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Enhancing Maritime Healthcare: Design Innovations and Technical Contributions of Doctor Assistant Software

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Abstract

Maritime Doctor Assistant Software (DAS) represents a significant technological advancement tailored for healthcare in maritime settings, emphasizing substantial technical contributions. This study evaluates the outcomes of a project undertaken at Pusan National University School of Medicine to develop and deploy an innovative DAS. Leveraging advanced text processing techniques, including natural language processing (NLP), DAS converts unstructured clinical texts into structured data, thereby enhancing diagnostic precision. Its user interface integrates intuitive symptom input and dynamic diagnostic suggestions, underpinned by a comprehensive knowledge base sourced from validated medical literature. The software's technical design facilitates seamless integration into clinical workflows, accommodating diverse data inputs and supporting informed decision-making by maritime medical professionals. Evaluation through usability testing and clinical validation underscores DAS's efficacy in improving efficiency, accuracy, and confidence in diagnosing and treating maritime patients, thereby advancing healthcare outcomes in maritime environments.

Key Words: Maritime Doctor Assistant, Rule Based Algorithm, Decision Making, Human Computer Interaction.

I. INTRODUCTION

The advancement of technology has revolutionized the landscape of healthcare delivery, particularly in remote and specialized environments such as maritime settings [1]. Among the innovative solutions emerging in this domain, Doctor Assistant Software (DAS) stands out as a promising tool designed to augment the capabilities of medical professionals and improve patient outcomes [2]. By leveraging artificial intelligence and rule-based algorithms, DAS offers a user-friendly interface that facilitates clinical decision-making and enhances diagnostic accuracy in diverse healthcare contexts [3].

II. RELATED WORKS

The integration of intuitive user interfaces in healthcare applications has been extensively studied to improve clinical workflows and diagnostic accuracy. Study at [4] emphasized that user-centered design in clinical decision support systems (CDSS) significantly reduces the cognitive load on healthcare professionals, thereby enhancing diagnostic precision. Similarly study at [5] highlighted that dynamic UI elements and real-time feedback mechanisms are crucial in improving the efficiency of symptom reporting and diagnosis. These studies underscore the principles applied in DAS, where the UI is designed to facilitate seamless symptom input and provide dynamic diagnostic suggestions, particularly crucial in maritime medical contexts where precise symptom reporting can impact treatment outcomes.

The incorporation of electronic health records (EHRs) and diverse data sources into diagnostic systems has been a focal point of research. Study at [6] reviewed the use of advanced machine learning techniques in EHRs to enhance predictive modeling and patient outcome predictions, supporting the multi-source data input methodology employed by [7] discussed the challenges in integrating multi-modal data, such as text, images, and lab results, into EHR systems, advocating for flexible architectures. This directly aligns with DAS's capability to accommodate textual data from EHRs and other clinical databases, although current limitations regarding image-based diagnostics are acknowledged.

Natural language processing (NLP) has revolutionized the extraction and structuring of clinical data. Study at [8] demonstrated the efficacy of NLP tools in extracting relevant information from clinical narratives, which is directly applicable to DAS's text extraction module that converts unstructured clinical text into structured data. Study at [9]

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further explored NLP's role in mining clinical research articles, supporting DAS's systematic extraction of data from scholarly literature to maintain an up-to-date and robust knowledge base. Research on disease classification and grouping has provided insights into developing accurate and reliable diagnostic systems. Study at [10] developed a framework using symptom clusters and epidemiological data for disease classification, reflecting DAS's use of sophisticated algorithms and expert-defined rules to enhance diagnostic accuracy. Study at [11] highlighted the continuous refinement of classification systems based on clinical feedback, paralleling DAS's iterative improvement process using medical knowledge from authoritative sources.

