# An Educational Chatbot Using AI in Radiotherapy

Authors:

Kartik Kumar , Khushi Sharma , Anand Sharma

Guide Prof. Badal Bhushan

Assistant Professor, Department of CSE

**Department Of Computer Science and Engineering**

**IIMT College Of Engineering**

**Chapter : 1**

**Abstract:**

Context: The surge in demand for information in cancer centers and hospitals, particularly during the pandemic, overwhelmed the limited manpower available. To address this challenge, there arose a need to develop an educational chatbot tailored for diverse user groups in the field of radiotherapy, including patients and their families, the general public, and radiation staff. Objective: In response to the pressing clinical demands, the primary aim of this endeavor is to delve into the intricacies of designing an educational chatbot for radiotherapy using artificial intelligence.Methods: The chatbot is meticulously crafted using a dialogue tree and layered structure, seamlessly integrated with artificial intelligence functionalities, notably natural language processing (NLP). This adaptable chatbot can be deployed across various platforms, such as IBM Watson Assistant, and embedded in websites or diverse social media channels.Results: Employing a question-and-answer methodology, the chatbot adeptly engages users seeking information on radiotherapy, presenting an approachable and reassuring interface. Recognizing that users, often anxious, may struggle to articulate precise questions, the chatbot facilitates the interaction by offering a curated list of questions. The NLP system augments the chatbot's ability to discern user intent, ensuring the provision of accurate and targeted responses. Notably, the study reveals that functional features, including mathematical operations, are preferred in educational chatbots, necessitating routine updates to furnish fresh content and features.Conclusions: The study culminates in the affirmation that leveraging artificial intelligence facilitates the creation of an educational chatbot capable of disseminating information to users with diverse backgrounds in radiotherapy. Furthermore, the importance of rigorous testing and evaluation, informed by user feedback, is emphasized to iteratively enhance and refine the chatbot's performance.

Keywords: AI, machine learning, NLP, chatbot, radiotherapy, IoT, healthcare.

## Chapter : 2

### Motivation :

In the dynamic landscape of healthcare, particularly in the domain of cancer treatment, the emergence of the COVID-19 pandemic has amplified the challenges faced by cancer centers and hospitals worldwide. The convergence of increased demand for information and the constraints imposed by limited manpower has underscored the urgent necessity for innovative solutions to bridge the existing information gap. At this critical intersection of healthcare and technology, the development of an educational chatbot emerges as a timely and indispensable response to this pressing issue.

Unmet Information Needs during the Pandemic:

The COVID-19 pandemic has imposed unprecedented strain on healthcare systems globally, profoundly impacting cancer patients and their families. Facing a myriad of questions and concerns, often compounded by fears and uncertainties, these individuals have found themselves navigating through uncharted territories, seeking reliable information and guidance amidst the chaos. However, the constraints imposed by the pandemic, including limitations on in-person interactions and the redistribution of healthcare resources, have rendered it increasingly challenging for healthcare providers to comprehensively address the informational needs of cancer patients and their support networks.

The Role of Technology in Addressing Information Gaps:

Against this backdrop, the pivotal role of technology in healthcare innovation becomes increasingly evident. Leveraging the power of artificial intelligence (AI) and natural language processing (NLP), an educational chatbot presents itself as a promising solution to the prevailing information deficit. By offering a user-friendly interface accessible via digital platforms, such as websites or mobile applications, a chatbot can provide timely and accurate information tailored to the specific needs and preferences of various user groups, including patients, families, the general public, and radiation therapy staff.

