact with virtual applications that seem like they're actually talking [1]. Chatbots can be as easy as basic applications to answer simple queries, and they can also require cutting-edge technology, such as personal assistants, who can use big data to answer queries in a variety of casesBut in manufacturing, AI wasn't very involved in chatbots [1]. Today, most services have automated chatbots that can interact with users [3]. Automation through chatbots and many situations demonstrated the usefulness of improving the user experience [4] The study highlights that chatbot applications will be a key technology in IT technology in the future [5]. Robot Process Automation (RPA) technology is the technology that makes chatbots like personal assistants[5]. RPA is the evolution of next-generation automation systems that deliver faster, more accurate performance and higher return on investment in business applications [6].

In this study, we designed a chatbot that works with MES and uses the technology of RPA. With the development of smart manufacturing, processes and inquiry screens through screens are becoming more complicated in a manufacturing environment with a lot of data. In Chatmes, you can get the information you want anytime, anywhere through an accessible messenger, and you can work through messenger by registering simple queries, scheduling tasks, and even complex tasks with intent through RPA. In addition, Chatmes designed an architecture that enables RPA by accessing various messenger programs and legacy systems except MES with the API plug-in layer in mind.

This study consists of: Section II. describes the relevant operation. Section III. presents the architecture of the manufacturing chatbot and describes the architecture. Section IV. confirms the results of the manufacturing chatbot through experiments. Finally, section V. discusses conclusions and future research plans.

2. Related Work

2.1 Smart Manufacturing

Smart manufacturing is a term coined by several organizations, such as the Department of Energy (DoE) and the National Institute of Standards and Technology (NIST) in the United States. Using information and communication technology (ICT) and data analysis, the manufacturing site was improved and the operation of the factory was emphasized [7, 8, 9] Smart manufactur-

ing integrates various technologies such as CyberPhysical Production Systems (CPPS), IoT, robotics/automation, big data analytics, and cloud computing to enable data-driven connectivity [10]. Intelligent manufacturing has been used in the same sense as smart manufacturing. The technology and essential elements of smart manufacturing were studied to explain the difference between smart manufacturing and intelligent manufacturing [7, 11, 12]. Research has been conducted on the features and essentials of smart manufacturing and intelligent manufacturing technology [13]. Intelligent manufacturing focuses more on the technical side and less on the organizational side than on smart manufacturing. In the context of Industry 4.0, intelligent manufacturing is drawing tremendous attention from government, corporate and academic researchers [14].

2.2 Chatbot

Chatbots are also called messenger bots because they are based on text messages exchanged between users and bots in chat spaces. When a user enters a text message in a virtual space, the software analyzes the message, creates an appropriate response, and sends the message back to the user. Therefore, the user can communicate with the soft-agent-bot through interaction with the soft-agent-bot and verify that the soft-agent-bot has performed the correct operation. In general, chatbots are systems that send corresponding messages according to already defined rules as needed. In the initial development version, a method of checking simple matches of keywords and return values was performed. However, due to recent advances in various technologies, the requirements are defined by identifying and analyzing the natural language entered by users. Chatbots can fulfill requirements and respond to results [15]. The function of these chatbots means that they can act as agents, as mentioned above. The agent is an abstract object in terms of software. Engineering has the same area as methods, functions, and modules, but the difference is that it performs autonomous operations instead of simple functions [16, 17].

2.3 RPA

Process automation technology is used to automatically control processes. Technological advances have enabled industrial automation systems to be introduced wherever possible. Process automation can be divided into hard automation and soft automation [18]. Hard automation refers to the performance of fixed iterations on a given product, and soft automation performs a variety of non-fixed operations. RPA is a technology that belongs to soft automation[19] The software bot handles data (read, write, numerically, and compute) with applications through procedured workflows [20]. In various cases of analyzing RPA inside the device, it was confirmed that the processing speed of some tasks in the organization was shortened and productivity was increased when RPA was applied. In a recent study, a prototype of an interactive digital assistant based on natural language processing has been presented to present tasks related to intelligent RPA. Through this, it is predicted that interactive bot will be able to solve business [21, 22].

3. ChatMES System Architecture Based on RPA

In our study, ChatBot's research using RPA was conducted so that the current status of the manufacturing site can be checked quickly and easily anywhere.