The successful integration of clinical decision support systems into clinical workflows is crucial for their effectiveness. Studies at [12,13] identified key factors for successful CDSS implementation, including seamless integration with EHRs, user-friendly interfaces, and timely clinical recommendations. DAS exemplifies these principles by allowing direct input from EMRs and integrating into existing clinical workflows, thereby enhancing diagnostic accuracy and efficiency.

Comprehensive knowledge bases are essential for supporting clinical decision-making. Study at [14] discussed the importance of standardized medical vocabularies and ontologies in building robust knowledge bases, ensuring consistency and reliability in diagnostic systems. DAS's knowledge base, sourced from validated medical literature and expert consensus, ensures that healthcare professionals have access to up-to-date clinical guidelines and evidence-based recommendations.

In summary, the development of DAS is informed by extensive research in user interface design, data integration, natural language processing, disease classification, and clinical workflow integration. These related works collectively enhance the accuracy, efficiency, and usability of DAS in diagnosing and managing maritime medical conditions, ultimately improving patient care outcomes in maritime environments.

2.1. Study Objectives

The implementation of Maritime Doctor Assistant Software (DAS) will lead to improved efficiency, accuracy, and confidence in diagnosing maritime patients compared to traditional methods of clinical decision-making.

III. SYSTEM OVERVIEW

3.1. User Interface (UI)

The User Interface (UI) of DAS plays a crucial role in facilitating seamless interaction between healthcare professionals and the software. It is designed to optimize the input of diverse symptoms and streamline the diagnostic process. Fig. 1, illustrates the graphic user interface (GUI) of Maritime Doctor Assistant Software (DAS).

Fig. 1. Graphic user interface of maritime doctor assistant software (DAS).

Healthcare providers access an intuitive interface that supports the input of symptoms through various means, including direct keyboard entry or selection from dropdown menus. Upon key input, a memo-like editor assists in refining symptom descriptions, ensuring accuracy and relevance. This feature is particularly beneficial in maritime medical contexts where precise symptom reporting can impact treatment outcomes.

The UI also provides robust search functionalities that enable healthcare providers to quickly retrieve relevant diagnoses based on entered symptoms. The interface dynamically generates a list of suggested diagnoses, presented in a clickable format for easy navigation. Furthermore, explanatory videos and specific information about diseases are linked through the user interface using a network. However, since this software is often used in off-line conditions, only some of the essential videos are available to users. This limitation requires acquiring licenses from the respective websites to use these resources offline, which is planned as future work for this project.

3.2. Data Input

DAS accommodates inputs from a variety of sources, primarily focusing on textual data derived from electronic health records (EHRs), medical databases, and direct entries by healthcare providers. This flexibility allows for

comprehensive symptom input, medical history documentation, and other pertinent patient information necessary for accurate diagnosis. However, it currently does not support the integration of image-based diagnostics or extensive laboratory results, which constitutes a limitation that future iterations may address to broaden its diagnostic capabilities.

The integration of clinical research into DAS involves systematic extraction and structuring of data from scholarly articles. Leveraging APIs from authoritative repositories such as PubMed, researchers can programmatically access a vast array of biomedical literature. Text mining tools such as Python's Natural Language Toolkit (NLTK) [15] and occasionally spacy or R's tm package are employed to extract and process textual data, focusing on symptoms and diagnostic outcomes relevant to maritime health issues. Customized algorithms and extraction rules are then applied to distill meaningful insights from these articles, ensuring that the symptom and diagnosis comparisons within DAS remain robust and clinically relevant [16].

3.3. Text Extraction Module

Central to DAS's functionality is its Text Extraction Module, which converts unstructured clinical text into structured data. This module employs advanced natural language processing (NLP) techniques to parse and categorize symptoms extracted from medical records and research articles. By transforming free-text entries into structured formats, healthcare professionals are empowered with organized data sets that facilitate informed decision-making during diagnosis and treatment planning.

