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"CHECKPRIVATE": Artificial Intelligence Powered Mobile Application to Enhance the Well-Being of Sexually Transmitted Disease Patients in Sri Lanka under Cultural Barriers

[1]Fernando W.A.M.A.R, [2]Jinadasa U.G.O.C, [3]Amarasinghe B.P.A, [4]Mandalawatta M.T, [5]Mrs. Uthpala Samarakoon, [6]Mrs. Manori Gamage

[1,2,3,4,5,6]Faculty of Computing, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka
Authors E-mail: [1]it20074654@my.sliit.lk, [2]it20115548@my.sliit.lk, [3]it20120016@my.sliit.lk, [4]it20163754@my.sliit.lk, [5]uthpals.s@my.sliit.lk, [6]manori.g@my.sliit.lk

Abstract **- The increase in sexually transmitted diseases (STDs) is a significant public health crisis that requires immediate attention and action. Like many other countries, Sri Lanka faces a significant rise in social diseases due to a lack of education and awareness about the dangers of STDs. There are nine significant STDs affecting populations globally, and in Sri Lanka, they mainly focus on Gonorrhea, Syphilis, Genital Herpes, and HIV diseases. The few available applications only cover a limited number of easily detected STDs, leaving a significant gap in the ability to track and manage the spread of these diseases. Utilizing technology and data to improve the tracking and management of STDs is crucial to preventing the spread of these diseases and providing early intervention and treatment. This requires a comprehensive approach that involves educating the public about the dangers of STDs, increasing access to affordable healthcare services for early detection and treatment, and utilizing technology and data to improve the tracking and management of these diseases. The mobile application targets a wide range of users, including STD patients, recovered patients, and individuals unaware of their STD status. The application harnesses the power of cutting-edge technologies such as image detection, symptom-based identification, prevention methods, doctor and clinic recommendations, and virtual counsellor chat to provide a holistic approach to STD management. It is recognized that CNN, Machine Learning, Artificial Intelligence, and NLP-based solutions can be provided to solve this problem.**

Keywords: STD, Machine Learning, Convolutional Neural Network, Natural Language Processing, Artificial Intelligence.

I. INTRODUCTION

Sexually transmitted diseases (STDs) continue to pose a significant global health challenge, affecting millions worldwide. The term "sexually transmitted diseases" encompasses a broad range of infections that can be transmitted through various forms of sexual contact, including vaginal, anal, and oral sex. While anyone can contract an STD, specific populations, such as young adults and men who have sex with men, may be at a higher risk. The pathogens responsible for STDs are diverse and include bacteria, viruses, parasites, and fungi. Each type of infection presents unique symptoms and complications. For instance, chlamydia and gonorrhoea, caused by bacteria, are two of the most common bacterial STDs. If left untreated, these infections can lead to pelvic inflammatory disease in women, increasing the risk of infertility and ectopic pregnancies. In pregnant individuals, certain STDs can result in stillbirths or newborns with congenital infections. Apart from the immediate health consequences, STDs also contribute to the overall burden of disease. The World Health Organization (WHO) estimates that approximately 376 million new cases of four curable STDs (chlamydia, gonorrhoea, syphilis, and trichomoniasis) are reported annually worldwide [1].

These numbers highlight the urgent need for effective prevention, diagnosis, and treatment strategies to mitigate the spread of STDs and minimize their associated complications. Moreover, the transmission of STDs is not limited to sexual intercourse alone. Some infections, such as herpes and human papillomavirus (HPV), can be transmitted through skin-to-skin contact. These viruses can cause genital warts, cervical cancer, and other malignancies. Some STDs, like HIV, can be transmitted through contaminated needles or from mother to child during childbirth or breastfeeding.To address the global burden of STDs, public health organizations and healthcare

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providers emphasize the importance of comprehensive sexual education, access to affordable and confidential testing, and barrier methods such as condoms. Early detection and prompt treatment of STDs are crucial for preventing complications and reducing transmission rates. By raising awareness and promoting responsible sexual behaviour, it is possible to make significant progress in combating the spread of STDs and safeguarding public health. In Sri Lanka, the prevalence of sexually transmitted diseases (STDs) poses a significant challenge to public health, often shrouded in secrecy and cultural barriers.The Ministry of Health has identified gonorrhoea, syphilis, chlamydia, and HIV as the most common STDs in the country [2]. Alarming trends indicate that the incidence of STDs has been escalating in recent years, particularly among high-risk populations like drug users, sex workers, and men who have sex with men [3].

