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Performance Investigation of Software Agents in Artificial Intelligence and Document Object Model Domain

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ABSTRACT

Assessing the performance impact of Artificial Intelligence on questionnaires of pharmacological unit is necessary from the perspective of medical practitioners as well as patient's perspectives. The proposed study ascertained that software agents based on Artificial Intelligence and Document Object Model domain can deliver better service in medical units in contrast to its other deployment methodologies. So, the proposed work, a prototype is developed by using dialog control class file which accesses the system resources through the kernel objects. We call the software agent as MBot (prototype bot for medical unit). The prototype is deployed for pharmacological unit where the clinical instruction against the disease can be suggested. The experimental arrangement, deployment architecture of MBot, performance metrics and the statistical analysis for the observed data sample are discussed here. The novelty of the proposed work highlights the performance aspects of MBot against its counterpart. It reveals that better response time and validates that the dialog controller class of MBot can process questionnaires through its intelligence.

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1. INTRODUCTION

Artificial Intelligence (AI) is a technical tool that provides highly customized user experience with organizational units. With the rapid increase of users demand and problems, the capabilities of learning, increasing responsiveness of a service unit and solving issues of end users is gaining more attention in the community of scientific group and generic people. Among different applications, the Bot acts as software agent for performing automated job role. Bot is defined as a computer program that replies messages, performs task against command with minimal intervention of human being. It can eliminate the repetitive manual task and can support self-service capabilities. It can be programmed to simulate the behaviour of human activity. The Chatbot is the part of Bots that can be deployed for messaging purpose. The primary role of Chatbot is to establish communication with the human and perform the conversation for the specific query [1]. It is desirable that information can be accessed easily by human being. In such cases, the messaging platform can become flexible and convenient platform for day to day communication among people [2]. With the rapid growth of Chatbot requirement, developing and implementing conversation friendly user interface has become an essential commodity for the digital service. The user wants the Chatbot as like it works like human chatting [3]. In the digital market, the dependency over Chatbot for dealing with any issues faced by human being is increasing gradually. However, as the demand of deploying Chatbot increases, the process of evaluating the performance of Chatbot for the specific service has become a concern of many researchers, service users and entrepreneurs [4] [5]. The identification of performance metrics and finding the correlation among them can act as a performance toolset for the Chatbot [6]. As such, the identification of comprehensive set of metrics can become the candidature for the performance evaluation of Chatbot. In the proposed work, a novel methodology is proposed by using AI and document object model (DOM) principle for deploying Chatbot. The prototype is deployed for pharmacological and medical unit where the clinical instruction against the disease can be suggested to end user. We call it as MBot (Bot for Medical Instruction). The MBot is designed to experience the self-service for different clinical instruction. Here, the end user can feel the environment of pharmacological or medical unit over internet in the domain of AI. The performance of Chatbot model is evaluated through statistical analysis to establish the viability of the deployment.