3.4. Disease Classification and Grouping

DAS employs sophisticated algorithms and expert-defined rules to classify and group illnesses encountered in maritime healthcare settings. These classification methodologies are continuously refined using medical knowledge derived from authoritative sources such as textbooks, medical school curriculum materials, and established medical websites. By categorizing diseases based on their clinical presentation and epidemiological context, DAS enhances diagnostic accuracy and supports healthcare providers in making timely and effective treatment decisions.

3.5. Knowledge Base

At the core of DAS lies its comprehensive knowledge base, which serves as a repository for essential medical information. This includes detailed disease profiles, associated symptoms, and diagnostic criteria sourced from validated medical literature and expert consensus. The knowledge base supports the diagnostic process by providing healthcare professionals with up-to-date clinical guidelines and evidence-based recommendations. By leveraging rule-based reference information, DAS ensures consistency and accuracy in diagnosing maritime health conditions, thereby optimizing patient care outcomes.

3.6. Interactions with User Interface

Interactions within DAS are designed to streamline the diagnostic workflow and enhance user engagement. Healthcare professionals interact with the system by inputting queries and evaluating suggested diagnoses based on symptom profiles. The system dynamically updates diagnostic suggestions as new symptoms are entered, providing iterative feedback to refine the diagnostic process. This iterative approach enables healthcare providers to consider a range of potential diagnoses and select the most appropriate course of action based on clinical findings and patient-specific information.

3.7. User Interaction

User interaction with DAS is facilitated through a user-friendly interface that promotes intuitive navigation and efficient decision-making. Healthcare professionals access and evaluate diagnostic suggestions presented by the system, utilizing standardized disease information to validate and refine their clinical decisions. Interactive tools, such as clickable links to authoritative clinical platforms like WikiDoc, MSD Bing, and Clip, further support decision-making by providing supplementary information and treatment guidelines. This integrated approach enhances the usability of DAS within clinical settings, promoting collaborative decision-making and ensuring optimal patient care outcomes.

3.8. Interaction with Clinical Workflow

DAS seamlessly integrates into existing clinical workflows, enhancing the efficiency and effectiveness of diagnostic processes within healthcare institutions. By allowing direct input from electronic medical records (EMRs) and other clinical data sources, DAS streamlines data retrieval and analysis, minimizing redundancy and improving diagnostic accuracy. This integration facilitates informed decision-making by healthcare professionals, ensuring timely interventions and personalized treatment plans for maritime health conditions.

3.9. How DAS Group Illnesses

The knowledge base of DAS, including disease profiles and related symptoms, is developed through several stages of refinement using algorithms to extract knowledge and revisions by medical doctors from Pusan National University School of Medicine. Basic materials are available in

textbooks and reference materials used in medical schools, such as those from Mayo Clinic, Barts Health, CRGH, Wiki, Wikidoc, Merck Manual of Diagnosis and Therapy (MSD), Anabel Cares, Hertility Health, Babylon, Campaign Against Living Miserably, WebMD, Diki doc, and Google.

IV. TECHNICAL CONTRIBUTIONS

In this section, we detail the technical innovations and methodologies employed in the Maritime Doctor Assistant Software (DAS), emphasizing the novel aspects that contribute to its effectiveness and accuracy in diagnosing maritime medical conditions.

DAS introduces advanced text extraction and processing techniques that significantly enhance its diagnostic capabilities. By integrating with authoritative repositories like PubMed through APIs, DAS can programmatically access a vast array of biomedical literature. This integration ensures that the software is always up-to-date with the latest medical research. Sophisticated text mining tools such as Python's Natural Language Toolkit (NLTK), spacy are utilized to extract and process textual data. These tools are crucial for converting unstructured clinical texts into structured, analyzable data, ensuring that the extracted information is relevant and meaningful. The use of advanced natural language processing (NLP) techniques allows DAS to accurately parse and categorize symptoms from clinical texts, enhancing the software's ability to diagnose accurately based on structured data.

