VIDEO-CALL PLATFORMS FOR ONLINE HEALTHCARE

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Abstract - This research work is the first phase of a larger project that aims to identify and develop mobile computing services to benefit patients and physicians while improving health outcomes and reducing healthcare costs. The work reviews existing healthcare teleconferencing software platforms that enable online doctor appointments and nursing at distance. This provides secure and green solution for doctor appointments. It will helps in reducing the traffic which in turn improves the air quality and provides a convenient communication method for several patient groups such as elderly people. Healthcare requirements have been determined by professional experts from m-Health Solutions, the project industry partner. A preliminary research identified and evaluated a list of available teleconferencing platforms that meet the healthcare requirements. Healthcare experts reviewed this list and suggested to review three teleconferencing software platforms for supporting online healthcare services. A comprehensive testing strategy has been designed to evaluate the selected teleconferencing platforms and to identify the necessary online healthcare services that are not implemented by the current teleconferencing technologies. This paper presents details of the preliminary research, the testing strategy used and the testing results including quantitative and qualitative analysis.

Index Terms - Online healthcare, telemedicine, software engineering, teleconferencing, eHealth.

I. INTRODUCTION

The medical industry has always made certain to use technological advancements in various different aspects, the initial approach is changing the way physician tackle interacting with patients on a day to day basis by using tools and techniques that benefit all the key members using technology. Each year there is a rise in the number of diagnosed diseases especially with seniors, the emergency department also keeps seeing a rise of the length of stay of people admitted to hospital. The Canadian Institute for Health Information said in an article [1] "When looking at all ED visits in 2016–2017, 9 out of 10 people left the ED within 7.8 hours. This means 10% of people had a longer ED visit." As the number of patients rises there will be a need for more physician, nurses, and caretakers to maintain the services being provided at present. Seniors who are homebound do not receive personal care by a skilled nurse are obligated to travel to the nearest clinic to obtain the needed care or consultation. This is a major limitation on the quality and type service delivered in a timely manner.

The rising in waiting times in the ED and the need for more medical professionals require sustainable solutions. These solutions should change the current healthcare methods in ways that maximizing the utilization of the available medical professional while improve the quality of the healthcare services. If physicians were able to communicate with patients from anywhere around the world using teleconferencing, it would reduce wait times and ease the stress of physicians, nurses, and caretakers. Can the available teleconferencing technologies address this problem? The patient could do a teleconference video call to explain their problem but this raises the question: which teleconference software or technology is the most appropriate for online healthcare services? Several different platforms are trying to answer this question.

The goal of this work is to improve accessibility in healthcare by identifying/develop an appropriate online and green solution that uses teleconference video calls, mobile computing, cloud computing, and wearables to meet the healthcare requirements. Maintaining Privacy, ensuring communication security and the ease of use are the main three motivations for reviewing various teleconference systems to select an appropriate platform for the project. The remaining parts of the paper present background, methodology, results, analysis and conclusion.

II. BACKGROUND

Computing and communication technologies facilitate online health-related activities such as online doctor's appointments, getting the medical test results and finding useful health information online [2]. This work focuses of the online doctor's appointments because it makes the appointments more flexible and significantly decreases the efforts and costs [3-5] associated with the face to face appointments such as transportation. Eliminating the transportation needed for the face-to face appointment has positive impacts on the society towards improving the traffic and support green environment. additionally, the online health services improve the quality of life significantly [4]

Although computing and communication technologies improved the online health-related services, their usage rate by older patients is lower than younger patients. Research in united states showed that 32% of the patients aged between sixty-five and seventy-four

use the online health-related tools but only 14.5% of the older patients rely on these online tools [6]. Research shown that this usage rate is changing from country to country in Europe. For example, the usage rate of these online health services in Greece and Denmark is 23% and 62% respectively [7]. Patients who use the online health services confirmed their feeling more pleased than using the traditional health services [8].