The ability of end users of any system to make necessary questions, such as: (i) what is the medicine for Acne ? (ii) How to take the medicine for conjunctivitis ? etc., can lead to critical aspects of system integration and outcomes [7-10]. Many researchers discussed the importance of deploying intelligent based Chatbot for different domain [11-15]. Harper et al. (2003) proposed a model by using Chatbot for raising queries with improved problem solving issues [16]. Brandtzaeg et al. (2017) discussed the issues of deployment of Chatbot in the sector of banking, e-commerece, business, education as a deployment tool for support and enhancement of the service [17]. Verleger et al. (2018) proposed a novel methodology for deployment of intelligent interface for computer programming courses. The worthiness of the system was evaluated through false-positive response [18]. Rajkumar et al. (2020) proposed a methodology to correlate different learning styles through a set of questioners. The accuracy of classification for different E-learning modules can be accessed through evaluation methodology through the proposed Chatbot model [19]. Ren et al. (2020) proposed a methodology for physicians who can deploy conversational interface Chatbot for health consultations. The proactive Chatbot was evaluated through quantitative analysis [20]. Zhang et al. (2020) introduced a novel model for retrieval of polished response on a large scale data set for human robot dialog. The authors have also proposed a future work on removing irrelevant information from the domain [21]. Ait-Mlouk et al. (2020) had proposed a novel architecture for user interface called KBot. The Chatbot provides a platform for accessing information by using linked data. A machine learning module was also introduced to understand user intents and queries [22]. Daniel et al. (2020) had proposed a novel framework, called Xatkit to define voice Bot and Bot in general. They also highlighted the importance of deep learning for a specific targeted domain [23]. Bora et al. (2020) discussed a novel deployment methodology for implementation of software as a service (SaaS) for disease processing system. The study reveals that in multi tenant environment, the evaluation of failure rate is important as it can impact the overall performance of a system [24][25]. Martins et al. (2021) proposed a novel method of Chatbot that can be deployed for virtual learning environment. The assessment of such deployment was evaluated through pattern behavior and identification of performance measurement [26]. Daniel et al. (2021) had discussed the challenges of software modules for implementation of smart Chatbot. The requirement of expertise in high quality technical domain and their impact while developing complex Chatbot was also discussed in [27]. Chen et al. (2021) had emphasized the deployment of Chatbot for manufacturing industries. A novel Chatbot was designed to help users to complete a task that simulates the behaviors of manufacturing settings [28]. Abdulelah et al. (2021) discussed the deployment methodology by using deep learning for human health management system [29]. Altayeb et al. (2021) proposed a novel voice control system for service delivery to end user. However, no research group had carried out any study to highlight the performance metrics of service execution that can mimic the real world scenario as in [30].

The uniqueness of MBot is in contrast to Chatbot as discussed earlier is observed in the deployment methodology by using AI and DOM domain. The features of AI markup language are used to develop the intelligence. The novelty of the proposed work highlights the performance aspects of MBot against its counterpart. A novel prototype software agent is prepared by using a dialog controller class file that generates the kernel object for accessing the system resources. Here, a novel methodology is also introduced to study the performance of MBot for interactive user communication in the domain of AI and DOM processing.

2. RESEARCH METHOD

The MBot is deployed in a system having specifications: 4 GB RAM, 64 bit Microsoft Windows 10 Professional Operating System, Intel(R) Core(TM) i3 2GHz processor with 1 TB hard drive. The MBot is developed by using Python programming language (Version 3.7). The intelligence is developed by using AI Markup Language (AIML). The size of the intelligence is kept at 3 KB for the experimental purpose. Both MBot and the AIML file are kept in the same system. The end user hits the MBot and gets the user interface for entering the query. The request is generated for information and sent to AIML engine for generating the response from the intelligent set. The response is processed by the MBot and given to the end user. The deployment architecture of MBot is shown in Figure 1.

A test case is designed with the objective to perform action with the expected response to be achieved. The test case is used to generate the data sample of the performance metrics while using MBot. The test case includes the steps are as follows: (a) Open the user interface of MBot, (b) Prompt the user to enter a disease name, (c) Type a disease name and hit enter, and (d) Get valid response from MBot.

The test case takes a disease name as a keyword. In this case, the end user hits the keyword “Fever”. The pharmacological response is generated by the MBot through its intelligence. The test case is designed to generate a data collection set to capture the data of processor time (PT) and disk response time (DRT) of MBot. Microsoft Corporation’s Performance Monitor (Version 10.0.10011) is configured to execute the test cases [31].

To validate the data sample as generated by the test cases, the data sample is evaluated through statistical analysis by using linear trend line, correlation, histogram, normal probability plot (NPP), descriptive analysis, Chi - Square test (x^2) of Goodness of Fit (GoF). The performance of the MBot is observed on real time basis. The data sample is taken while executing the MBot as per query generated by users.