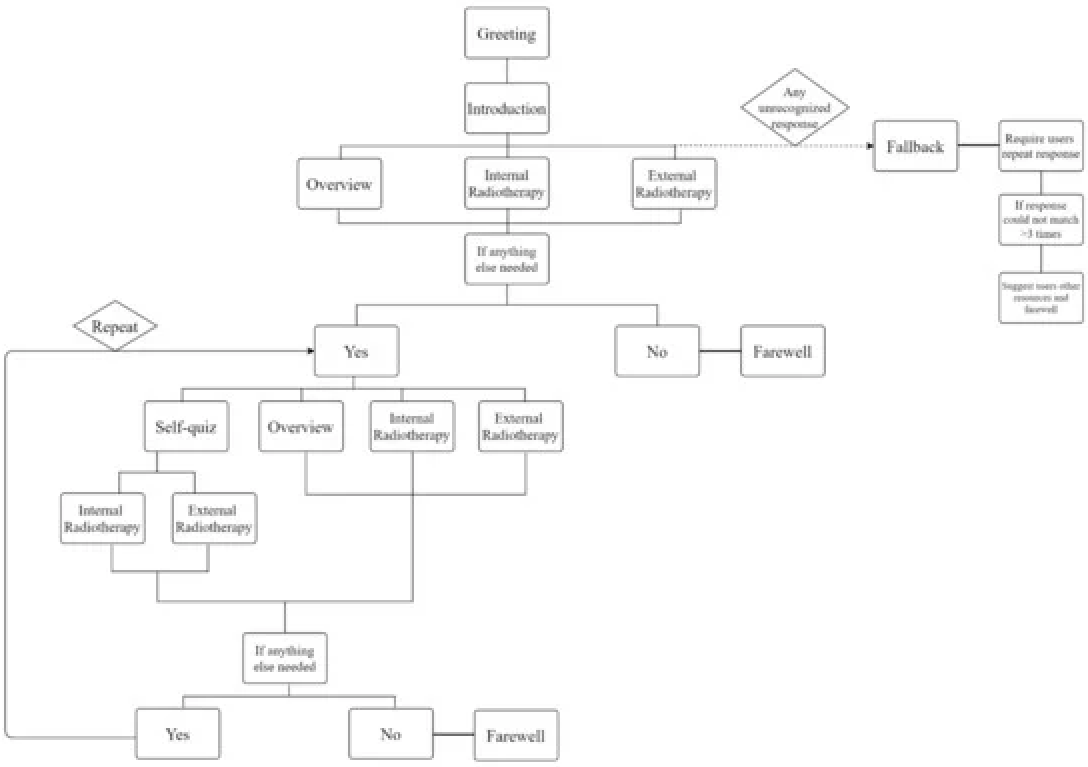
Customization and Accessibility:

One of the key advantages of an educational chatbot lies in its ability to deliver personalized information and support services round-the-clock, transcending the limitations of traditional healthcare delivery models. Through the integration of AI algorithms, the chatbot can adapt its responses based on user input, learning from each interaction to refine its knowledge base and enhance the quality of future interactions. Furthermore, by offering multi-lingual support and accommodating diverse learning styles, the chatbot ensures inclusivity and accessibility, empowering users from diverse backgrounds to access reliable information and support resources tailored to their individual needs.

Conclusion:

In conclusion, the development of an educational chatbot represents a transformative innovation in the field of healthcare communication and patient education, particularly in the context of cancer treatment. By harnessing the capabilities of AI and NLP, the chatbot has the potential to address the unmet information needs of cancer patients and their support networks, providing timely, accurate, and personalized information in a user-friendly format. As we navigate through the complexities of the COVID-19 pandemic and beyond, investing in the development and implementation of such innovative solutions is essential to ensuring equitable access to information and support services for all individuals affected by cancer.

Flowchart of RT Bot

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**Chapter : 3**

## LITERATURE SURVEY RELATED TO TOPIC

| SL No. | Paper Title | Authors | Year | Name of Publisher | Technology |
|---|---|---|---|---|---|
| 1 | Learning the Treatment Process in Radiotherapy | Nathanael Rebelo1 ; Leslie Sanders2 | 2022 | Rebelo et al | Artificial Intelligence |
| 2 | Graph Based Conversational AI | Savvas Varitimiadis 1,2, Konstantinos Kotis 1, | 2021 | MDPI | Artificial Intelligence |
| 3 | Machine Learning in Healthcare Communication | Sarkar Siddique 1 and James C. L. Chow | 2021 | MDPI | Machine Learning |

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| 4 | Artificial intelligence in radiotherapy | Sarkar Siddiquea, James C.L. Chow | 2020 | ELSEVIER | Artificial Intelligence |
| 5 | An Internet of Things app for monitor unit calculation in superficial and orthovoltage skin therapy | Julia Pearse1 and James C L Chow | 2020 | IOP Publishing | Internet of Things |
| 6 | Extending Patient-Chatbot Experience with Internet-of-Things and Background Knowledge | Amit Sheth,Hong Yung Yip | 2019 | IEEE | Artificial Intelligence,MachineLearning |
| 7 | A Chatbot Versus Physicians to Provide Information for Patients With Breast Cancer | Jean-Emmanuel Bibault1* , MD, PhD; Benjamin Chaix2 | 2019 | Bibault et al | Artificial Intelligence |
| 8 | Internet-based computer technology on radiotherapy | James C.L. Chow | 2017 | ELSEVIER | Big Data Analysis/Machine Learning |
| 9 | A REVIEW ON USER INTERFACE DESIGN PRINCIPLES TO INCREASE SOFTWARE USABILITY FOR USERS WITH LESS COMPUTER LITERACY | Ali Darejeh and Dalbir Singh | 2013 | Science Publications | Artificial Intelligence |

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| 10 | Natural language processing | Prakash M Nadkarni,1 Lucila Ohno-Machado,2 | 2011 | J Am Med Inform Assoc | Artificial Intelligence |

**Chapter: 4**

**Literature review**

Title of research paper : Learning the Treatment Process in Radiotherapy

Journal : JMIR Publications Advancing Digital Health & Open Science

In the context of cancer education, existing resources on hospital websites often lack personalization and interactivity. This is especially problematic for patients, families, and the public facing critical health crises, compounded by the scarcity of comprehensive information on radiotherapy, particularly for older patients. To address this, the study introduces an AI-assisted chatbot using IBM Watson Assistant, designed to provide accessible and accurate information on the radiation treatment process.