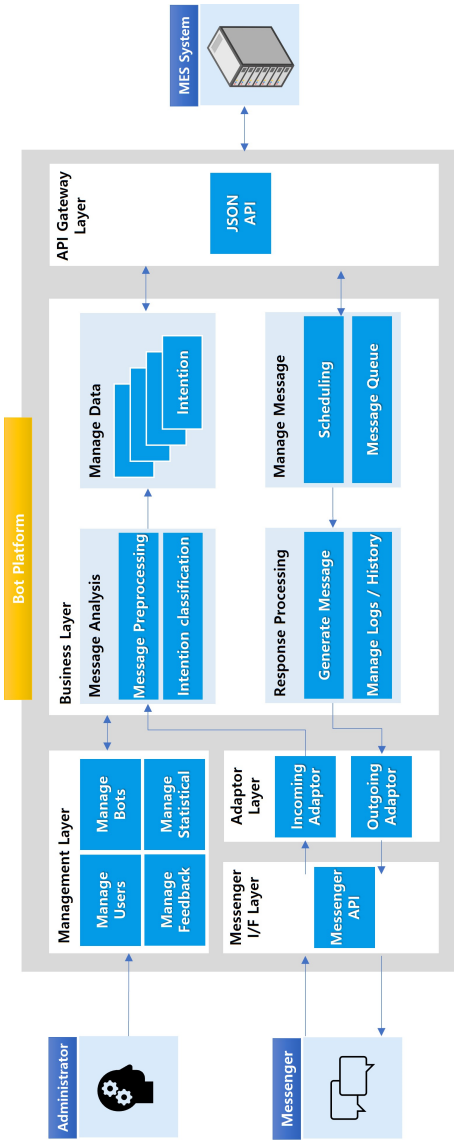

Fig. 1: ChatMES System Architecture

Figure 1 shows the architecture we studied. All processing is done on the Bot Platform. The Bot Platform is divided into the Management Layer, Messenger I/F Layer, Adapter Layer, Business Layer, and API Gateway Layer.

First, in the Management Layer, there are Manage Users, Manage Bots, Manage Feedback, and Manage Statistical. Manage Users manages registered users. Only authorized users are allowed to use it, and because they have permission to view information based on their ratings, they are granted permissions based on their query intentions. Manage Bots manages data that

can be viewed. Data that users use a lot is created and managed by intention. Manage Feedback verifies that the user's intended data has been sent, analyzes messages that have not been identified, and fine-tunes them according to their intentions by type of message to modify their intentions in Manage Data. Manage Statistical is to understand the statistics of the messages you use. The high frequency of messages is modified to be more diversified and used, and the low frequency of use is further supplemented to increase the frequency of users' use so that they can be used more conveniently.

Second, Messenger I/F Layer. You will use it to connect your messenger to your Chatbot. It helps you communicate in both directions and is used for smooth message delivery. In this study, Knox Messenger was used, but in order to use various messengers, API can be connected to the layer in a plug-in manner.

Third, the Adaptor Layer. This layer is associated with the Messenger I/F layer to receive a message through the Incoming Adapter and send the message to the Business Layer. In contrast, the Outgoing Adapter receives outgoing messages from the Business Layer and sends them to the Messenger I/F Layer. Although it appears to be two-way communication on the layer, it is divided internally because the communication direction of the incoming and outgoing messages is different.

Fourth, the Business Layer includes Message Analysis, Manage Data, Manage Message, and Response Processg. Message Analysis preprocesses messages received through the Incoming Adapter and distributes the types and variables by intent. Identify and distinguish intentions from pretreatment. Find the right intention in Manage Data with differentiated intentions and match the variables accordingly. Manage Message uses JSON to separate the instant and scheduled messages from the results data received and to manage them in a message queue. Response Processing generates a result message with the data stored in the message queue. And leave the message history and logs so that you can verify that it worked properly.

Fifth, API Gateway Layer exists to query data and receive results from the system. Currently, it is designed to receive only MES data, so it connects to the MES System using the JSON API for JSON connectivity. However, if users want to connect to other legacy systems such as ERP and SCM, not just MES systems, they can connect to non-MES systems and receive messages by adding APIs of promised communication to the API Gateway Layer.