This work evaluates the available teleconference video call platforms for the online healthcare services. It will test privacy, security, ease of use and other requirements for healthcare services. Many teleconference platforms are available but few systems meet the requirements of privacy, security and usability for improving the quality of patient's life. This evaluation paves the way for identifying how to combine cloud computing and wearables for promoting the usage of the online health services

III. METHODOLOGIES

This section introduces the methods used to identify top teleconferencing software platforms and evaluate the strengths and weaknesses when using them for online healthcare application

A. Preliminary evaluation to identify top teleconferencing platforms that support online healthcare appointments

The purpose of the preliminary evaluation is to filter or reduce the number of teleconference platforms that will be tested comprehensibly. The google search produces many video call platforms that support healthcare practices.

A simple search and evaluate method is proposed to generate an initial list of teleconferencing platforms that support online healthcare appointments. The list is generated based on several google search transactions with various keywords such as online healthcare, telehealth and eHealth. Each software in this list is assigned a score based on evaluating all its features in usability, security, healthcare support and portability. Each feature is assigned a weight according its importance for the patient and the service provider to reflect the feature significance to the stakeholders as shown in Fig 1.

Each feature of the software is evaluated based on user reviews and the official website of each software. If several users (more than ten) complain about a particular feature. The score of this feature will be set to 0. The feature described on the software official website and no user complained about it or appreciated it will get 100% score.

The total score of all features for each software in the list is calculated. The list then is sorted in a descending order based on the total score and the top teleconference platforms in the list are selected for further testing
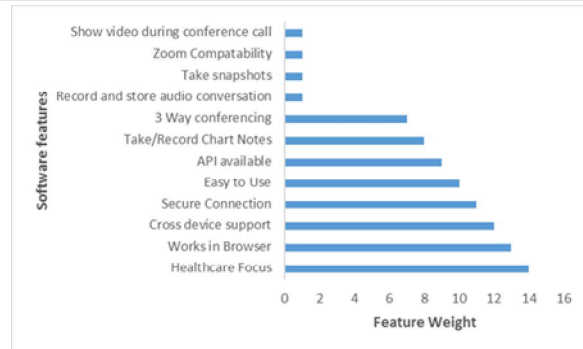

Fig1: Feature weights for evaluating the platforms

B. Testing Strategy

The objective of the testing strategy is to investigate the healthcare-related attributes of each software in the teleconference technologies selected based on the preliminary evaluation. Forty-two test cases are designed to test teleconferencing software selected using the preliminary evaluation. The test cases check the software attributes: usability, portability, security, the API utility and healthcare focus

The usability, portability, security and API are the most important technical teleconferencing attributes to be tested for online healthcare applications. Teleconference applications with user friendly interfaces should build a great user experience for physician /healthcare practitioners and. patients. Running the teleconferencing using web browsers is better than standalone application that would require downloading supporting libraries. Easy to use is a major benefit for healthcare-based applications that are accessed by people of diverse age groups. This promotes using the online healthcare services. Portability enables cross-device support to reach patients with various devices. Security is the highest priority when handling healthcare data, having a secure connection to access accounts and communicate with patients during doctor appointments is a requirement that must be mandated by teleconference technology. Teleconference technology with access to API enables communication with other applicationsfor sharing data. This provide great opportunities to extend the functionality of the teleconferencing technology and using new technologies such as wearables and machine learning. The healthcare focus is the essential attribute to evaluate a teleconferencing technology. Healthcare focus refers to ability of the teleconferencing application to provide the healthcare-related services for doctors and patients such as taking notes. In a medical environment taking notes is critical for providing details to patients about prescriptions and information discussed during the online appointment. Teleconferencing applications that allow recording or logging notes using both visual and audio format would be rated much higher over apps that do not provide these capabilities. Another healthcare-related service is the capability of conferencing multiple guests during a video call. This would also include

having the ability to share videos, images in a secure manner where a firewall would be running in the background. Conferencing features should also include a sharing of screen option to display any form of reports or results that would be needed to share with the recipients.