The methodology involves breaking down the treatment process and utilizing natural language processing (NLP) for the chatbot's ability to navigate conversations. Results indicate successful integration into a website, with the chatbot responding to queries and providing additional resources. Positive testing outcomes and user feedback mechanisms affirm the chatbot's effectiveness, emphasizing its potential to enhance cancer education and support. As a dynamic tool, it promises personalized healthcare information for those navigating the complexities of cancer treatment.

| Pros | Cons |
|---|---|
| Enhances user understanding of radiotherapy process | Requires continuous updates and refinement |
| Facilitates continuous improvement | Resource-intensive |
| Assists users with diverse needs | Initial setup complexity |

Title of research paper : Learning the Treatment Process in Radiotherapy

Journal : Applied Sciences

Museum chatbots are undergoing a transformative shift, embracing advanced AI technologies like ML and NLU to offer human-like interactions. The integration of knowledge graphs (KGs) enhances these chatbots' capabilities, enabling flexible and context-aware responses. Leading platforms such as Wit.ai and IBM's Watson contribute to the development of intelligent museum chatbots.

Evaluation frameworks, including the Analytic Hierarchy Process (AHP), assess chatbots and platforms based on their ability to conduct human-like conversations and provide comprehensive, accurate responses. A groundbreaking approach introduces a distributed, collaborative, and graph-based architecture, fostering knowledge-sharing among multiple chatbots. Examples like COBOTS and OpenDialog showcase progress in achieving efficient multi-chatbot collaboration, promising a more responsive museum ecosystem.

| Pros | Cons |
|---|---|
| Facilitate easy development with predefined platforms | Often lack human-like conversational features |
| Enables chatbots to "learn" and adapt to user interactions | Requires massive and long-term training with big data |
| Offers potentially unlimited knowledge to chatbot users | Requires continuous integration and updating of KGs |
| Enables collaboration among chatbots, leveraging diverse knowledge sources | Coordination complexities, potential redundancy in knowledge |

Title of research paper : Artificial intelligence in radiotherapy

Journal : Science Direct

AI's rapid evolution promises a transformative impact on radiotherapy, enhancing workflow automation, quality assurance, and personalized treatment. Leveraging machine learning and deep learning, AI efficiently processes vast medical data, significantly advancing precision medicine. Radiotherapy's intricate multi-step chain, involving simulation, contouring, planning, and outcome prediction, stands to benefit from AI integration.

Progress in AI applications spans image acquisition, where various modalities enhance precision, to contouring, automating target delineation and reducing inter-observer variability. Treatment planning witnesses AI optimizing dose distribution in techniques like IMRT and VMAT. Quality assurance procedures benefit from AI, ensuring both machine and patient-specific checks. Displacement correction addresses potential errors during treatment, while outcome prediction explores personalized benefits and toxicities, crucial for tailored radiotherapy.

Challenges include data quality dependency for AI model training and the need for extensive datasets. Despite challenges, AI's significant strides in radiotherapy hold promise for revolutionizing patient-centric, efficient, and knowledge-driven radiotherapeutic interventions.

| Pros | Cons |
|---|---|
| Highly automated radiotherapy workflows | Challenges in addressing inter and intra-observer variability |
| Personalized treatment guided by multi-omics data | Constraints in considering tumor radiosensitivity heterogeneity |
| Efficiency in treatment planning through reverse planning and AI optimization | Challenges in quantifying benefits and toxicities individually |
| Exploitation of large databases like TCGA and TCIA for AI studies | Potential limitations in the adequacy and range of usable data |

Title of research paper : Machine Learning in Healthcare Communication

Journal : Encyclopedia

ML and AI, including chatbots, enhance healthcare communication by providing instant responses, conducting health surveys, and improving accessibility. ML contributes to diagnostics, therapeutic support, and population health management. Chatbots like iDecide improve patient knowledge in specific conditions. Chatbots, such as Woebot, show efficacy in reducing depression levels. AI-driven interventions in mental health are gaining traction.