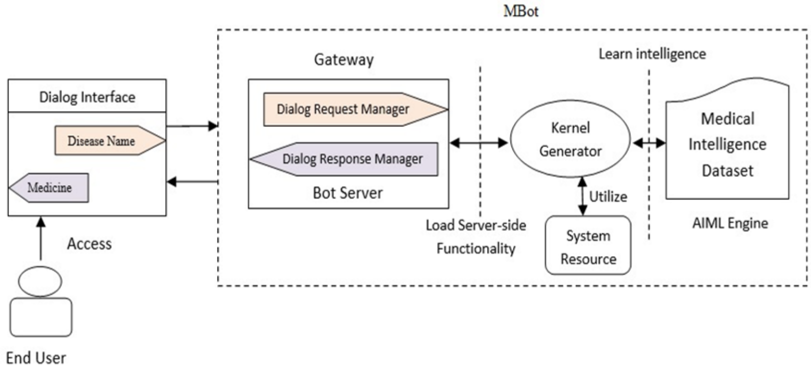

Figure 1. The deployment architecture of MBot

Figure 2 shows the performance of the system while executing the MBot with AIML engine. The minimum, maximum and average PT is observed to be 1.34, 21.09 and 6.81 msec, respectively. Figure 3 shows the performance of the system without executing the MBot with AIML engine. The minimum, maximum and average PT is observed to be 1.17, 15.64 and 4.33 msec, respectively. It is observed that the execution of MBot impacts the system resources. A data sample of 50 records is taken to study the PT and DRT nature over execution of MBot. The linear trend line of PT and DRT of MBot is observed and found to be linear at 95% confidence level.The significance of PT and DRT is evaluated through R2. It is 82.7% and 91.4% for PT and DRT, respectively. The results are shown in Figure 4 and Figure 5, respectively. The correlation of DRT and PT is evaluated through linear regression analysis.The correlation of PT and DRT is evaluated through R^2. It is 91.6%. As such, it can be concluded the the PT and DRT metrics of MBot is strongly correlated. Figure 6 shows the correlation of PT and DRT while executing the MBot with AIML engine. The statistical analysis is carried out for the data sample of PT and DRT of MBot at 99% confidence level. The results of the analysis by considering mean ($\overline{m}$), median (M_d), Standard Deviation (S_d), minimum (M_n), maximum (M_x) are shown in Table 1.