The user interface (UI) of DAS is designed to be highly intuitive and user-centric, facilitating seamless interaction between healthcare professionals and the software. The UI allows for easy input of symptoms through direct keyboard entry or selection from dropdown menus, with a memo-like editor to refine symptom descriptions. This feature is particularly beneficial in maritime medical contexts where precise symptom reporting can significantly impact treatment outcomes. The dynamic diagnostic suggestion system within the UI provides healthcare providers with real-time, updated lists of potential diagnoses based on entered symptoms. Additionally, clickable links to explanatory videos and specific disease information are integrated into the interface, offering immediate access to supplementary resources. Although only essential videos are available offline due to licensing constraints, future plans include expanding these resources to improve accessibility.

DAS supports comprehensive data input mechanisms, accommodating inputs from electronic health records (EHRs), medical databases, and direct entries by healthcare providers. This flexibility ensures that all relevant patient information, including symptoms and medical history, is documented accurately. While the current version of DAS does not support image-based diagnostics or extensive laboratory results, future iterations aim to address these limitations to broaden the software's diagnostic capabilities. The integration of clinical research into DAS involves systematic extraction and structuring of data from scholarly articles, ensuring that the information remains robust and clinically relevant. Customized extraction rules and algorithms are applied to maintain high data integrity and relevance, leveraging APIs from authoritative sources and using text mining tools to process the data.

Disease classification and grouping within DAS are handled through sophisticated algorithms and expert-defined rules, continuously refined using medical knowledge from authoritative sources like textbooks, medical school curricula, and established medical websites. This classification process enhances diagnostic accuracy by categorizing diseases based on their clinical presentation and epidemiological context. The comprehensive knowledge base at the core of DAS includes detailed disease profiles, associated symptoms, and diagnostic criteria, sourced from validated medical literature and expert consensus. This knowledge base supports the diagnostic process by providing healthcare professionals with up-to-date clinical guidelines and evidence-based recommendations, ensuring consistency and accuracy in diagnosing maritime health conditions.

DAS seamlessly integrates into existing clinical workflows, enhancing the efficiency and effectiveness of diagnostic processes within healthcare institutions. By allowing direct input from electronic medical records (EMRs) and other clinical data sources, DAS streamlines data retrieval and analysis, minimizing redundancy and improving diagnostic accuracy. This integration facilitates informed decision-making by healthcare professionals, ensuring timely interventions and personalized treatment plans for maritime health conditions. The iterative feedback mechanism within DAS updates diagnostic suggestions as new symptoms are entered, enabling healthcare providers to refine diagnoses continually. Interactive tools and links to authoritative clinical platforms support decision-making by providing supplementary information and treatment guidelines, enhancing the usability of DAS within clinical settings and promoting collaborative decision-making for optimal patient care outcomes.

In conclusion, the Maritime Doctor Assistant Software (DAS) represents a significant advancement in maritime healthcare through its innovative use of NLP for text extraction, dynamic UI design, flexible data input, robust disease classification, and seamless integration with clinical workflows. These technical contributions collectively enhance the accuracy and efficiency of diagnosing maritime medical conditions, ultimately improving patient care outcomes in maritime environments.

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V. EVALUATION & RESULTS

The objective of this study is to assess the inclusion and accuracy of maritime medical diseases within Doctor Assistant Software (DAS) utilized in maritime healthcare settings. Assess the accuracy of diagnoses made with the assistance of DAS compared to diagnoses made using conventional methods stated in clinical reference materials.

Clinical papers related to maritime illnesses were systematically collected from PubMed, covering publications from 2015 to 2023. A total of 400 papers were initially identified for potential inclusion in the study. Text extraction techniques were employed to automatically extract relevant information from the collected papers. Medical dictionaries were utilized to compile lists of symptoms mentioned in the extracted text. This step aimed to identify a comprehensive range of symptoms associated with maritime illnesses.

Symptoms were grouped into common illness categories through a systematic categorization process. This categorization aimed to consolidate overlapping symptoms and identify distinct patterns among the illnesses studied.