The surge in STD cases among these vulnerable groups is primarily attributed to a lack of awareness, the persistent social stigma surrounding STDs, and limited access to healthcare facilities. To combat the STD epidemic in Sri Lanka, the government has undertaken several measures. These initiatives include the provision of free STD testing and care, promotion of contraceptive use, and endeavour to raise awareness about the perils of unprotected sex. Despite these efforts, effectively reaching the at-risk populations and eradicating the social stigma associated with STDs pose ongoing challenges. Therefore, it becomes imperative to combat the prevalence of STDs through comprehensive public education campaigns that emphasize preventive measures, heightened awareness among the general populace, and legislation addressing the underlying factors contributing to the transmission of STDs [4]. By prioritizing a multifaceted approach that combines preventive measures, education, and legal frameworks, Sri Lanka can make significant strides in reducing the prevalence of STDs. Public health officials must work diligently to dispel misconceptions, engage with vulnerable communities, and foster an environment of understanding and acceptance. Through sustained efforts, Sri Lanka can create a society where individuals are equipped with knowledge, access to healthcare, and a supportive environment to protect themselves from STDs, ultimately leading to better overall health outcomes for the nation. On a global scale, efforts to prevent and controlSTDs involve increased testing and treatment availability, promoting healthy sexual behaviour, and enhanced education and awareness about STDs.

Stigma, prejudice, and gender inequality must be addressed as they serve as societal and cultural drivers of STD transmission. The WHO has set global goals, including a 90% reduction in the incidence of gonorrhoea, chlamydia, and syphilis by 2030. Achieving these targets will require governments worldwide to allocate more resources, increase spending, and make significant political commitments. The burden of STDs remains substantial worldwide, underscoring the ongoing need for efforts in both prevention and treatment. By addressing the underlying causes of STD transmission and promoting education and knowledge about safe sexual practices, we can effectively reduce the prevalence of STDs in Sri Lanka and worldwide.

II. LITERATURE REVIEW

Sexually transmitted diseases (STDs) pose a significant public health concern in Sri Lanka, exacerbated by cultural barriers and a lack of knowledge about sexual health and prevention methods. In Sri Lankan society, a significant stigma and taboos exist associated with discussing matters related to sexual health openly, leading to fear and shyness among individuals when seeking medical assistance or discussing STD-related concerns with healthcare providers. These cultural barriers, coupled with a general lack of awareness about sexual health and prevention methods, contribute to the spread of STDs within the population. Many individuals are unaware of the importance of safe sexual practices, the availability of testing and treatment options, and the potential consequences of untreated STDs. This lack of knowledge further hinders efforts to control and reduce the prevalence of these infections. To address these challenges, the STD unit in Sri Lanka introduced a web application named Know4sure [5]. However, the app has not been effectively promoted within the local community, resulting in limited awareness and usage among the population. Additionally, the global app, STI Tx Guideline [6], introduced by the Centers for Disease Control and Prevention (CDC), is inaccessible to Sri Lankans due to regional restrictions.

To overcome these issues and bridge the gap in accessible and user-friendly sexual health resources, a research-proposed app called CheckPrivate will be available to the local community. CheckPrivate aims to provide a comprehensive platform that offers valuable information, guidance on prevention methods, and access to testing and treatment services for STDs. The app is designed with a user-friendly interface and incorporates various features to ensure easy navigation and engagement. Through the introduction of CheckPrivate, it is hoped that individuals in Sri Lanka will have a reliable and accessible resource to educate themselves about sexual health, gain knowledge about prevention methods, and overcome the cultural barriers and hesitations surrounding discussions with healthcare professionals. By addressing these underlying issues, it is anticipated that the prevalence of STDs in Sri Lanka can be effectively reduced, leading to improved overall sexual health outcomes within the population.

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A) Identify the Gonorrhoea and Syphilis using Image Processing

Detecting gonorrhoea and syphilis, two common sexually transmitted infections (STIs), poses a significant challenge to public health. Current diagnostic methods often involve invasive and uncomfortable procedures, discouraging early detection and treatment. This delay affects individual health and contributes to the spread of these diseases. Therefore, there is a critical need for a non-invasive and efficient approach, such as image detection, to diagnose gonorrhoea and syphilis accurately and overcome the barriers associated with conventional techniques. Research has demonstrated that computer vision and image processing techniques can identify gonorrhoea and syphilis from camera images of affected areas. A study published in BMC Medical Informatics and Decision Making in 2022 [31] revealed that a machine learning model trained on a dataset of over 10,000 images achieved 97% accuracy in identifying gonorrhoea and 95% accuracy in identifying syphilis. Implementing animage detection solution for gonorrhoea and syphilis can potentially revolutionize STI detection.

This solution could encourage more individuals to undergo timely testing and treatment by offering a non-invasive and convenient diagnostic method. This, in turn, would improve health outcomes for individuals and communities and help curtail the spread of these diseases. Aside from the mentioned research, other studies have highlighted the potential of image detection for STI diagnosis. For instance, a study published in BMC Public Health in 2018 [32] found that using geosocial networking smartphone applications increased the risk of STIs among men who have sex with men. This suggests smartphones can deliver STI prevention and education messages and collect data on STI prevalence and risk factors. In another study published in Procedia Computer Science in 2021 [33], researchers developed a smartphone application called SOS Syphilis, which maps syphilis attention networks. This application enables users to report syphilis cases and track the disease's spread within communities. The development of an image detection solution for gonorrhoea and syphilis holds great promise for improving public health outcomes. By providing a non-invasive and convenient diagnostic method, this solution could encourage more individuals to seek timely testing and treatment, leading to enhanced health outcomes for individuals and communities and helping curb the spread of these diseases.