The forty-two test cases check the attributes: usability, portability, security, the API utility and healthcare focus see fig 2. twenty test cases are designed to evaluate the usability of each software in the selected list. These test cases check the easiness of the following: login process; changing font size and color setting; using teleconference software options such as recording and screenshots; accessing the account details, using the photo option such as checking the quality of images taken. Nine test cases on the usability test cases are shown in fig 3.1. Seven test cases are designed to evaluate the portability of each software in the selected list. These test cases check the compatibility with different internet browsers and various types of mobile devices. Five test cases to test healthcare focus of each software. The cases check adding a new doctor, sharing medical reports with privacy see figure 3.2. Four test cases are designed to evaluate the API options such as accessing the API see fig 3.3
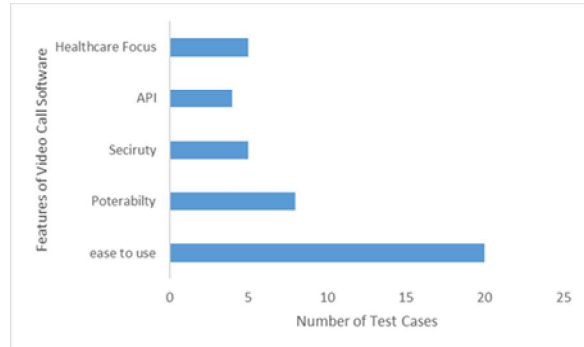

Fig 2: The distribution of the forty-two test cases over the five attributes of teleconference software

Five security test cases are show in Fig 3.4 and five healthcare focus test cases are shown in Fig 3.5. The results of these test cases are the main criteria of selecting a platform for the project. The attributes of each test case include: id, test case description, test case procedure and the expected results. The tester follows the test case procedure step by step and write the actual results of the test case which will be compared to the expected result later for analysis purposes

The tester also should describe any unexpected results or errors during conducting each test case.

ID	Test Case Description	Test Case Procedure	Expected Output
1. Check create an account with username and password only			
TC01	Checking new new account is created using username and password only	1: Open the web page of the software 2: create and account 3: Enter user name and password 4: Click create the account	The account is created succcssfully
2. check change font size and color settings			
TC02	Checking change font and color settings functionlity	1: login to your account 2: change the font size to 24 3: change the text background to blue 4: change the text color to yellow 5: apply these changes	font and colors changed succcssfully
TC03	checking the usability of changeing font size	1: count number of clicks to change the font 2: check wether new window will be poped up	increase/decrease the fond size in one click without poping any new windows
TC04	checking the usability of changing text color	1: count number of clicks to change the font 2: check wether new window will be poped up	change the text color in one click without poping any new windows
TC05	checking the usability of changing text background color	1: count number of clicks to change the font 2: check wether new window will be poped up	Change the text background color in one click without poping any new windows
3. check using voice to operate the system			
TC06	Checking login using voice	1: open the software app 2: use your voice to login (assumming the username and the password are stored in the browser)	the user will be logged on
TC07	Checking calling a specific person	1: use the appropriate command to the product you test for example use call Scott where Scott is registered into the contact list	Scott will be contacted
TC08	Checking end the conversation	1: use the appropriate command to the product you test for ending the conversation for example say END	The conversation will be ended.
TC09	Checking replay a video	1: use the appropriate command to the product you test for replay the ended video for exampl say Replay	The video will be replayed

Fig 3.1: Usability Test Cases

ID	Test Case Description	Test Case Procedure	Expected Output
1. Check running the software using different internet browsers			
TC11	Checking running the software from IE	1: use latest IE to open the software 2: run a conversation 3: play a video 4: close the software	all the functions work
TC12	Checking running the software from Firefox	1: use latest Firefox to open the software 2: run a conversation 3: play a video 4: close the software	all the functions work
TC13	Checking running the software from Google Chrome	1: use latest Chrome to open the software 2: run a conversation 3: play a video 4: close the software	all the functions work
TC14	Checking running the software from Safari Chrome	1: use latest safari to open the software 2: run a conversation 3: play a video 4: close the software	all the functions work
2. Check running the software using various devices			
TC15	Checking running the software using an android smart phone	1: use an android smartphone to open the software 2: run a conversation 3: play a video 4: close the software	all the functions work
TC16	Checking running the software using an Iphone smart phone	1: use an Iphone smartphone to open the software 2: run a conversation 3: play a video 4: close the software	all the functions work
TC17	Checking running the software using an IPAD	1: use an IPAD to open the software 2: run a conversation 3: play a video 4: close the software	all the functions work