NLP is crucial for computational phenotyping, clinical trial screening, and detecting adverse drug events. Various NLP systems have been developed for clinical use.DNNs are extensively used in gene expression, protein interaction prediction, and radiology. Notable applications include CheXNeXt for chest radiograph pathology detection.Chatbots have evolved from early versions like ELIZA to modern systems like VPbot, Doc-Bot, and iDecide, providing personalized medical information and assistance.

| Pros | Cons |
|---|---|
| Enhances accessibility to healthcare | Dependency on accurate data for training |
| Improves patient knowledge and adherence | Potential privacy and security concerns |
| Enables effective communication in multilingual settings | Risk of over-reliance on technology without proper evaluation |
| Contributes to public health predictions | Challenges in understanding diverse speech patterns in speech signal analysis |

**Chapter : 5**

## PROBLEM FORMULATION

The implementation of an educational chatbot in the field of radiotherapy presents several challenges that need to be addressed to ensure effective functionality and user satisfaction. These challenges primarily stem from limitations in existing platforms, including difficulties in global conversation restarts, limitations in performing mathematical operations for context variables, and challenges in accurately interpreting user inputs through natural language processing (NLP). Additionally, the integration of the chatbot across various platforms necessitates careful consideration to optimize user experience. Privacy and security concerns also need to be addressed to ensure the ethical and secure deployment of the educational chatbot.

### Objectives

1.Enhance Global Conversation Restart Capability:

Objective: Develop a mechanism to globally restart conversations initiated by users, overcoming platform limitations. Implement a user-friendly approach that allows seamless navigation back to the initial node, ensuring an improved overall user experience.

2.Enable Mathematical Operations for Context Variables:

Objective: Implement a feature that allows the educational chatbot to perform mathematical operations on context variables, especially in scenarios like radiation safety tests. Enhance the chatbot's capability to calculate and present results, moving beyond a binary "Correct" or "Incorrect" format.

3.Optimize NLP for Improved User Input Understanding:

Objective: Implement and enhance natural language processing capabilities to better understand and interpret open-ended or unstructured user inputs. Prioritize user classification based on background to provide tailored responses and access relevant data. Include guided options to mitigate potential misunderstandings.

4.Facilitate Integration Across Platforms:

Objective: Integrate the educational chatbot seamlessly across various platforms, including third-party media such as WhatsApp, Slack, Facebook Messenger, SMS, and web platforms like Weebly or WordPress. Ensure platform-specific adjustments to maintain optimal user experience.

5.Address Privacy and Security Concerns:

Objective: Design the educational chatbot to uphold privacy and security standards by facilitating a unidirectional information flow from the chatbot to the user. Ensure no storage or record of personal user information, addressing potential time delay issues to guarantee prompt and secure interactions.

6. Implement Evaluation and Testing Procedures:

Objective: Define and implement performance metrics to assess the educational chatbot's efficiency, accuracy, and user satisfaction. Collect user feedback regularly to identify areas of improvement and iteratively update the chatbot to align with user expectations and needs.

**Chapter : 6**

## METHODOLOGY/PLANNING OF WORK

The implementation of an educational chatbot in the field of radiotherapy involves addressing several programming challenges and considerations to ensure seamless functionality and user experience. The methodology encompasses key steps in addressing these challenges, integrating natural language processing (NLP), and deploying the chatbot on various platforms while prioritizing privacy and security.

### 1. Global Conversation Restart Capability:

- Issue Identification: The lack of a global ability to restart conversations freely by users on the deployed chatbot, particularly on IoT platforms.

- Solution Approach: Introduce a new intent linked to an exit node, allowing a user to navigate back to the first node seamlessly. Address any unforeseen errors arising from the modification of conversation flow.

### 2. Mathematical Operations for Context Variables:

- Issue Identification: Inability to perform mathematical operations on context variables, hindering functionalities such as calculating test scores for radiation safety tests.

- Solution Approach: Develop a mechanism within the chatbot to process and calculate results, considering the limitations of the development tool. Explore alternative methods to display results beyond a simple "Correct" or "Incorrect" format.

### 3. NLP for User Input Understanding:

- Issue Identification: Challenges in understanding and interpreting open-ended or unstructured user inputs, common in the complex and varied language of medical contexts.

- Solution Approach: Implement NLP capabilities to enhance the chatbot's ability to comprehend user inputs. Prioritize user classification into distinct groups (e.g., patients, radiation staff, general public) based on background to tailor responses and access relevant data. Include guidance with fixed options to mitigate misunderstandings.

### 4. Integration and Implementation Across Platforms:

- Platform Choices: Utilize IBM Watson Assistant for chatbot development, allowing for integration with various third-party media such as WhatsApp, Slack, Facebook Messenger, SMS, and Intercom. Consider platform-specific adjustments for optimal user experience.