B) Predict the Sexually Transmitted Diseases Using Symptoms

Some individuals diagnosed with STDs may choose not to capture photographs of the affected areas to determine the specific ST disease they are infected with. An understanding can be derived from the exhibited symptoms alone. Numerous resources are available to learn more about STDs; however, these resources provide individual information on each disease. Therefore, if an individual wants to know which disease they are infected with, they must go through all the symptoms of all ST-related diseases. Some studies have already been conducted for general disease prediction using symptoms [22], but they are not intended for the treatment of STDs. It would be a significant advancement to have a system that predicts ST disease after the patient records their symptoms [23]. As a result, a component has been created to extract symptoms from questionnaires and identify STDs. A set of binary questions has been developed for patients to answer, and based on the responses, the proposed system will predict the diseases that can be contracted and the likelihood of being infected by predicted STDs.

C) Giving the Personalized Recommendations

In Sri Lanka, there exists a significant lack of awareness and knowledge regarding sexually transmitted diseases (STDs), including their causes, prevention techniques, and available healthcare providers [14], [15]. A survey conducted in the local community highlighted the magnitude of this issue, revealing a widespread lack of understanding among the population. The research landscape primarily consists of papers centred on the medical field, with a limited focus on information and communication technology (ICT). Although a few research papers address sexually transmitted diseases in Sri Lanka, their emphasis primarily lies in the medical aspects of these diseases. While personalized recommendations for common diseases are available, they do not specifically cater to STDs. It is essential to provide personalized recommendations that encompass prevention techniques for sexual health protection.[12] Furthermore, there is a lack of research papers highlighting features such as locating nearby STD centres and hospitals and filtering doctors based on gender, availability, and contact information at each hospital [14].

CheckPrivate is a comprehensive platform offering users valuable information on STD prevention methods, both before and after exposure. The system incorporates features such as location tracking, enabling users to quickly locatethe nearest healthcare providers, whether in the private or government sectors. Additionally, users can search for doctors based on their gender preference, and the system provides doctor

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reviews to assist in selecting the most suitable healthcare professional based on the user's needs. Furthermore, the system displays the availability of doctors, ensuring that users do not waste their valuable time searching for specialized expertise. By introducing CheckPrivate, this proposed system aims to bridge the knowledge gap regarding STDs in Sri Lanka, providing users with accessible information on prevention techniques and facilitating connections with relevant healthcare providers. Through this comprehensive and user-friendly platform, individuals will be empowered to take proactive measures in managing their sexual health, ultimately contributing to a healthier and more informed society.

D) Provide the Mental Health Supporter as a Virtual Counsellor

STD patients often face significant challenges related to their physical and mental well-being. Mental health issues associated with STDs can impose a substantial psychological and social burden on individuals. This applies to patients currently undergoing treatment, those who have recovered, and even individuals unaware of their STD status. In addition to physical complications, they also encounter various psychological problems. Traditional methods like counselling, support groups, and education on coping mechanisms for managing mental health are available. However, there is a lack of online platforms specifically designed to support STD patients in Sri Lanka. Another reason for selecting this virtual counsellor component is its compatibility with existing IT platforms.

In Sri Lanka, a web application called Know4sure serves as a reliable means to identify and utilize this component. It specifically caters to government-standard hospitals and clinics, functioning as an e-channeling app designed to assess disease risks. However, it is essential to note that this application does not address patients' mental health concerns. Additionally, the CDC app lacks support for individuals with sexually transmitted diseases (STDs) and fails to address their mental health issues. A comparison of STD-related research papers was conducted in selecting a virtual counsellor component. One of these papers focused on STD mental health but did not provide any supportive measures for patients [1]. None of the research papers discussed the inclusion of AI-assisted counsellors, psychological support, or patient-to-patient conversations.

Additionally, there is no process for identifying psychological treatment or different counselling approaches within this context [1] [2] [3] [4] [5]. Recognizing this issue through a research survey, a potential solution has been identified: virtual counsellors equipped with AI and NLP-based solutions. These counsellors would utilize a simple questionnaire to determine the appropriate treatment approach for each user. Based on the predicted needs, the virtual counsellor would engage in conversations to provide personalized support and guidance.

III. METHODOLOGY

The below Fig. 1 diagram represents all four components of this system and how each component utilized its functionality through the mobile application.