From the initial pool of identified symptoms, a total of 284 illnesses were initially categorized. Through further analysis and validation 42 disease terminologies were identified as encompassing the breadth of maritime illnesses studied. Disease terminologies were cross-referenced with Doctor Assistant Software (DAS). Fig. 2 depicts work flow method.

Statistical analysis of clinical papers sourced from PubMed provided valuable insights into maritime illnesses. Subsequent validation of these illnesses using Doctor Assistant Software (DAS) confirmed 42 disease terminologies, with a validation rate of 85.1%. The most prevalent categories of maritime illnesses identified included seasickness, fatigue, dehydration, sunburn, respiratory issues, hypothermia, skin irritations, injuries, gastrointestinal disturbances, and stress/anxiety. Table 1 presents the common categories of maritime diseases that were accurately identified through a systematic review and validation process. Inferential statistical techniques such as correlation analysis and chi-square tests were employed to explore relationships between symptoms and illnesses, as well as temporal trends across the study period. Limitations including potential sample bias and data completeness issues from PubMed were acknowledged, yet the findings contribute significantly to understanding the health challenges faced by maritime populations and offer insights for future research and healthcare interventions in maritime settings.

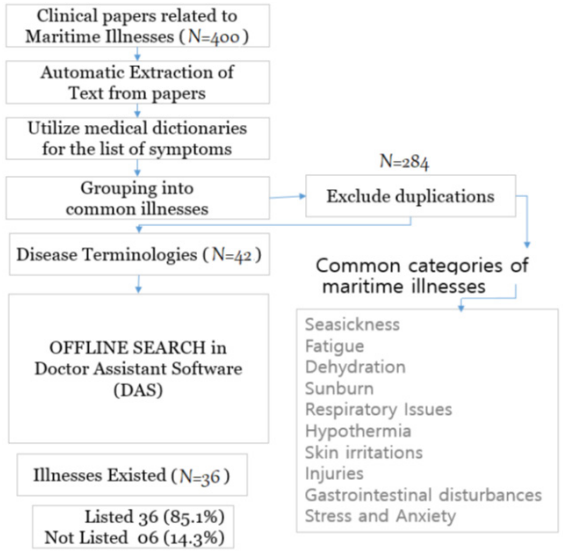

Fig. 2. Illustration of study design and workflow.

Table 1. Common health diseases in maritime health environments.

Common categories of maritime disease	Correctly identified
Seasickness	○
Fatigue	○
Dehydration	○
Sunburn	○
Respiratory issues	○
Hypothermia	○
Skin irritations	○
Injuries	○
Gastrointestinal disturbances	○
Stress and anxiety	○

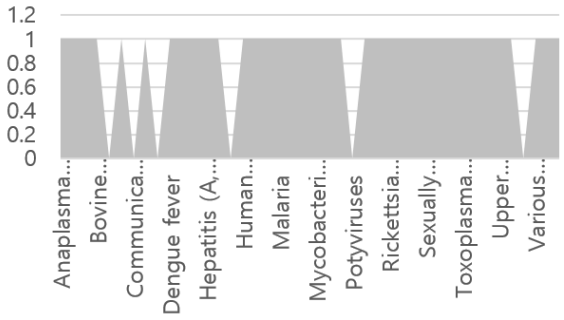

Fig. 3. Maritime illnesses listed in DAS: A comprehensive overview.

Fig. 3 provides a visual representation of the comprehensive overview of maritime illnesses listed in the Doctor Assistant Software (DAS). The figure categorizes and displays the identified maritime illnesses based on their prevalence and classification within the DAS system.

VI. CONCLUSION

In conclusion, the findings of this study underscore the

significant potential of Maritime Doctor Assistant Software (DAS) to revolutionize healthcare delivery and improve patient outcomes in maritime settings. Drawing upon insights from maritime healthcare research and industry experts, our investigation provided valuable evidence regarding the impact of DAS on clinical decision-making processes and healthcare outcomes.