- Web Integration: Deposit the chatbot into a website using platforms like Weebly or WordPress to enhance discoverability by web crawlers. This ensures that individuals searching for a radiotherapy chatbot can easily find and access the educational resources.

### 5. Privacy and Security Measures:

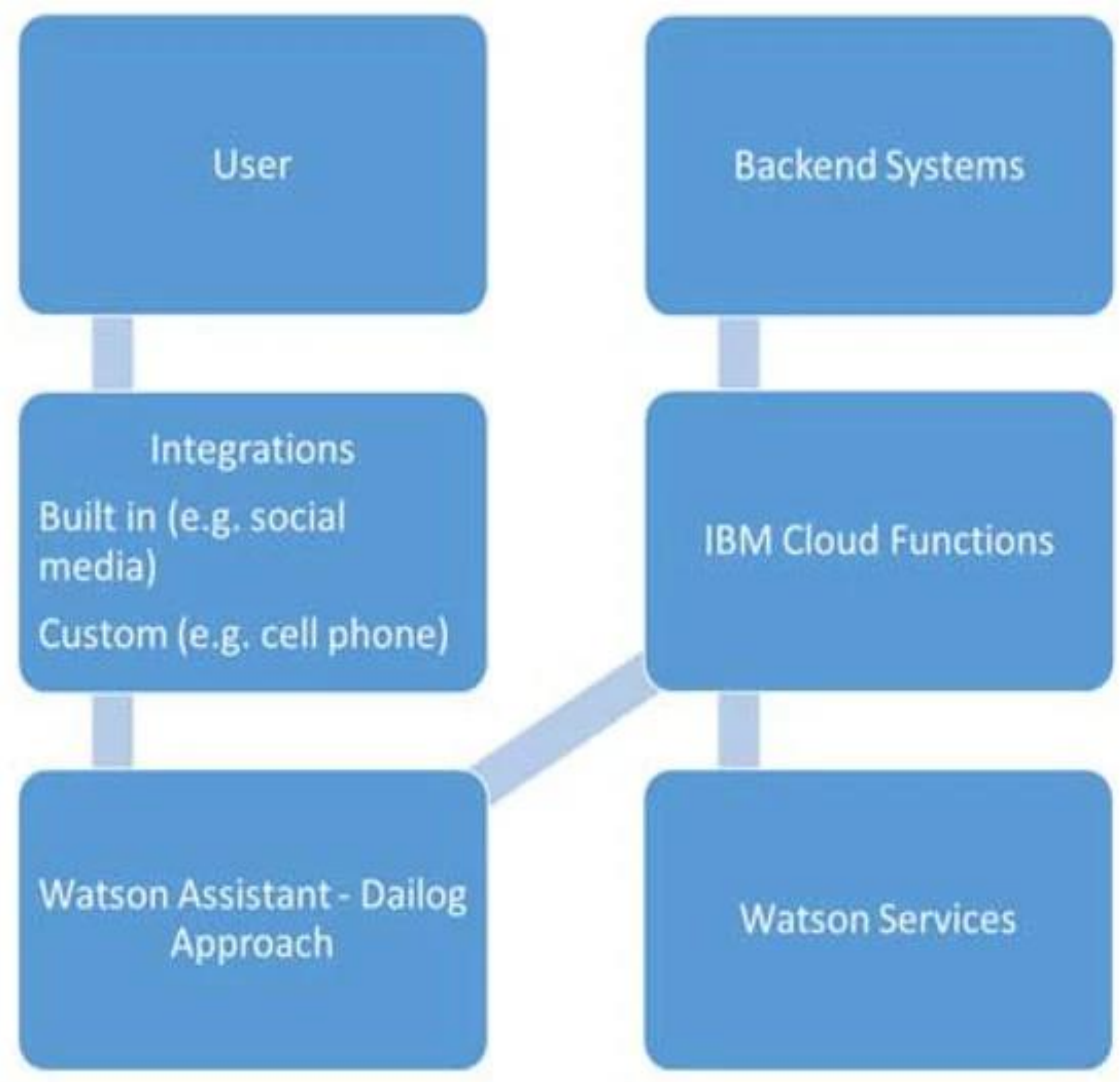
- Information Flow: Design the chatbot to facilitate a unidirectional information flow from the chatbot to the user, minimizing privacy concerns by not storing or recording personal user data.

- Time Delay Considerations: Assess and address any potential time delay issues in the chatbot's functionality, ensuring prompt and efficient responses.

**6. Evaluation and Testing:**

- Performance Metrics: Define and implement performance metrics for the chatbot, considering factors such as response time, accuracy, and user satisfaction.

- User Feedback: Collect user feedback to continuously evaluate and refine the chatbot's performance. Iteratively update the chatbot based on real-world user interactions.