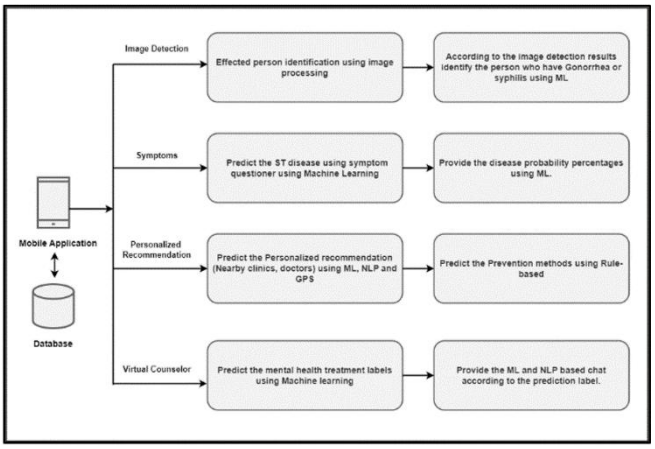

Figure 1: Overview of the system diagram

A) Provide the software solution for identifying Gonorrhoea and Syphilis using image detection

The method for the detection of gonorrhoea and syphilis, the use of photo processing and deep mastering, consisted of several key steps. To train the convolutional neural network (CNN) version, a complete library of images displaying gonorrhoea and syphilis infections was gathered from legit clinical sources, which include medical databases and research articles. The dataset was carefully curated to cover illnesses at extraordinary ranges and shows, ensuring a diverse variety of instances [7], [8], [9], [10]. Pre-processing techniques were hired to normalize the pix and assemble them for similar evaluation. This involved scaling the images and converting them to a standardized colour space. Using these pre-processing steps, the dataset changed as it should be transformed, improving the model's capability to extract applicable features and styles. A deep getting-to-know method changed to using three extraordinary architectures: Xception, ResNet50v2, and VGG16 [30], [29]. These fashions, pre-trained on big-scale photograph datasets, have been selected for her capability to seize excessive-level capabilities, which are essential for correct ailment detection. The dataset was divided into a 70:30 split, with 70% of the records used for education and the final 30% for trying out and assessment.

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The CNN models, namely Xception, ResNet50v2, and VGG16, had been educated on the education set and quality-tuned to optimize their performance [29], [30]. Augmentation strategies, which include rotation, shearing, and zooming, were carried out throughout the training process. These strategies enhanced the dataset, introducing variations and permitting the fashions to more efficiently generalize and understand various infection styles. To examine the performance of the models, numerous metrics had been employed, collectively with accuracy, precision, recollect, and loss.The accuracy of each version comes to be computed on the test set, thinking of an assessment of the architectures. Among the evaluated models, Xception has proven to have a lovely accuracy, indicating its superior performance in detecting gonorrhoea and syphilis infections from snapshots.

Additionally, the Xceptionarchitecture with ResNet50v2 and VGG16 was assessed. This evaluation concerned comparing their respective accuracies, assessing their precision, recollect, and loss values, and analyzing their overall performance at the check set.By evaluating those architectures, it was decided that Xception outperformed ResNet50v2 and VGG16 regarding accuracy and average detection functionality. In precis, the technique for detecting gonorrhoea and syphilis through photo processing and deep learning worried facts series, pre-processing, model preference (Xception, ResNet50v2, and VGG16), dataset partitioning, model training, and performance evaluation. Augmentation techniques had been applied to beautify the fashions' capacity to apprehend various illness styles. The outcomes indicated that the Xception structure exhibited the best accuracy in several of the evaluated models, signifying its effectiveness in detecting gonorrhoea and syphilis infections from photographs.

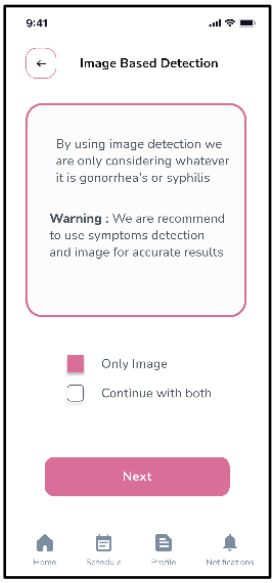

Figure 2: Image Detection UI02

Figure 3: Image Detection UI02

B) Develop a component that extracts the symptoms from the questionnaire and identifies the STD

This research focuses on identifying sexually transmitted diseases (STDs) and sexually transmitted infections (STIs) using specific symptoms. The proposed application seeks to provide users with an assessment of their chances of contracting an STD based on their symptoms. This evaluation is generated by asking users a series of binary questions totalling 20. These questions are based on expert knowledge and consider various factors, including the user's symptoms, medical history, and physical changes. A comprehensive dataset was compiled to ensure the accuracy of the assessment. The information was gathered from publicly available datasets, reputable websites, and medical blogs that provide STD information [11], [19]. This realistic data serves as the research's foundation, allowing for development of an effective symptom-based identification system. Several pre-processing steps were completed before using the dataset for classification. These procedures are critical for preparing data for machine learning models. Lowercasing and stripping were the first pre-processing techniques, which involved converting all text to lowercase and removing unnecessary whitespace. This step ensures that the dataset is uniform and consistent.