4. Experiment and Results

We experimented with an architecture designed in Figure 1. ChatBot was designed through the Brity RPA of Samsung SDS, an open RPA system, and Samsung SDS used Knox Messenger.

igure 2 shows that the message is communicated in JSON format and that the variable is received and processed. Messages will be received through the Incoming Adaptor in the Adaptor Layer. A message is received

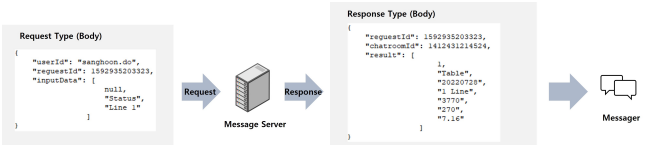

Fig. 2: Message Communication

from the Business Layer, preprocessed, matched with the intention of the Mange Date, and processed by the appropriate application in the MES system to query the promised data. The data received by messenger was divided into date, intention, and line. The date was set as a mandatory variable because there is a risk that a large amount of data will be inquired. If you do not enter a date, it will be recognized as a null value, so you will query the date you sent the message, and if you do not specify a line, the MES system will query all lines. You will receive a result message through JSON through the server. The body part of the result message is received and the first value indicates the value of the intention inquired. 1 is a message about the production status and will reply according to the format. If you reply to the second value in a table format, the subsequent value sends the result values that you see in order. Response Processing generates a message in a format that responds to the user via the Outgoing Adaptor and Messenger API.

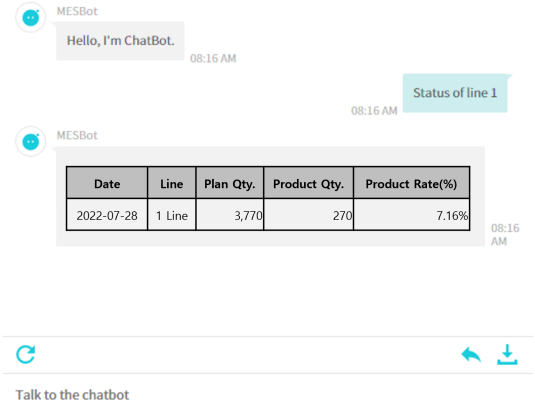

Fig. 3: Massage of Production Progress

Figure 3 received a message of line status, one of the intentions registered in Chatbot, through messenger to check the production progress of line 1. You have not specified a date, so you have received a production status of 1 line on the day you sent the message.

Figure 4 is a simple RPA that is set to communicate the intent of the 2-line defect status to the messenger.

Figure 5 is the result of experimenting with a message to check the bad status of the 2 line. I sent a message to Chatbot according to the intention of the defect status for each registered line and received the result of the defect status on the day of inquiry of the 2nd line through RPA.