Fig 3.2: Portability Test Cases

ID	Test Case Description	Test Case Procedure	Expected Output
1. Access to API			
TC31	Can access and implement API of the system	1: Download or access API of system 2: Implement basic data access to test API	Associated code compiles and successfully transfers test data
2. API Integration			
TC32	Share data between video system and scheduling application	1: Create test date data in video system 2: Implement functionality for date data to pass between the two systems 3: Attempt to pass data	Date data should be transferred between applications, the scheduling app updated to match what was just received
TC33	Create username and password via API implementation	1: Implement functionality based off the API to create new username and password 2: Attempt to make new username and password outside of the system based off of the built functionality via the API	A new username and password has been created through functionality provided by the API
TC34	Checking to see if you can create an account from API	1: make account from API	Account should be created

Fig 3.3: API Test Cases

ID	Test Case Description	Test Case Procedure	Expected Output
1. Multiple Logins			
TC21	Log into the system from the same machine	1: Log into the system with one browser/session 2: Perform basic operation, ex check settings 3: Open a new browser session/instance of the software and log into the same account	Second login attempt should be prompted with 'User already logged into the system elsewhere' response. Second session should not allow user into the system
TC22	Log into the system from different machines	1: Log into the system through one machine's browser/session 2: Perform basic operation, ex check settings 3: Using a different machine, attempt to log into the system through a new session	Second login attempt should be prompted with 'User already logged into the system elsewhere' response. Second session should not allow user into the system
2. Web Browser Security			
TC23	Confirm all pages served through a web browser are a https url	1: Access the system through a web browser 2: Search through all pages of the site. Check to make sure each url is served securely via https	All web pages should be prepended by https in the url
TC24	Check if Form pages (ex, login page) can be locally circumvented	1: Access the system through a web browser 2: Find a page that accepts data/has a form format, such as a login page or other data submission 3: Enter web browser console by hitting f12 4: Find and remove any form of client side validation. Ex, javascript files that handle input elements 5: Attempt to enter incorrect or invasive data	Web page should return an error due to backend/server side validation not accepting data.
3. Mobile Application Security			
TC25	Access the system through a mobile device such as a phone or tablet	1: Access the system with a mobile device 2: See how the system is presented, either through a web browser or a native application	Operations with the system should be hosted through an in app web browser or a default browser of the device. Natively developed apps cannot be definitively proven to be secure without investigating entire codebase

Fig 3.4: Security Test Cases

ID	Test Case Description	Test Case Procedure	Expected Output
1. Adding doctor to contact list			
TC41	Adding doctors to contact list using regular search	1: Enter the name of doctor to search in search bar 2: From the result found add the doctor	The doctor should be visible in the paitents contact list
TC42	Adding doctors to contact list using text-to-speech	1: Say the name of doctor using text-to-speech using on screen keyboard 2: Click on search to begin search operation 3: From the result found add the doctor	The doctor should be visible in the paitents contact list
2. Sharing medical records			
TC43	Share medical records using software built-in sharing feature	1:Click on the sharing option 2:Select the medical record in any type of format 3:Click on share once the file is selected	Medical records should be shared to the opposite party for viewing
3. Viewing medical records			
TC44	Downloading the shared medical record for viewing	1:Click on the file to download 2:Save the file on a known location 3:Open the file to view it	Medical records should be viewed upon opening
TC45	View the shared document using software's built-in feature	1:Click on the file to view	Medical records should be viewed upon opening

Fig 3.5: Health focus Test Cases

IV. RESULTS

This section presents the results of the two methods used in this research: primary evaluation and the testing strategy