Encoding categorical variables was the next pre-processing step. Because machine learning algorithms are typically trained on numerical data, categorical variables such as symptoms and disease labels were converted to numericalvalues. This transformation enables the algorithms to process the data and generate accurate predictions effectively. Furthermore, disease labels were assigned numerical values to aid in the classification process. The models can learn to associate specific symptoms with STDs or

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STIs by assigning distinct numerical identifiers to different diseases. This mapping improves the machine learning models' overall performance and interpretability. After pre-processing, the dataset was divided into training and test data sets. The training set contained 80% of the data, while the test set received 20%. This division ensures that the models are trained on a large amount of data while allowing for rigorous performance testing on previously unseen instances.

Several machine learning-based supervised learning algorithms were used in this study. The Random Forest classifier, XGBoost, Naive Bayes classifier, and k nearest neighbours' classifier are among them [22], [24], [25], [31]. Each algorithm brings to the task of symptom-based identification its own set of strengths and characteristics. Researchers can determine the most effective approach for accurate STD and STI identification by comparing the results of these algorithms.In conclusion, by developing an application, this research component focuses on leveraging specific symptoms to identify STDs and STIs. Machine learning models are trained to predict the likelihood of infection based on user-provided symptoms using a large dataset and various pre-processing techniques. The comparison of various algorithms aids in determining the best approach for adequate identification. This study has the potential to improve early detection and prevention efforts, leading to better STD and STI management and control in the future.

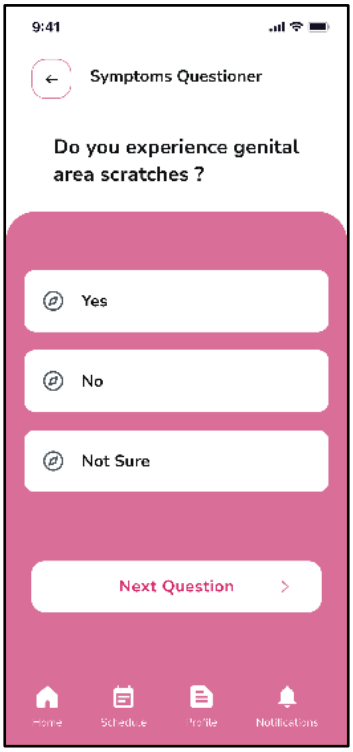

Figure 4: Symptoms Identification UI 01

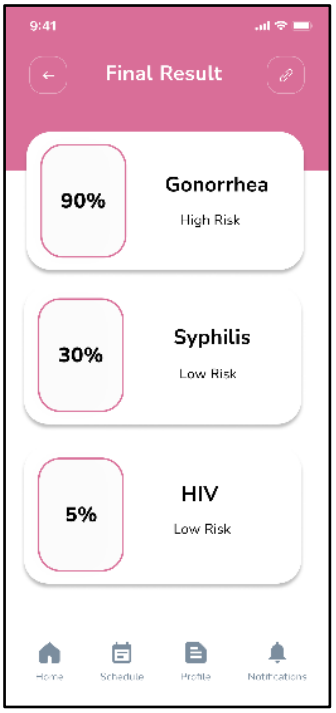

Figure 5: Symptoms Identification UI 02

C) A platform for managing STDs that offers resources for a personalized recommendation

This research component mainly focuses on personalized prevention methods, availability of the specialized venereologist doctor recommendation, and health care provider's details. For the doctor recommendation and health care providers, the information dataset was prepared with a manual process, and data were collected through the annual report of the STD unit and got some support from the relevant parties, too. In the doctor recommendation part, the structures and attributes of the doctor review dataset, including the different aspects (Staff, Punctuality, Helpfulness, Knowledgeability) and the corresponding sentiment labels. The architectural design of the deep learning models used for multi-aspect sentiment analysis. Here, the model is based on theRecurrent Neural Network (RNN) and the architecture used for the text classifications. Specify the framework and libraries for implementing the methodology, including TensorFlow, Keras, sci-kit-learn, NumPy, pandas, matplotlib, and seaborn. Based on the RNN architecture here, the model accuracy test is according to these Long Short Term Memory algorithms (LSTM) and Gated Recurrent Unit algorithm (GRU) [27], [28].

The pre-processing steps applied to the text data include tokenization, lowercasing, removal of stop words, and encoding of the data into numerical representations. Optimization algorithms, loss functions, and evaluation metrics were used during the training process. Training data takes 75% and test data 25% from the whole dataset for the

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health care providers. The information section presents the methodology for identifying the best clinics based on gender, user location, and maximum distance [12]. The research employed a data-driven approach, leveraging clinic data, doctor data, and doctor scores to assess and rank clinics according to user-specific criteria. The location was split into separate Longitude and Latitudes. The GPS gives the user the current location, making it easy to track it [13]. The Haversine formula was employed to calculate the distances between each clinic's location (specified by latitude and longitude) and the user's location.

The data frame was filtered to retain only those rows where the 'distance' was less than or equal to the specified maximum distance to narrow down the list of clinics based on the user's maximum distance preference. The filtered data frame was sorted based on the 'distance' column in ascending order. The mentioned methodology enabled the identification of the best clinics based on the user's gender, location, and maximum distance. By leveraging the integration of clinic data, doctor data, and doctor scores, the research provided valuable insights for users seeking suitable clinics based on their specific preferences. The rule-based method is used for the prevention technique recommendation, and it will generate accurate data for the input that belongs to the user inputs [35].