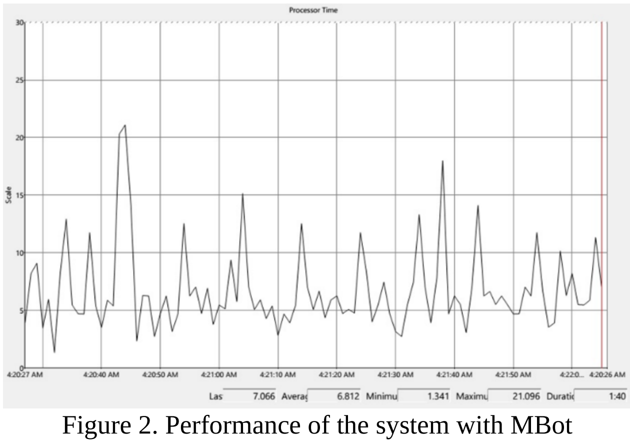

Figure 2. Performance of the system with MBot

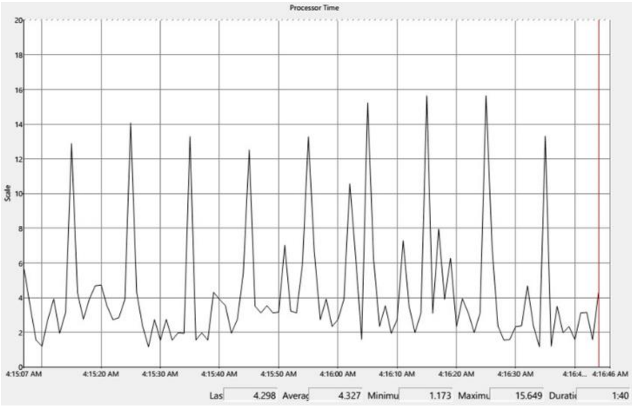

Figure 3. Performance of the system without MBot

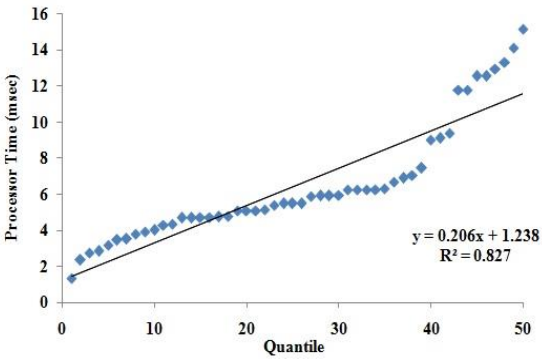

Figure 4. Linear trend line of PT for MBot

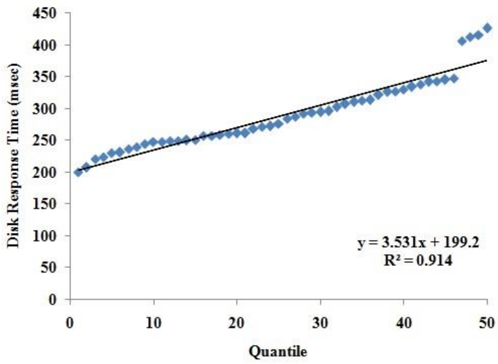

Figure 5. Linear trend line of DRT for MBot

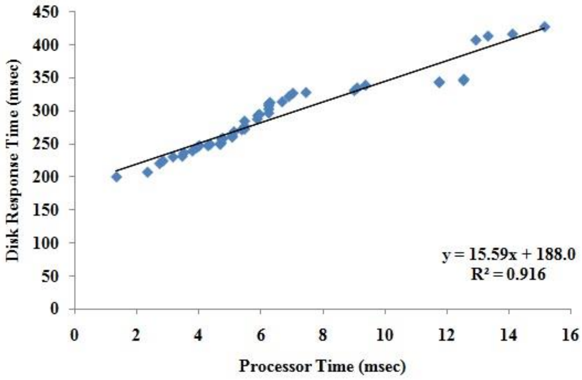

Figure 6. Correlation and linear trend line of PT and DRT of MBot

The histogram of PT and DRT is shown in Figure 7 and 8, respectively. In both histograms, single peak bin is observed. For PT histogram, the highest data points falls in the range of 3.31 to 5.28. For DRT histogram, the highest data points falls in the range of 232.28 to 264.57. Table 2 and 3 shows the bin frequencies of PT and DRT for both the histogram.The test of normality is observed through visual interpretation of NPP. The NPP of PT and DRT is shown in Figure 9 and Figure 10, respectively. The visual interpretation reveals that the recorded data points of PT and DRT are normal in distribution.The GoF for the recorded data points and the validation of the hypothesis are evaluated by using Chi - Square test through p-value. The p-value validates the probability of obtaining observed results, if the null hypothesis is true [32]. The statistical measurement is evaluated at 95% confidence level for PT and DRT, respectively. It is shown in Table 4. The null hypothesis is assumed that the data samples fit the normal distribution and follows the properties of the recorded population. Since the p-value is less than 0.05, we accept the null hypothesis. As such, higher the significance of the valid recorded data sample. That means we have enough evidences to conclude that the distribution of frequencies in the bins is from the distribution of the normally distributed data sample.