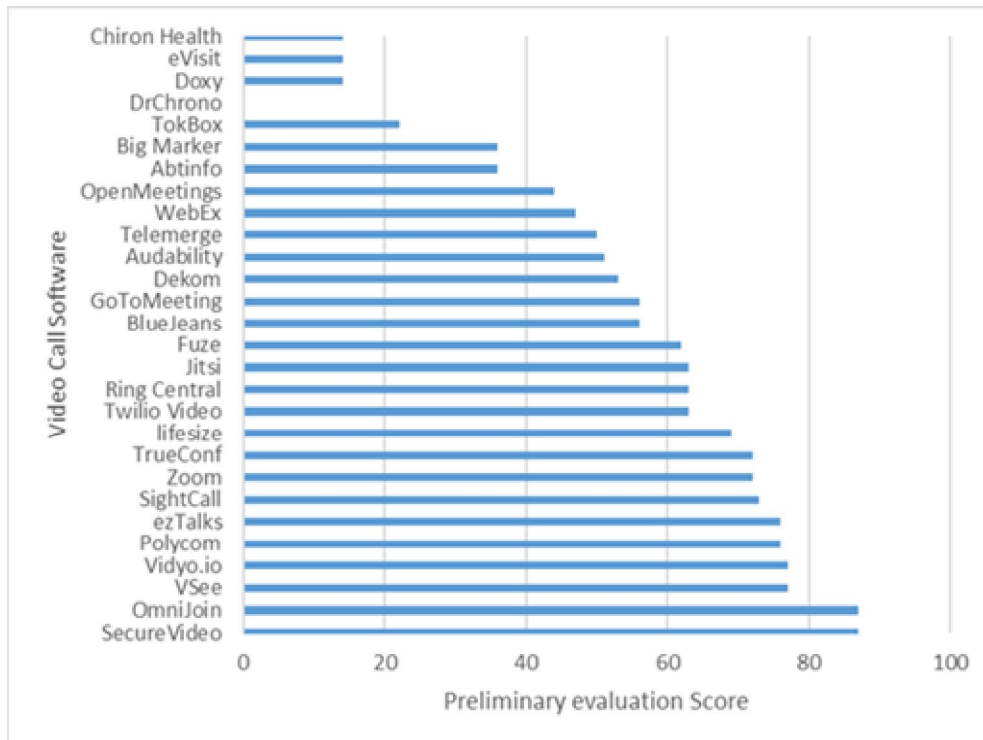### A. Results of the preliminary evaluation

Fig 4: Scores of the available video call platforms

The primary evaluation for the available teleconference platforms produced twenty-eight teleconference platforms and the scores assigned to these platforms as shown in Fig 4. The score given to each teleconferencing technology shows the level of meeting the online healthcare requirements determine by m-Health Solutions based on their experience. The preliminary evaluation results have been reviewed

by a committee from m-Health Solutions. The committee selected the two teleconferencing technologies Securevideo and OmniJoin because they received the two highest score in the prelimnary evaluation. The committee also selected Jitsi because it is an open source teleconferencing technology that can be extended by adding modules to enable using machine learning and wearables. This produce a list of three teleconferencing platforms to be tested. These teleconferencing platforms are: SecureVideo, OminiJin, and Jitsi

B. Results of the preliminary evaluation

The most successful teleconferencing software was OmniJoin, and the least successful software was Jitsi.