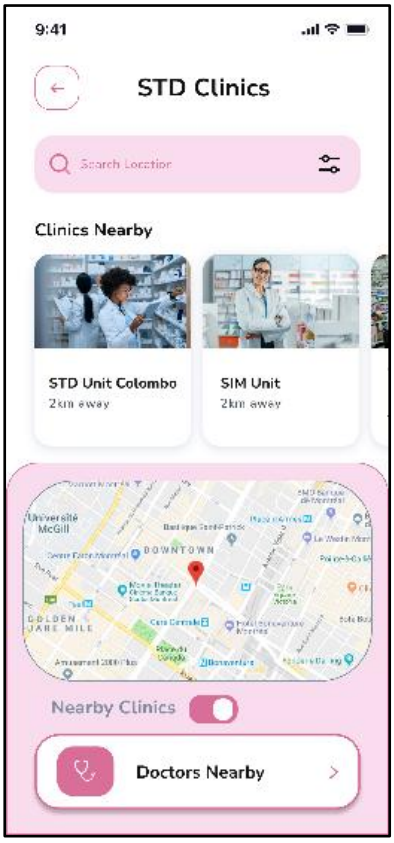

Figure 6: Personalized Recommendation UI01

Figure 7: Personalized Recommendation UI02

D) Providing virtual counsellor to assist STD patients with mental health problems

This research component demonstrates ways to utilize Machine Learning (ML) and Natural Language Process (NLP) principles for STD mental health [17], [18], [20]. This component is referred to as a virtual counsellor. The virtual counsellor has two different models. The first model gives the prediction about treatment type for users. Thisprediction can be counselling, medical treatment, and self-care activities. Here, ask out compulsory questions and predict the treatment type. A dataset was created by gathering realistic data from public datasets, websites, and blogs devoted to Sri Lankans. The dataset was divided into training and test data, each having 30% and 70% of the total data. The dataset was then enhanced utilizing augmentation approaches to improve accuracy, and the optimal technique with the highest accuracy was chosen. This model will use ML-based supervised learning algorithms. Those are the Random Forest classifier, Support Vector Machine SVM, XGBoost, and decision tree classifier [21], [22], [23], [31] among these random forest classifiers get high accuracy.

Here, use the pre-processing techniques such as data loading, label encoding, handling missing data, feature scaling/normalization, and train-test split. Here, use the missing Data Filters to remove rows or columns with missing values, imputing missing values with statistical measures, or use advanced methods like interpolation. The second approach focuses on natural language processing. Here, individuals can

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ask questions concerning their predictions. A dataset was created by gathering realistic data from public datasets, websites, and blogs devoted to relevant Sri Lanka. This will be constructed utilizing the best Recurrent Neural Network (RNN) architecture. The best accuracy is attained by combining the Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) algorithms.The five main components of the virtual counsellor architecture are user input analysis, dialogue management, information retrieval, data source, and response generation. The user's text entry initiates the procedure to begin. The user will enter a question. The user input analysis component receives the user request and analyses it to determine the ailment the user has provided and any applicable data [16].

After identifying the question from the data source using the information retrieval component, the virtual counsellor will ask clarifying questions once he has chosen the best interpretation. The data source will be preferable to web-based or knowledge-based alternatives. After retrieving data, a response generator will generate a human-like, natural-language answer for the user. The dialogue management component monitors and modifies the conversational context. Use pre-processing techniques such as text cleaning, tokenization, lowercasing, stop word removal, Lemmatization or Stemming, Spell Checking and Correction, and Handling Rare Words or Out-of-Vocabulary (OOV) Words. These two models specify the framework and libraries for implementing the methodology, including TensorFlow with Keras, sci-kit-learn, NumPy, pandas, matplotlib, and seaborn.

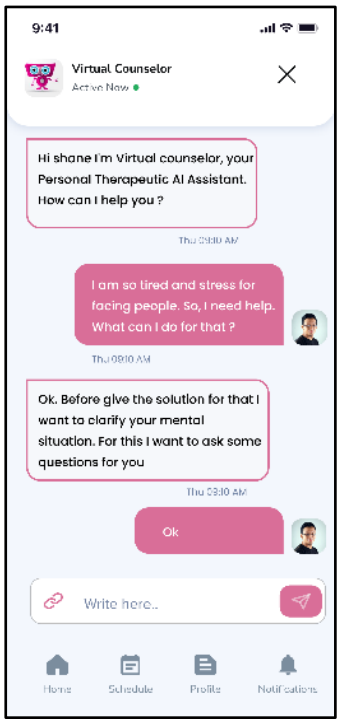

Figure 8: Virtual Counselor UI 01

IV. RESULT AND DISCUSSION

The evaluation of gonorrhoea and syphilis detection models, namely Xception, ResNet50v2, and VGG16, revealed Xception to be the most effective in accurately identifying infections. Metrics such as accuracy, precision, and recall were computed on the test set to assess the models' performance, with Xception consistently outperforming the other architectures. The Xception model exhibited a more diagonal distribution in the predicted values, indicating higher accuracy than ResNet50v2 and VGG16. This superiority was further supported by the visual comparison of evaluation results, where Xception consistently demonstrated better accuracy, macro average, and weighted average performance. These findings highlight Xception as the optimal architecture for accurate gonorrhoea and syphilis detection. Confusion matrices provided insights into the models' classification accuracy for each class, further confirming Xception's superiority. Overall, the results in Figure 9 demonstrate that Xception outperforms ResNet50v2 and VGG16, making it the recommended choice for reliable disease detection in healthcare settings.