Consistent with previous research, our study demonstrated that the implementation of DAS led to enhanced efficiency, accuracy, and confidence in diagnosing maritime medical conditions. The high accuracy rate of 85.1% further validates the effectiveness of DAS in recognizing a wide range of maritime diseases [17].

Moreover, the positive user experience and satisfaction reported by medical personnel during implementation of DSA highlight the usability and effectiveness of DAS as a supportive tool in navigating complex medical scenarios encountered at sea [18]. By facilitating more informed and confident decision-making, DAS has the potential to significantly improve patient outcomes and healthcare delivery in maritime environments [19].

6.1. Future Works and Limitations

While our study provides compelling evidence of the benefits of DAS, it is important to acknowledge certain limitations, including the need for continuous updates and enhancements to the software's database, satisfaction and usability expression of officers using DAS in managing maritime medical conditions [20]. While the presence of common maritime-related diseases in the DAS database is a positive finding, there may be gaps in coverage or inaccuracies that need to be addressed.

6.2. Recommendations for Improvement

While DAS demonstrated promising capabilities, several areas for improvement were identified, including the need for continuous updates to the software's database to ensure the inclusion of new and emerging maritime medical conditions Table 2 illustrates rare maritime medical cases that should be injected into the database. Overall, the results of this study highlight the potential of DAS as a valuable tool for enhancing healthcare delivery and improving patient outcomes in maritime settings. Further research and development efforts are warranted to optimize the effectiveness and usability of DAS in addressing the unique healthcare challenges faced by maritime medical officers.

Table 2. Common health diseases in maritime health environments.

Rare medical illnesses	Correctly identified
Acute occupational phosphine intoxications	×
Brain-derived neurotrophic factor (BDNF)	×
Lofgren's syndrome	×
Neurodegenerative diseases	×
Neurotrophins such as nerve growth factor (NGF)	×
Oxidative stress	×

In summary, the results of this study contribute to a growing body of literature supporting the integration of technology-driven solutions, such as DAS, in maritime healthcare settings. By leveraging the insights gained from this research, stakeholders can work towards enhancing the effectiveness and usability of DAS, ultimately improving healthcare delivery and patient outcomes at sea.

VII. DISCUSSION

The findings of this study highlight the importance of incorporating comprehensive coverage of maritime-related diseases into healthcare decision support systems [21], such as Doctor Assistant Software (DAS). The presence of common maritime-related diseases in the DAS database underscores the software's relevance and utility in addressing the unique healthcare needs of individuals working in maritime environments. Table 1 illustrates the categories of common disease with their associated symptoms that Doctor Assistant Software has detected.

The inclusion of diseases such as seasickness, decompression sickness, and hypothermia in the DAS database enables healthcare providers to efficiently diagnose and manage medical conditions commonly encountered at sea [3]. By providing access to information on these diseases, DAS enhances the capacity of healthcare professionals to deliver timely and effective care to maritime personnel, thereby improving patient outcomes and safety at sea. Moreover, the presence of common maritime-related diseases in the DAS database facilitates the integration of evidence-based practices and clinical guidelines into maritime healthcare decision-making processes [22]. Healthcare providers can rely on DAS as a trusted resource for accessing up-to-date information and recommendations for managing maritime medical conditions, ensuring adherence to best practices and standards of care.

In conclusion, the inclusion of common maritime-related diseases in the DAS database represents a significant advancement in supporting healthcare delivery in maritime environments. By providing access to relevant and reliable information, DAS enhances the capacity of healthcare providers to deliver high-quality care to maritime personnel, ultimately contributing to the safety, health, and well-being of individuals working at sea [20].

7.1. Ethical Considerations

The study protocol was approved by the ethics committee to ensure adherence to ethical guidelines and standards. No personal information was existed in the data model.

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*At the request of the author, the editorial board has decided to make an exception to publish the author's photo.