Jitsi is the only open-source teleconferencing software in the selected list. It had no healthcare-related implementations causing it to fail the majority of test cases that were designed to check the healthcare focus. Even though Jitsi has not been customized for healthcare, it was able to pass 23.81% of the forty-two test cases. It successfully passed most test cases of the portability and health focus attributes in addition to half of the API test cases, fig 5. This shows Jitsi's potential to be extended for healthcare applications. On the other side, Jitsi was not able to pass the Ease to use and the security test cases. This could befixed by adding new modules that implement the required features. Jitsi allows adding new services using Java.
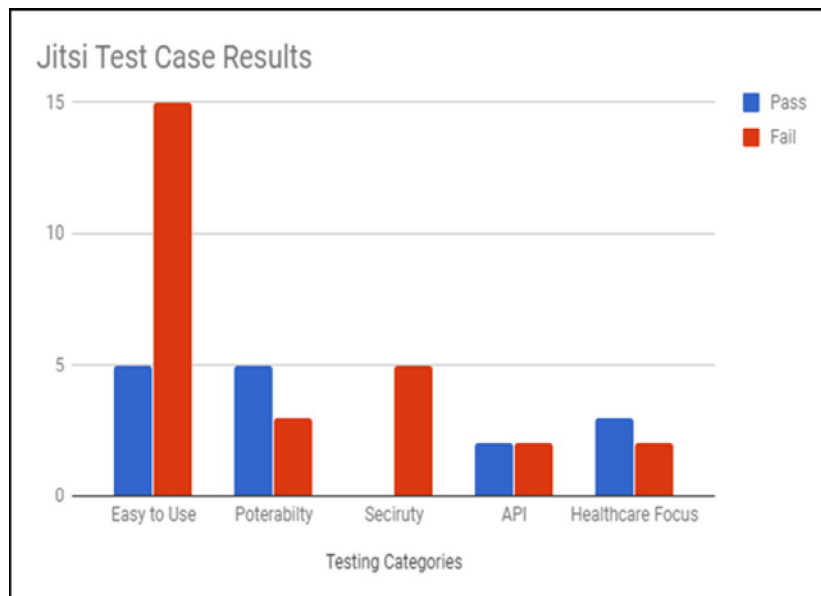

Fig. 5. Jitsi Test Case Result Chart

OmniJoin is the most successful software in passing the test cases. It passed most of the healthcare focus test cases and all the portability test cases. In addition, it passed more than half of the Ease to use test cases, fig 6. OmniJoin implements many healthcare services so it successfully passed 59.52% of the tests
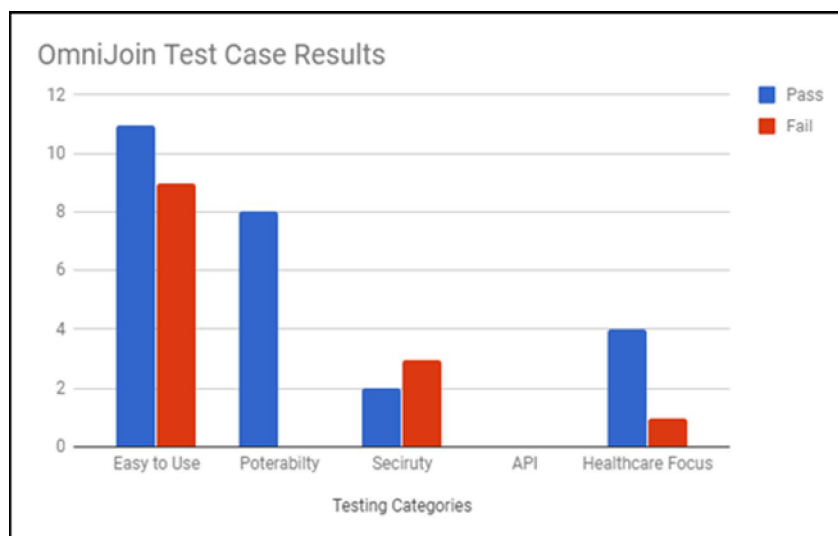

Fig. 6. OmniJoin Test Case Result Chart

SecureVideo is an online healthcare-focused software. It successfully passed 54% of the test cases It failed most of the test cases related to the Ease of use and the healthcare focus attributes, fig 7. The reason for this was the need of a third-party software to run most of the video conferencing and some of the healthcare services. While failing many test cases, SecureVideo had a lot of extra attributes that has not been tested. These untested attributes could be beneficial for the healthcare applications.

V. ANALYSIS

SecureVideo was expected to win the first place in terms of healthcare focus but the first place has been taken by omniJoin and the SecureVideo won the second place as hown in Fig 8.