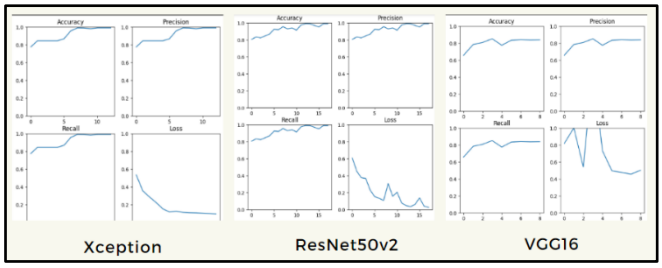

Figure 9: Accuracy of the Image Detection Component

STD prediction using symptoms component models was assessed using accuracy, precision, recall, and F1-score metrics. Random Forest and XGBoost outperformed all other algorithms tested regarding the accuracy, precision, recall, and F1 score. The Naive Bayes algorithm performed moderately well, while the K-nearest neighbours (KNN) algorithm performed poorly. It is critical to consider these evaluation results when selecting the best algorithm for STD prediction using the symptoms component. Figure 10 below depicts the performance metrics of the various algorithms that train the models on the given dataset.

	Algorithm	Accuracy	Precision	Recall	F1-Score
0	Random Forest	0.985714	0.987143	0.985714	0.985805
1	XGBoost	0.985714	0.986813	0.985714	0.985451
2	Naive Bayes	0.742857	0.786250	0.742857	0.747795
3	KNN	0.900000	0.914773	0.900000	0.895504

Figure 10: Accuracy of the Symptoms Prediction Component

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The personalized recommendation component model is based on the doctor's recommendation part. Here, the model is trained according to the Recurrent Neural Network architecture (RNN), and based on that architecture, to test the accuracy, it takes two algorithms, which are called Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) [27], [28]. Both algorithms gave the same accuracy because, according to the RNN, both algorithms return the same output. So here, the doctor reviews are taken according to the stars. The stars can be between 1 to 5. The value of the stars will be shown in Figure 11.

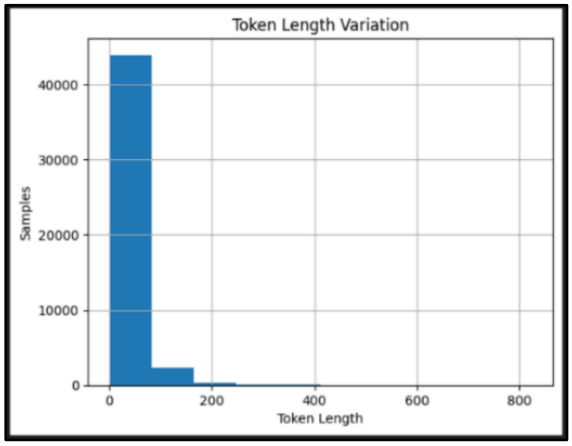

Figure 11: Token Length Variation

The accuracy of the doctor's recommendation part shows the review of the doctor with the staff's support, punctuality, helpfulness, and knowledgeability. The validation of metrics falls under the desired levels of accuracy, precision, recall, and F1 scores. Figure 12 shows the classification report of the metrics and the most accurate ones. By examining the report's display, valuable insights can be gained regarding the reliability and effectiveness of the system's recommendations.

Classification Report - Staff

	precision	recall	f1-score	support
1 star	0.89	0.91	0.90	2174
2 star	1.00	0.90	0.95	812
3 star	0.94	0.89	0.92	1466
4 star	0.97	0.90	0.93	2891
5 star	0.98	0.99	0.99	39309
accuracy			0.98	46652
macro avg	0.96	0.92	0.94	46652
weighted avg	0.98	0.98	0.98	46652

Classification Report - Helpfulness

	precision	recall	f1-score	support
1 star	0.89	0.91	0.90	3235
2 star	0.98	0.92	0.95	737
3 star	0.97	0.89	0.93	577
4 star	0.97	0.89	0.93	951
5 star	0.99	0.99	0.99	41152
accuracy			0.98	46652
macro avg	0.96	0.92	0.94	46652
weighted avg	0.98	0.98	0.98	46652