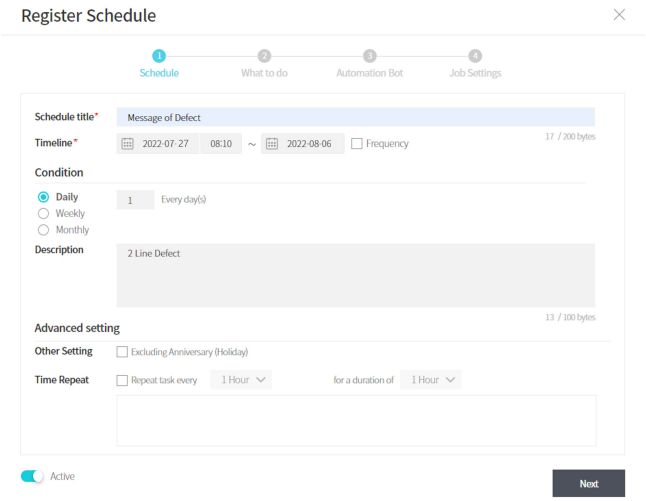

Fig. 4: Scheduling of Defect

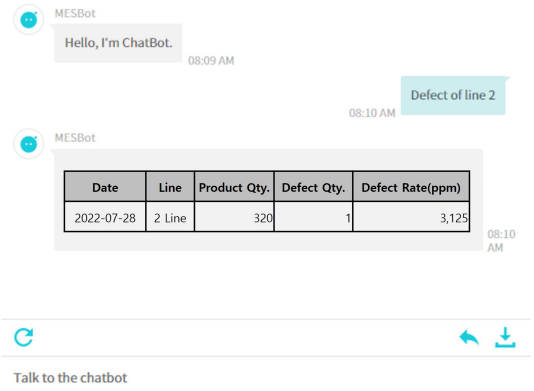

Fig. 5: Massage of Defect

Through the results of the experiment, I was able to quickly and easily receive the data of the designated intention through Chatbot RPA using messenger. Applying RPA to messenger has four advantages. First, there is a low dependence on the type of device. The form of messenger exists everywhere in the form of a PC or mobile. Even now, wearable devices can also function as messengers. The advantage is that authorized users can receive MES information from anywhere. You can receive information from anywhere in the factory or outside the factory. Second, it has the advantage of being able to access multiple messengers and multiple legacy systems by adding APIs to Messenger I/F Layer and API Gateway Layer in the architecture. Third, there is no need for equipment redevelopment. In the past, the development of the same screen was different due to the size of the device in the MES system, so the development of the PC version and the mobile version were renewed. However, there is no need to develop new information through messenger because the layout of messenger is the same regardless of device. Fourth, you don't have to perform many steps to access the system screen for information inquiry, and you don't have to display standardized data that you don't need.

5. Conclusions

In this study, we proposed an architecture of ChatMES that allows complex messengers to query and process information from manufacturing sites in a simple and efficient manner. We presented the architecture to connect messenger and MES system and considered the management aspect to efficiently manage Chatbot. This architecture is highly scalable with an architecture that considers connecting any variety of messengers to any variety of legacy systems. In addition, the MES characteristics are directly related to the manufacturing site, so we designed the intent to reduce the load and implemented an architecture that can be performed according to the designated intent. There have been fewer studies using chatbots in closed manufacturing systems than in other fields. I hope that this study will help to further activate the use of chatbots using RPA in the manufacturing site.

Future research needs to be done on natural language. There are difficulties in management because we made movements according to the exact intentions. Research on natural language is needed to enable interaction, and we will conduct research so that the standardized screen of MES can be reduced and the UI of MES can be portalized.

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References

[1] T. -Y. Chen, Y. -C. Chiu, N. Bi and R. T. -H. Tsai, "Multi-Modal Chatbot in Intelligent Manufacturing," in IEEE Access, vol. 9, pp. 82118-82129, 2021, Available: https://doi.org/10.1109/ACCESS.2021.3083518

[2] H. Chen, X. Liu, D. Yin and J. Tang, "A survey on dialogue systems: Recent advances and new frontiers", ACM SIGKDD Explor. Newslett., vol. 19, no. 2, pp. 25-35, Nov. 2017. Available: https://doi.org/10.1145/3166054.3166058

[3] B. Nardi, S. Whittaker and E. Bradner, "Interaction and Outeraction: Instant Messaging in Action", Proc. of the 3rd CSCW Conference, pp. 79-88, 2000. Available: https://doi.org/10.1145/358916.358975

[4] L. Klopfenstein, S. Delpriori, S. Malatini and A. Bogliolo, "The Rise of Bots: a Survey of Conversational Interfaces Patterns and Paradigms", Proc. of the 12th DIS Conference, pp. 555-565, 2017. Available: https://doi.org/10.1145/3064663.3064672

[5] The Road to Enterprise AI, RAGE Frameworks, 2017.

[6] Lacity, Mary C., and Leslie P. Willcocks. "A new approach to automating services." MIT Sloan Man-

agement Review 58.1 (2016): 41-49. Available: http://eprints.lse.ac.uk/id/eprint/68135

[7] Klaus-Dieter Thoben, Stefan Wiesner, and Thorsten Wuest, ""Industrie 4.0" and Smart Manufacturing – A Review of Research Issues and Application Examples," Int. J. Automation Technol., Vol.11, No.1, pp. 4-16, 2017 Available: https://doi.org/10.20965/ijat.2017.p0004

[8] Martin, Bradley, et al. "A strategic assessment of the future of us navy ship maintenance: challenges and opportunities." (2017). Available: https://apps.dtic.mil/sti/citations/AD1085610