Regardless of the results of the test, SecureVideo is

still phenomenal because of its useful APIs. This API library provides most of the necessary functions needed for the healthcare application. The major problem with SecureVideo is the installation of a third party application to run most of the software features, this may seem like a turn off and would move one to another software, but it was the complete opposite. With the third party application, SecurVideo allows the optimization of healthcare-related operations. This allowing for the best of both worlds. Installation of the third party software was very easy on every platform, this includes on mobile devices. On every platform, all functionality would work seamlessly. The main concern going with SecureVideo is that we would not own the software and the app would need to follow with what SecureVideo does. SecureVideo will be a great short term software.
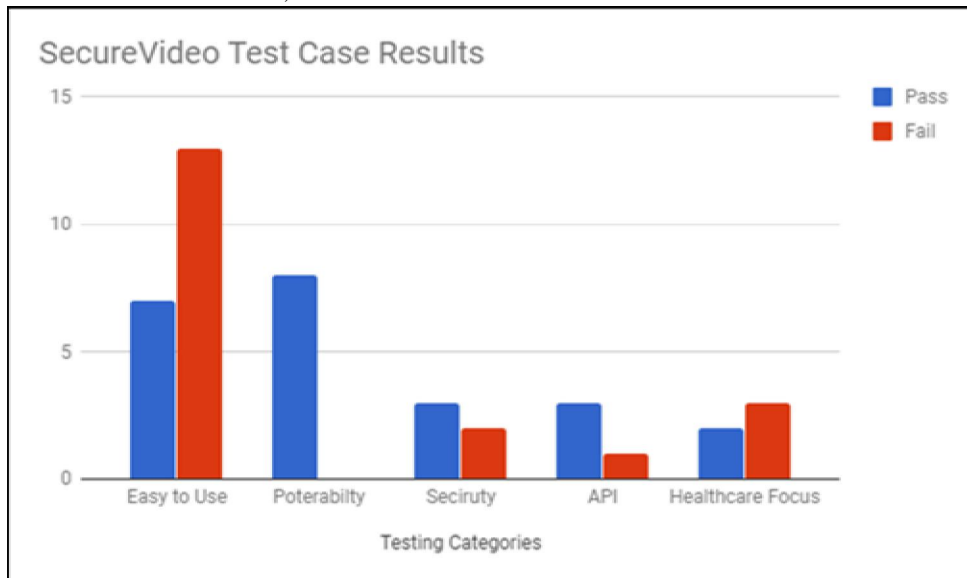
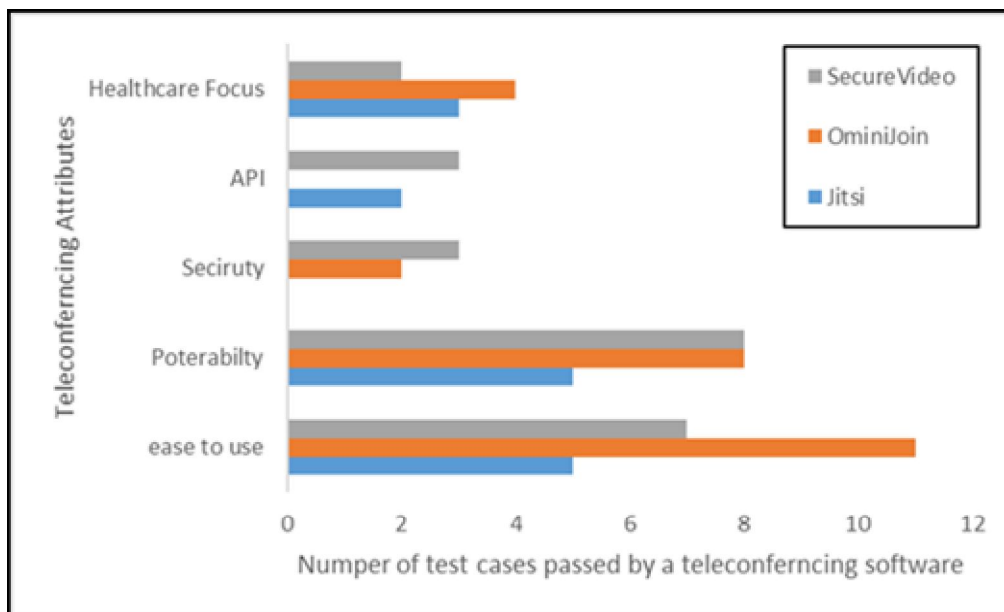