Classification Report - Punctuality

	precision	recall	f1-score	support
1 star	0.91	0.90	0.91	2180
2 star	1.00	0.88	0.94	832
3 star	0.94	0.91	0.92	1641
4 star	0.96	0.91	0.93	4021
5 star	0.98	0.99	0.98	37978
accuracy			0.97	46652
macro avg	0.96	0.92	0.94	46652
weighted avg	0.97	0.97	0.97	46652

Classification Report - Knowlegebility

	precision	recall	f1-score	support
1 star	0.88	0.91	0.89	2419
2 star	0.97	0.90	0.93	842
3 star	0.98	0.90	0.94	864
4 star	0.98	0.90	0.94	954
5 star	0.99	0.99	0.99	41573
accuracy			0.98	46652
macro avg	0.96	0.92	0.94	46652
weighted avg	0.98	0.98	0.98	46652

Figure 12: Classification Report of the Doctor's Recommendation

The virtual counsellor has two models. In the mental health treatment type data set before selecting the best model using Random Forest, Decision Tree, SVM, and XGBoost classifiers [21], [22], [23], [31]. Here, we get the best accuracy using a confusion matrix. So, the Random Forest classifier's actual predicted value distribution is more closely diagonal. Random Forest classifiers are tested to select the best-performing model and provide the highest accuracy. The final model is shown in Figure 13, along with the actual predicted value distribution.

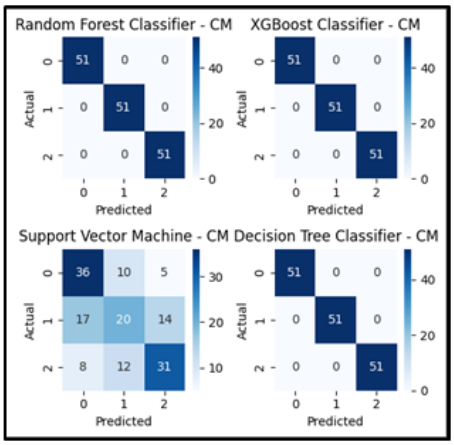

Figure 13: Confusion Matrix for all the four algorithms

The second model extensively evaluates three datasets in JSON format before determining the optimal model, employing GRU and LSTM classifiers, both of which belong to the RNN architecture. These models exhibit similar behaviours due to their shared architecture. Gated Recurrent Units (GRUs) are carefully examined to determine the model with the highest accuracy and efficiency. The resulting accuracies of the final model and the macro average and weighted average are presented in Figure 14.

Classification Report

	precision	recall	f1-score	support	
accuracy			0.98	384	Counselor dataset
macro avg	0.98	0.98	0.98	384	
weighted avg	0.98	0.98	0.98	384	
accuracy			1.00	305	Self-Care Activity dataset
macro avg	1.00	1.00	1.00	305	
weighted avg	1.00	1.00	1.00	305	
accuracy			0.99	309	Medical Treatment dataset
macro avg	0.99	0.99	0.99	309	
weighted avg	0.99	0.99	0.99	309	

Figure 14: Accuracy of the Virtual Counsellor Component

V. CONCLUSION

In conclusion, developing a mobile application for identifying STD patients in the pre-stages using image detection and symptom analysis holds great potential for improving public health and promoting early intervention. This research paper has presented the design and implementation of such an application, which not only aids in the early detection of STDs but also provides valuable

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recommendations for prevention methods, information on nearby clinics, and personalized doctor recommendations. Additionally, the app's virtual counsellor chat feature allows users to receive mental health support and guidance. The research paper emphasizes the significance of using image detection technology and symptom analysis for the early identification of STDs. Through image recognition algorithms, the mobile app can assess visual symptoms, enabling users to take proactive measures, seek medical care, and prevent the spread of STDs. The app also provides personalized prevention recommendations, educating users on reducing risks. Additionally, it integrates information on nearby clinics and doctor recommendations, facilitating easy access to specialized healthcare. Moreover, the app includes a virtual counsellor chat, addressing the mental health aspect by offering a confidential platform for users to seek guidance and support during STD diagnosis and treatment.

Furthermore, it is worth noting that in this topic, we have encountered ethical challenges in data gathering and public engagement. We obtained data using an ethical clearance letter to address these concerns, ensuring that our research adhered to ethical standards. This approach posed several challenges, but it was essential to maintain the integrity and credibility of our work. Overall, developing a mobile application for identifying STD patients in the pre-stages using image detection symptom analysis and providing recommendations for prevention methods, nearby clinics, and virtual counsellor chat represents a significant advancement in the field of sexual health. The application has the potential to empower individuals, reduce the transmission of STDs, improve access to healthcare services, and provide necessary mental health support. Continued research and development in this area will further enhance the effectiveness and impact of such applications, ultimately leading to better sexual health outcomes for individuals and communities. The application's scope of diseases will be widened to cover the most prevalent diseases in Sri Lanka in the future, along with the release of a web version of the application.

Additionally, we aim to enhance the mobile application's performance to facilitate its commercialization. One key area of improvement lies in addressing the limited dataset, which resulted in lower accuracy for the recommendation models. Utilizing more extensive and diverse datasets can improve the accuracy of the overall proposed system.

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