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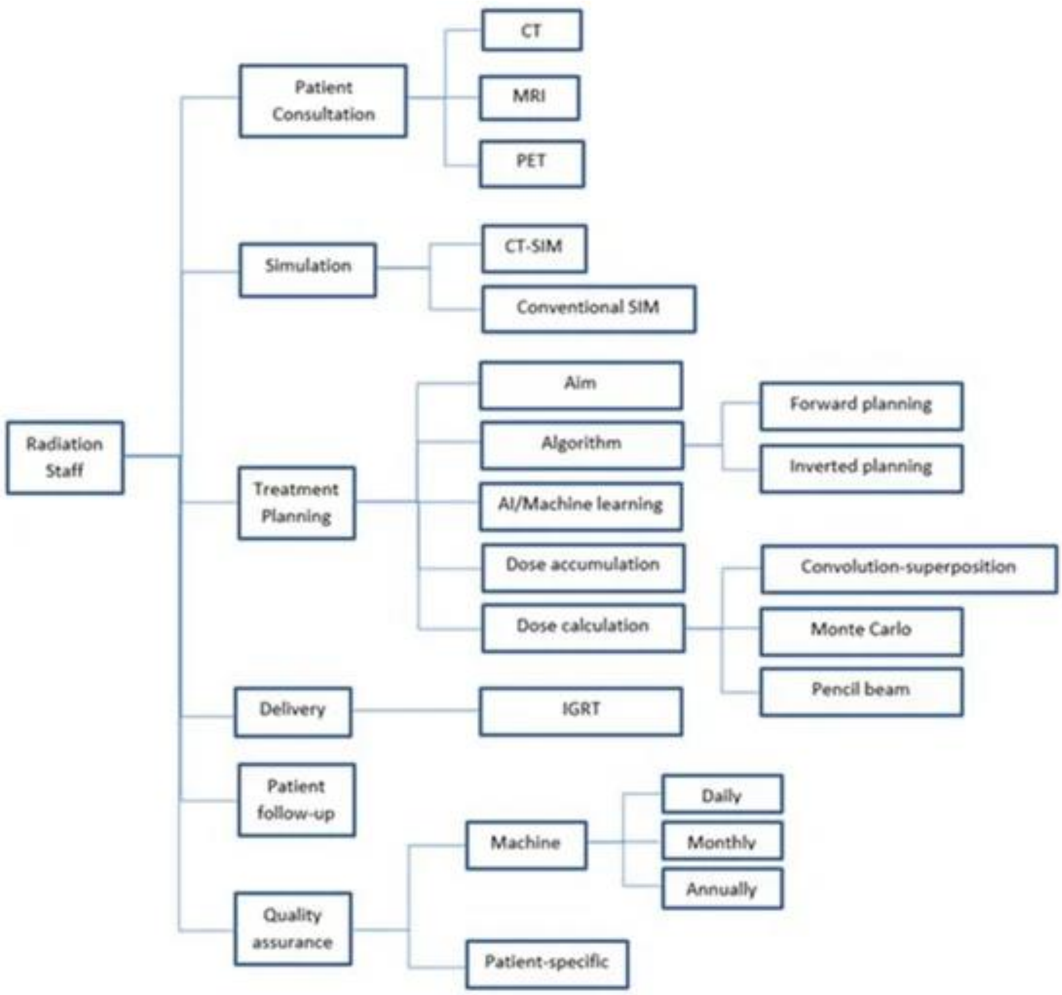
**Planning of work**