Fig. 7. SecureVideo Test Case Result Chart

Fig. 8. Test cases passed by the three teleconferencing platforms

Upon examining the five attributes of Omnijoin teleconferencing using the forty-two test cases, a few issues have been noticed as follows:

1. Security risk: In order to complete a call, the host must send a direct link to the server where the call is taking place to the client. This is a double-edged sword as this means that clients do not need to create an account to be added to call which improves usability and accessibility. At the same time, OmniJoin failed the client requiring to only have a username and password when creating an account test case. This creates a problem because it creates a huge security risk for the patient and/or doctor and there is no way to verify a user allowing anyone to click on a direct link and join the call. A solution to this problem would be to add account creation module for new users to improve security and user verification.

2. No contact list: Another problem with OmniJoin was that there are no contact lists to access clients or doctors. This forces users' to use external contact lists such as an email list or a social media messenger application in order to communicate which is not optimal in case of emergency.

3. Unable to zoom: OmniJoin does not have the ability to zoom in and out of a video. This creates a problem if the client needs to zoom in on a specific area and show very specific details. An example could be if a patient has a mole on their body. It could be hard for a doctor to diagnose if that mole was cancerous without getting a closer look at the mole. A solution to this would be to implement zooming functionality to the software using an open source image processing library such as OpenCV.

4. Lake of voice commands: OmniJoin does not have login capability, initiate a call, end a call or allow video replay using voice commands. This can be considered an issue in a healthcare environment as it limits patient accessibility. Users may not always have access to a mouse or the ability to use their hands to interact with the software. Voice commands could probably be possible using a third-party application but that would require more resources. The best solution would be to implement Google voice actions as this API is known to be reliable during voice control.

5. Fixed font size: OmniJoin also does not have the option to change font size, text color or background color. This presents a problem in a medical context because not being able to adjust font size creates a problem for the visually impaired and elderly clients. In addition, there is no option to adjust text and background color would create problems for people who are dyslexic or color blind. A solution to this problem would be to add another menu option and create a cascading style sheet to alter text and background.

As expected from an open-source software, Jisti failed most of the test cases because the software did not have most of the required features implemented in it. In the easy to use category, most test cases the software failed were related to the overall user interface, since Jisti does not have an official user interface there is no other way of the testing UI capabilities. As far as video conferencing capabilities goes in that category, it passed all test cases. Moreover, Jitsi does not have any healthcare focused features that we were looking for in a software and because of that, the software failed all of the test cases related to healthcare. Jitis does provide an API which can be used for video calling and comes with SDKs for iOS and Android. Jisti does not have a lot of security features implemented in it and so it failed all of the test cases related to security. Portability wise, Jitsi failed almost all of the test cases because the software they have for trail only displays the video capabilities on the web and in our test cases we had testing for all types of browsers like chrome, internet explorer, in which Jitsi failed to perform well in internet explorer, Microsoft Edge, Safari but runs well on Chrome, Firefox, iOS and Android phones. Even though Jitsi is missing a lot of features compared to the other competitor softwares tested, since it is an open-source software there is a great opportunity for adding the missing and newer features, while having the full-ownership of additional components on top of the software, which is better than comparing to other software where you do not have any ownership at all and have little control over changing the components.

CONCLUSION

This work investigated teleconferencing platforms for online physician appointments as foundation of a bigger task that improves the quality of healthcare services while reduces human services costs. This research work reviewed existing teleconferencing platforms that empower online physical checkups, nursing in an online space. A preparatory research distinguished a rundown of teleconferencing platforms that meet the online healthcare services prerequisites. Health service specialists surveyed this rundown and chose the best three teleconferencing platforms for online healthcare services. A software testing strategy has been intended to assess the three teleconferencing platforms for online healthcare services. No perfect teleconferencing platform for the online healthcare found. each platform has its strengths and weaknesses. It is recommended to use the closest teleconferencing to the application requirement then extend its functionality using the API functions or adding new modules if possible.

ACKNOWLEDGMENT

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