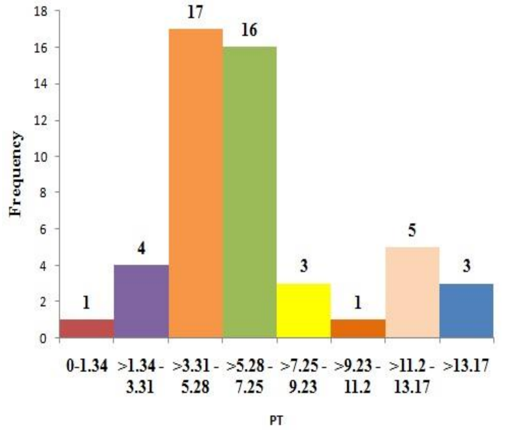

Figure 7. Histogram of PT and their frequencies

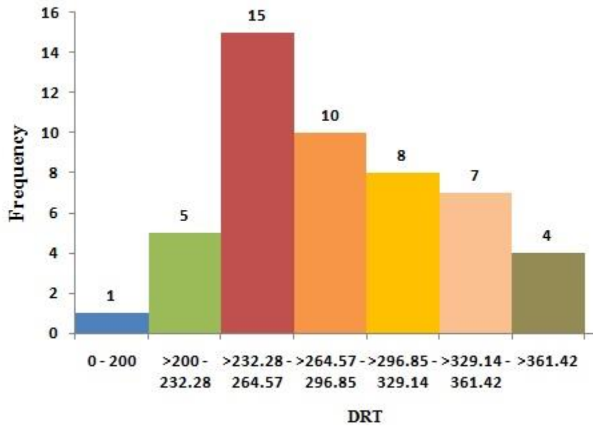

Figure 8. Histogram of DRT and their frequencies

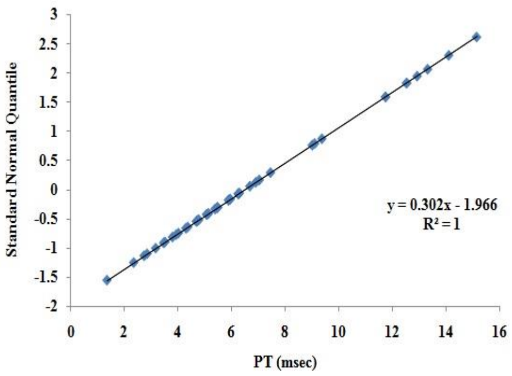

Figure 9. NPP of PT

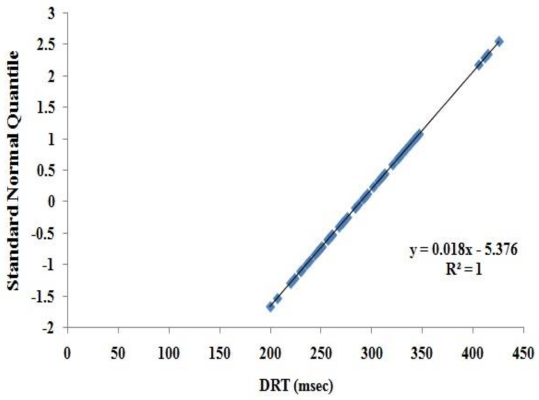

Figure 10. NPP of DRT

Table 1. Statistical analysis of PT and DRT of MBot

Parameter	$\bar{m}$	M_d	S_d	M_n	M_x
PT	6.49	5.47	3.3	1.34	15.15
DRT	289	280	53.82	200	426

Table 2. Bin frequency of PT histogram

Bin	Frequency
0-1.34	1
>1.34 - 3.31	4
>3.31 - 5.28	17
>5.28 - 7.25	16
>7.25 - 9.23	3
>9.23 - 11.2	1
>11.2 - 13.17	5
>13.17	3

Table 3. Bin frequency of DRT histogram

Bin	Frequency
0 - 200	1
>200 - 232.28	5
>232.28 - 264.57	15
>264.57 - 296.85	10
>296.85 - 329.14	8
>329.14 - 361.42	7
>361.42	4

Table 4. Statistical measurement of GoF against the data sample of PT and DRT.

Parameter	x^2	p-value	*Degree of Freedom*	*Corresponding Chi Critical Value*
PT	46.96	0.0000000568	7	14.067
DRT	20.55	0.0022	6	12.592

3. RESULTS AND DISCUSSION

The objective of the proposed investigation is to observe the performance of MBot by using AI and DOM process. The performance of the model is observed in real time. The linearity of recorded data sample is observed. The recorded data sample for PT and DRT is normal in nature. Strong correlation of PT and DRT is also observed. The normal distribution of recorded performance metrics is observed and significant at 95% confidence level. It follows the recorded performance of the population. The R^2 is 82.7% and 91.4% for PT and DRT respectively. The histograms of PT and DRT have single peak bin. For the histogram of PT, the highest data points of 17 counts are in the range of 5.28 to 7.25. For the histogram of DRT, the highest data points of 15 counts are in the range of 232.28 to 264.57. The correlation of PT and DRT is observed to be strong at 91.6%. The NPP of PT and DRT shows the normal distribution of the recorded data sample. The GoF of PT and DRT is evaluated through x^2 test. It accepts the hypothesis that the data sample follows the recorded population of MBot. It means that the applicability of MBot is observed. A comparative evaluation of MBot deployment with deployment methodology as proposed by other research group is given in Table 5.