[9] Osterrieder, P.; Budde, L.; Friedli, T. The smart factory as a key construct of industry 4.0: A systematic literature review. Int. J. Prod. Econ. 2020, 221, 107476. Available: https://doi.org/10.1016/j.ijpe.2019.08.011

[10] Sjödin, D.R.; Parida, V.; Leksell, M.; Petrovic, A. Smart Factory Implementation and Process Innovation: A Preliminary Maturity Model for Leveraging Digitalization in Manufacturing Moving to smart factories presents specific challenges that can be addressed through a structured approach focused on people, processes, and technologies. Res. Technol. Manag. 2018, 61, 22–31. Available: https://doi.org/10.1080/08956308.2018.1471277

[11] Wang, B.; Tao, F.; Fang, X.; Liu, C.; Liu, Y.; Freiheit, T. Smart Manufacturing and Intelligent Manufacturing: A Comparative Review. Engineering 2021, 7, 738–757. Available: https://doi.org/10.1016/j.eng.2020.07.017

[12] Mittal, S.; Khan, M.A.; Romero, D.; Wuest, T. Smart manufacturing: Characteristics, technologies and enabling factors. Proc. Inst. Mech. Eng. Part B J. Eng. Manuf. 2019, 233, 1342–1361. Available: https://doi.org/10.1177/0954405417736547

[13] Zhong, R.Y.; Xu, X.; Klotz, E.; Newman, S.T. Intelligent Manufacturing in the Context of Industry 4.0: A Review. Engineering 2017, 3, 616–630. Available: https://doi.org/10.1016/J.ENG.2017.05.015

[14] J. Wan, M. Yi, D. Li, C. Zhang, S. Wang and K. Zhou, "Mobile Services for Customization Manufacturing Systems: An Example of Industry 4.0," in IEEE Access, vol. 4, pp. Available: 8977-8986, 2016,doi:10.1109/ACCESS.2016.2631152.

[15] Noguera-Arnaldos, J.Á., Paredes-Valverde, M.A., Salas-Zárate, M.P., Rodríguez-García, M.Á., Valencia-García, R., Ochoa, J.L.: im4Things: an ontology-based natural language interface for controlling devices in the Internet of Things. In: Alor-Hernández, G., Valencia-García, R. (eds.) Current Trends on Knowledge-Based Systems, vol. 120, pp. 3–22. Springer, Cham (2017). Available: https://doi.org/10.1007/978-3-319-51905-0_1

[16] Nwana, Hyacinth S. "Software agents: An overview." The knowledge engineering review 11.3 (1996): 205-244. Available: https://doi.org/10.1017/S026988890000789X

[17] Huang, Jizhou, Ming Zhou, and Dan Yang. "Extracting Chatbot Knowledge from Online Discussion Forums." IJCAI. Vol. 7. 2007.

[18] "UIPath vs Automation Anywhere-Blue Prism", UiPath Community Forum - Robotic Process Automation, 2017, [online] Available: https://forum.uipath.com/t/uipath-vs-automationanywhere-blue-prism/5305

[19] M. Lacity, Robotic Process Automation: The Next Transformation Lever for Shared Services. Curators' Professor, College of Business University of Missouri-St. Louis, 2018.

[20] Jalonen, Helge. "Assessing robotic process automation potential." Tampere University of Technology (2017).

[21] Aguirre, S., Rodriguez, A. (2017). Automation of a Business Process Using Robotic Process Automation (RPA): A Case Study. In: Figueroa-García, J., López-Santana, E., Villa-Ramírez, J., Ferro-Escobar, R. (eds) Applied Computer Sciences in Engineering. WEA 2017. Communications in Computer and Information Science, vol 742. Springer, Cham. Available: https://doi.org/10.1007/978-3-319-66963-2_7

[22] S. Chen, B. Mulgrew, and P. M. Grant, "A clustering technique for Y. Rizk, V. Isahagian, S. Boag, Y. Khazaeni, M. Unuvar, V. Muthusamy, et al., "A conversational digital assistant for intelligent process automation", Proc. Int. Conf. Bus. Process Manage., pp. 85-100, 2020. Available: https://doi.org/10.1007/978-3-030-58779-6_6

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