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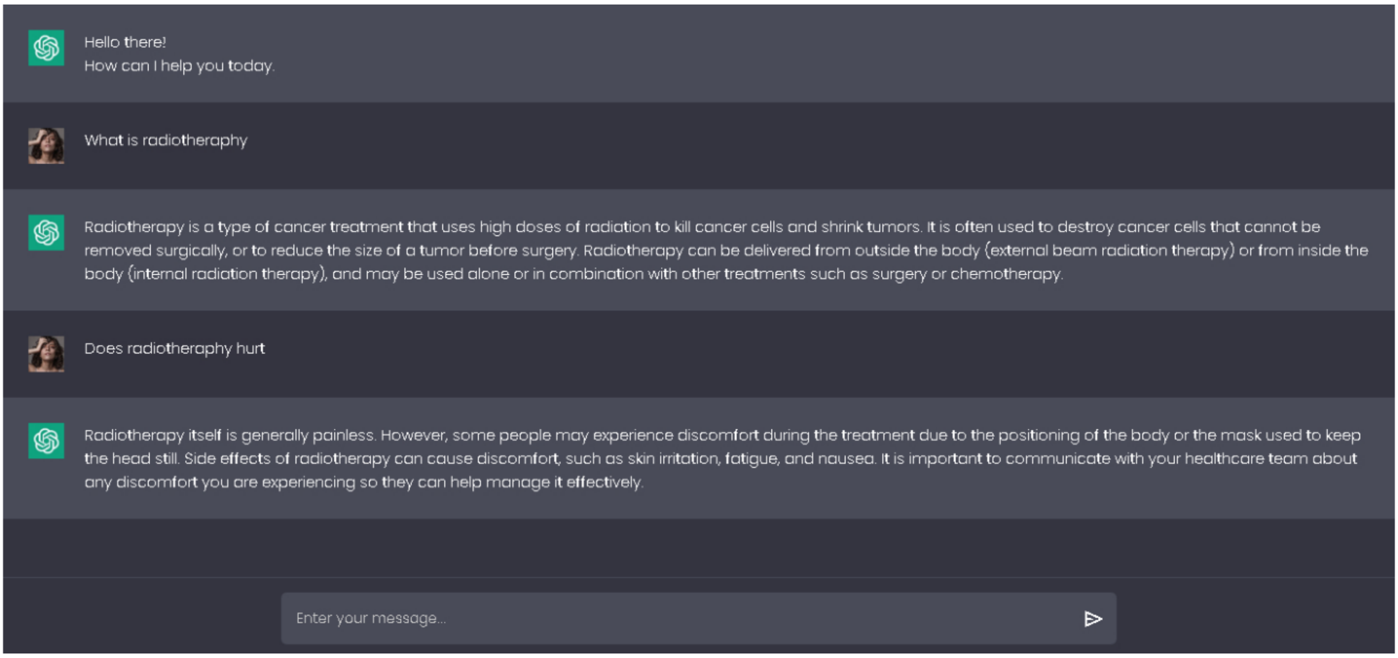

**Chapter : 7**

**FACILITIES REQUIRED FOR PROPOSED WORK**

**1. Computing Infrastructure:**

High-performance computing (HPC) facilities equipped with sufficient processing power and memory to support the development and deployment of AI algorithms.

Access to cloud computing resources for scalable storage and computational capabilities, essential for training and optimizing machine learning models.

**2. Software Tools and Development Environment:**

Integrated development environments (IDEs) for programming and debugging, such as PyCharm, Jupyter Notebook, or Visual Studio Code, to facilitate the development of chatbot applications.

Software libraries and frameworks for natural language processing (NLP), such as TensorFlow, PyTorch, or spaCy, to enable the chatbot to understand and generate human-like responses.

Version control systems (e.g., Git) for collaborative development and tracking changes across project iterations.

**3. Data Access and Management:**

Access to comprehensive datasets relevant to radiotherapy and cancer treatment, including patient demographics, treatment protocols, and medical imaging data.

Data storage infrastructure with appropriate security measures and compliance protocols to ensure the privacy and confidentiality of patient information.

**4. User Interface Design Tools:**

Graphic design software (e.g., Adobe XD, Sketch) for prototyping and designing intuitive user interfaces (UI) for the chatbot application.

Accessibility testing tools to ensure that the chatbot interface is usable and inclusive for individuals with diverse needs and abilities.

**5. Testing and Validation Environment:**

Simulation environments to test the chatbot's functionality and performance under various scenarios, including different user queries and edge cases.

User acceptance testing (UAT) facilities to gather feedback from stakeholders, including patients, healthcare providers, and radiation therapy staff, to refine and improve the chatbot's capabilities.

**6. Collaboration and Communication Tools:**

Collaboration platforms (e.g., Slack, Microsoft Teams) for facilitating communication and coordination among multidisciplinary team members involved in the chatbot development process.

Project management tools (e.g., Jira, Asana) for tracking tasks, milestones, and deadlines, ensuring efficient project execution and delivery.

**7. Ethical and Regulatory Compliance:**

Institutional review board (IRB) approval and compliance with ethical guidelines for conducting research involving human subjects, particularly regarding the collection and use of patient data.

Adherence to relevant regulatory frameworks, such as HIPAA (Health Insurance Portability and Accountability Act) in the United States, to ensure the privacy and security of patient health information.

**Chapter : 8**

**REFERENCES :**

1. Darejeh, A.; Singh, D. A review on user interface design principles to increase software usability for users with less computer literacy. J. Comput. Sci. 2013, 9, 1443

2. Chow, J.C. Some computer graphical user interfaces in radiation therapy. World J. Radiol. 2016, 8, 255

3. Varitimiadis, S.; Kotis, K.; Pittou, D.; Konstantakis, G. Graph-Based Conversational AI: Towards a Distributed and Collaborative Multi-Chatbot Approach for Museums. App. Sci. 2021, 11, 9160.