Table 5. A comparative evaluation of the proposed work with other deployment methodology as proposed by other authors.

Parameter	Proposed work	Kalita et al. (2011) [33]	Medhi et al. (2014) [34]	Saddik et al. (2006) [35]	Bezboruah et al. (2015) [36]
DRT	289 msec	52.4 sec	37.011 sec	Test not carried out	11.69 sec
Response Failure	Not occured	Occured	Occured	Occured	Occured
Reliability	Strong	Poor	Poor	Poor	Poor

The DRT of the proposed work is compared with the performance metric of the different deployment methodology as proposed by other research group. In case of Kalita et al., Medhi et al., Saddik et al., Bezboruah et al., the DRT is 52.4 sec, 37.011 sec and 11.69 sec, respectively. It is comparatively higher than the proposed work. As in case of MBot execution, it is recorded to be 289 msec. Failure rate is an important key metric for evaluation of reliability as it can impact the overall performance of the system. However, in case of proposed work, there is no occurrence of response failure of service. As such, it can be concluded that the system is strongly reliabe. On the contrary, for other deployment methodology as proposed by other research group, the occurrence of failure in response is observed. As such, poor reliability was observed for other group of authors. From the overall evaluation of MBot execution, it can be concluded that the proposed deployment methodology is stable, reliable and better than other deployment methodologies as proposed by other research groups.

4. CONCLUSION

A novel deployment methodology is proposed through MBot integrating AI and DOM processing. The validation of the recorded data sample is evaluated through statistical analysis at 99% confidence level. The $\bar{m}$, S_d, M_d, M_n, M_x for PT is recorded to be 6.49, 3.3, 5.47, 1.34 and 15.15 msec, respectively. The $\bar{m}$, S_d, M_d, M_n, M_x for DRT is recorded to be 289, 53.82, 280, 200 and 426 msec, respectively. So, we can conclude that the recorded metrics of MBot follows the mean. The histogram, NPP and x^2 GoF for PT and DRT is observed and found to be normalyl distributed. It is also observed that the DRT and PT are strongly correlated. The DRT increases proportionally with the increase in PT. From the overall evaluation of the proposed MBot, it can be concluded that, the proposed methodology with the integration of AI and DOM processing is applicable, valid and stable. So, we can also conclude that the kernel object and dialog control manager of MBot can support the demands of questioners through its intelligence. From the comparative assessment of the proposed work with methodology as proposed by other research groups, it can be concluded that, proposed methodology is better than other methodology that are primarily followed for service execution. However, the size of the intelligence is kept smaller in the proposed work to reduce the overhead of intelligence processing. As part of future work, we proposed to study the deployment of MBot against different sizes of the intelligence.

REFERENCES

[1] Ramos, C., Augusto, J. C., Shapiro, D. Ambient intelligence - The next step for articial intelligence, *IEEE Intell. Syst.*,(2008), 23(2) : 5-18.
[2] Schumaker, R. P., Chen, H. Interaction analysis of the ALICE chatterbot: A two-study investigation of dialog and domain questioning, *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans*, (2010); 40(1): 40-51.
[3] Ren, X., Yu, B., Lu, Y., Chen, Y., Pu, P. HealthSit: Designing posturebased interaction to promote exercise during tness breaks, *Int. J. Hum. Comput. Interact.*,(2019); 35(10): 870-885.
[4] Palanica, A., Flaschner, P., Thommandram, A., Li, M., Fossat, Y. `Physicians' perceptions of chatbots in health care: Cross-sectional web-based survey, *J. Med. Internet Res.*,(2019); 21(4) e12887. https://doi.org/10.2196/12887
[5] Powell, J. Trust me, I'm a chatbot: How articial intelligence in health care fails the turing test, *J. Med. Internet Res.*,(2019); 21(10).
[6] Ilgaz, H., Altun, A., Akar, P. The effect of sustained attention level and contextual cueing on implicit memory performance for e-learning environments, *Comput. Hum. Behav.*,(2014); 39:1-7.
[7] Shodell, M.. The question-driven classroom: student questions as course curriculum inbiology. *The American Biology Teacher*, (1995); 57(5): 278-281.
[8] Rezaee, M. S., Haeri, A., Noori, S. Automotive Vendor's Performance Evaluation and Improvement Plan Presentation by Using a Data Envelopment Analysis. *International Journal of Engineering, Transactions B: Applications*, 2018; 31(2): 374-381, DOI: https://doi.org/10.5829/ije.2018.31.02b.23
[9] Mokhtari, H., Noroozi, A., Molla-Alizadeh-Zavardehi, S. A Reliability based Modelling and Optimization of an Integrated Production and Preventive Maintenance Activities in Flowshop Scheduling Problem. *International Journal of Engineering, Transactions C: Aspects*, 2015; 28(12): 1774-1781, DOI: https://doi.org/10.5829/idosi.ije.2015.28.12c.10
[10] Bhardwaj, C., Jain, S., Sood, M. Automatic Blood Vessel Extraction of Fundus Images Employing Fuzzy Approach, *Indonesian Journal of Electrical Engineering and Informatics (IJEEI)*, (2019); 7(4):757-771, DOI: 10.11591/ijeei.v7i4.991
[11] Hutchinson, H., Hansen, H., Roussel, N., Eiderbäck, B., Mackay, W., Westerlund, B., Bederson, B. B., Druin, A., Plaisant, C., BeaudouinLafon, M., Conversy, S., Evans, H. *Technology probes: Inspiring design for and with families*, in Proc. Conf. Hum. Factors Comput. Syst. (CHI), (2003);17-24.
[12] Chiuchisan, I., Geman, O. An approach of a decision support and home monitoring system for patients with neurological disorders using Internet of Things concepts, *WSEAS Trans. Syst.*,(2014); 13(1):460-469.
[13] Fakeeh, K. A. Developing virtual class room models with bio inspired algorithms for E-learning: A survey for higher technical education for Saudi arabia vision 2030, Int. J. Appl. Inf. Syst., (2017); 12(8):8-21.
[14] Wu, Y., Wu, W., Xing, C., Zhou, M., Li, Z. *Sequential matching network: A new architecture for multi-turn response selection in retrievalbased chatbots*, in Proc. 55th Annu. Meeting Assoc. Comput. Linguistics, (2017); 496-505.
[15] Jamshidi, R. Bi-level Model for Reliability based Maintenance and Job Scheduling. *International Journal of Engineering, Transactions C: Aspects*, 2018; 31(3): 432-439, DOI: https://doi.org/10.5829/ije.2018.31.03c.05
[16] Harper, K. A., Etkina, E., Lin, Y. Encouraging and analyzing student questions in a large physics course: Meaningful patterns for instructors. *Journal of Research in Science Teaching*, 2003; 40(8), 776-791.
[17] Brandtzaeg, P. B., & Følstad, A. *Why people use chatbots*, In Proc. of International Conference on Internet Science, (2017); 377-392.
[18] Verleger, M., Pembridge, J. A Pilot Study Integrating an AI-driven Chatbot in an Introductory Programming Course, *IEEE Frontiers in Education Conference (FIE)*, (2018); 1-4, DOI: 10.1109/FIE.2018.8659282.
[19] Rajkumar, R. Ganapathy, V. Bio-Inspiring Learning Style Chatbot Inventory Using Brain Computing Interface to Increase the Efficiency of E-Learning, *IEEE Access*, (2020); 8: 67377-67395, DOI: 10.1109/ACCESS.2020.2984591.

[20] Ren, X., Spina, G., De Vries, S., Bijkerk, A. , Faber, B., Geraedts, A. Understanding Physician's Experience With Conversational Interfaces During Occupational Health Consultation, *IEEE Access*, (2020); 8: 119158-119169, DOI: 10.1109/ACCESS.2020.3005733.