4. Siddique, S.; Chow, J.C.L. Artificial intelligence in radiotherapy. Rep. Pract. Oncol. Radiother. 2020, 25, 656–666.

5. Chow, J.C.L. Internet-based computer technology on radiotherapy. Rep. Pract. Oncol. Radiother. 2017, 22, 455–462.

6. Liebrecht, C.; van Hooijdonk, C. Creating humanlike chatbots: What chatbot developers could learn from webcare employees in adopting a conversational human voice. In International Workshop on Chatbot Research and Design; Springer: Cham, Switzerland, 2020; pp. 51–64.

7. Siddique, S.; Chow, J.C.L. Machine Learning in Healthcare Communication. Encyclopedia 2021, 1, 220–239.

8. Kovacek, D.; Chow, J.C.L. An AI-assisted Chatbot for Radiation Safety Education in Radiotherapy. IOP SciNotes 2021, 2, 034002. [CrossRef]

9. Rebelo, N.; Sanders, L.; Li, K.; Chow, J.C.L. Learning the Treatment Process in Radiotherapy Using an Artificial Intelligence– Assisted Chatbot: Development Study. JMIR Form. Res. 2022, 6, e39443.

10. Turing, A.M. Computing machinery and intelligence. In Parsing the Turing Test: Philosophical and Methodological Issues in the Quest for the Thinking Computer; Epstein, R., Roberts, G., Beber, G., Eds.; Springer: Dordrecht, The Netherlands, 2009; pp. 23–65.

11. Xu, L.; Sanders, L.; Li, K.; Chow, J.C. Chatbot for health care and oncology applications using artificial intelligence and machine learning: Systematic review. JMIR Cancer 2021, 7, e27850.

12. Okuda, T.; Shoda, S. AI-based chatbot service for financial industry. Fujitsu Sci. Tech. J. 2018, 54, 4–8.

13. Heo, M.; Lee, K.J. Chatbot as a new business communication tool: The case of naver talktalk. Bus. Commun. Res. Pract. 2018, 1, 41–45.

14. Bates, M. Health care chatbots are here to help. IEEE Pulse 2019, 10, 12–14.

15. Denecke, K.; Tschanz, M.; Dorner, T.L.; May, R. Intelligent conversational agents in healthcare: Hype or hope. Stud. Health Technol. Inform. 2019, 259, 77–84.

16. Pearse, J.; Chow, J.C.L. An Internet of Things App for Monitor Unit Calculation in Superficial and Orthovoltage Skin Therapy. IOP SciNotes 2020, 1, 014002.

17. Sheth, A.; Yip, H.Y.; Shekarpour, S. Extending patient-chatbot experience with internet-of-things and background knowledge: Case studies with healthcare applications. IEEE Intell. Syst. 2019, 34, 24–30.

18. Chow, J.C. Artificial intelligence in radiotherapy and patient care. In Artificial Intelligence in Medicine; Springer International Publishing: Cham, Switzerland, 2021; pp. 1–13.

19. Ayanouz, S.; Abdelhakim, B.A.; Benhmed, M. A smart chatbot architecture based NLP and machine learning for health care assistance. In Proceedings of the 3rd International Conference on Networking, Information Systems & Security, Marrakech, Morocco, 31 March 2020; pp. 1–6.

20. Hirschberg, J.; Manning, C.D. Advances in natural language processing. Science 2015, 349, 261–266.

21. Bibault, J.E.; Chaix, B.; Guillemassé, A.; Cousin, S.; Escande, A.; Perrin, M.; Pienkowski, A.; Delamon, G.; Nectoux, P.; Brouard, B. A chatbot versus physicians to provide information for patients with breast cancer: Blind, randomized controlled noninferiority trial. J. Med. Internet Res. 2019, 21, e15787.

22. Chung, K.; Park, R.C. Chatbot-based heathcare service with a knowledge base for cloud computing. Clust. Comput. 2019, 22, 1925–1937.

23. Lokman, A.S.; Zain, J.M.; Komputer, F.S.; Perisian, K. Designing a Chatbot for diabetic patients. In Proceedings of the International Conference on Software Engineering & Computer Systems (ICSECS'09), Penang, Malaysia, 19–21 October 2009; pp. 19–21.

24. Hajare, A.; Bhosale, P.; Nanaware, R.; Hiremath, G. Chatbot for Education System. Int. J. Comput. Sci. 2018, 3, 52–57.

25. Setiaji, B.; Wibowo, F.W. Chatbot using a knowledge in database: Human-to-machine conversation modeling. In Proceedings of the 2016 7th international conference on intelligent systems, modelling and simulation (ISMS), Bangkok, Thailand, 25 January 2016; IEEE: New York, NY, USA, 2016; pp. 72–77.