[21] Zhang, L., Yang, Y., Zhou, J., Chen, C. , He, L. Retrieval-Polished Response Generation for Chatbot, *IEEE Access*, (2020), 8: 123882-123890, DOI: 10.1109/ACCESS.2020.3004152

[22] Ait-Mlouk, A., Jiang, L. KBot: A Knowledge Graph Based ChatBot for Natural Language Understanding Over Linked Data, *IEEE Access*, (2020); 8:149220-149230, DOI: 10.1109/ACCESS.2020.3016142.

[23] Daniel, G., Cabot, J., Deruelle, L., Derras, M. Xatkit: A Multimodal Low-Code Chatbot Development Framework, *IEEE Access*, (2020); 8:15332-15346, DOI: 10.1109/ACCESS.2020.2966919

[24] Bora, A., Bezboruah, T. Evaluating the Reliability of PwCOV: A Loosely Coupled Software as a Service for COVID-19 Data Processing System, *International Journal of Engineering, Transactions C: Aspects*, 2020; 33(12) : 2496-2502.

[25] Bora, A., Bezboruah, T. Investigation on reliability estimation of loosely coupled software as a service execution using clustered and non-clustered web server. *International Journal of Engineering, Transactions A: Basics*, 2020; 33(1) : 75-81, DOI: https://doi.org/10.5829/ije.2020.33.01a.09

[26] Lidia Martins da Silva, Lucas Pfeiffer Salomão Dias, Sandro Rigo, Jorge Luis Victória Barbosa, Daiana R. F. Leithardt, Valderi Reis Quietinho Leithardt, A Literature Review on Intelligent Services Applied to Distance Learning, *Education Sciences*, (2021); 11(666), DOI:https://doi.org/10.3390/educsci11110666.

[27] Daniel, G., Cabot, J. *The Software Challenges of Building Smart Chatbots*, IEEE/ACM 43rd International Conference on Software Engineering: Companion Proceedings (ICSE-Companion), (2021), 324-325, DOI: 10.1109/ICSE-Companion52605.2021.00138.

[28] Chen, T. Y., Chiu, Y. C., Bi, N., Tsai, R.T.H. Multi-Modal Chatbot in Intelligent Manufacturing, *IEEE Access*, (2021); 9: 82118-82129, DOI: 10.1109/ACCESS.2021.3083518.

[29] Abdulelah, A.J., Al-Kubaisi, M., Shentaf, A.M. An Efficient Human Activity Recognition Model Based on Deep Learning Approaches, *Indonesian Journal of Electrical Engineering and Informatics (IJEEI)*, (2022); 10(1):177-186, DOI: 10.52549/ijeei.v10i1.3438

[30] Altayeb, M., Al-Ghraibah, A., Voice controlled Camera Assisted Pick and Place Robot Using Raspberry Pi, *Indonesian Journal of Electrical Engineering and Informatics (IJEEI)*, (2022); 10(1):51-59, DOI: 10.52549/ijeei.v10i1.3636

[31] Perforamnce Monitor (2022). Retrieve on 8 July , 2022 from, https://en.wikipedia.org/wiki/Performance_Monitor

[32] P-value analysis (2022). Retrieve on 6 July , 2022 from, https://www.investopedia.com/terms/p/p-value.asp

[33] Kalita, M., & Bezboruah, T. Investigation on performance testing and evaluation of PReWebD: A. NET technique for implementing web application. *IET Software*, (2011); *5*(4), 357–365. DOI:10.1049/ietsen.2010.0139

[34] Medhi, S., & Bezboruah, T. Investigations on implementation of e-ATM Web Services based on. NET technique. *International Journal of Information Retrieval Research*, (2014); *4*(2), 42–51

[35] Saddik, A. E. Performance measurement of Web Service based application. *IEEE Transactions on Instrumentation and Measurement*, (2006); *55*(5), 1599–1605. DOI:10.1109/TIM.2006.880288

[36] Bezboruah, T. & Bora, A. Performance Evaluation of Hierarchical SOAP Based Web Service in Load Balancing Cluster-Based and Non-Cluster-Based Web Server, *International Journal of Information Retrieval Research*, (2015); 5(4),20-31, DOI: 10.4018/IJIRR.2015100102