Diagnostic Hysteroscopy Information System

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Summary

In gynecology, hysteroscopy is now a common investigative and therapeutic method. Many hysteroscope-based office operations can be carried out without anesthetic or analgesics [1]. Hysteroscopy is the method in endoscopic surgery where the examination of the endometrial cavity is performed. Hysteroscopy is performed to examine the uterus, possibility of pathologies in the endometrial cavity, fallopian tubes, etc. There are two types of hysteroscopic examinations, diagnostic and operative.

Diagnostic hysteroscopy, as the name says, is the type of hysteroscopy where the examination of the endometrial cavity is performed for various pathologies or inconsistencies. In diagnostic hysteroscopy, a very thin telescope is inserted through the vagina and the cervix so that the examination can proceed [2].

The purpose of this thesis is the creation of a system for guidance through the steps in a hysteroscopic examination, and for the entry of the data collected by the doctors through the examination. The system's purpose is to facilitate this process for the doctors, to use the data stored in the system to enrich it, and the use of the data stored in this system in future for the creation of new system/extensions.

Below various parts of the system are described, hoping that this will help the experts in the department of Gynecology. In the next chapters the system is being presented, as well as the process it took to design and implement it.

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Chapter 1

Introduction

1.1 Motivation & Purpose

Traditionally businesses as well as hospitals and clinics save their documents and records in paper form. While most companies digitise their data and use artificial intelligence to support their day-to-day operations, some companies and hospitals are not fully digitalized yet. These old school methods have proved to cause various issues.

Storing data on physical documents caused many issues. The most obvious one was the need for vast amounts of physical storage to be able to save them in one place, as well as creating a hassle when one needed to find a specific document or information. Especially when the storage and classification was not done properly. Additionally, there are many reports of cases, where fire or a natural disaster caused many companies or even public services departments or courts to lose vast numbers of documents. This caused the affected parties to dysfunction for a long time until they were able to recover the data, or in some cases the data were never recovered, losing important information.

The digitization process is progressing quickly, as are the transitions between stages. Developed nations like Germany, the United Kingdom, and the United States took nearly four years on average to move from the emerging to the transitional stage of digitization [3]. In an era that used physical documentation to save their data, developing Intelligence for a computer/program would be difficult since it has the need of digital data and not physical data, or at least the conversion of the physical data to digital data through various programs. Artificial Intelligence Learning uses a large amount of data (or big data) to be able to have many examples and cultivate “learning” from it.

The reasoning behind the creation of the current system was the need of gynaecologists to be able to save their Hysteroscopic Findings in digital form. Having

the findings in digital form will support more helpful software to be created. Software like this are further discussed in the next sections of the thesis.

Another reason behind the creation of this system was the need for a common structure for every gynaecologist performing the same examination. Due to the different cultures of each gynaecologist in the world, there hasn't been a universal structure of how a Hysteroscopy Examination should be processed. Specifically, the structure of a Hysteroscopic Examination, is where to begin with, what to check first, where to move on, the list of everything that should be checked before ending the hysteroscopic examination, what pictures/video to keep from it, etc. All the above was a needed structure to be kept so that the data collected from each gynaecologist would be of similar "variables" which ultimately support the aforementioned reasoning of the creation of AI.

To sum up, the need to move along with the exponential technological development over the years, and the need to be able to create a reliable "tool" that will be able to help newer generations of gynaecologists with their hysteroscopic examination was the cause of the creation of this system. It would give the ability to collect the knowledge of the more experienced gynaecologists from the system and then use it to create an Augmented Decision-Making System for various parts of a Hysteroscopic Exam, and an Image processing AI to be able to detect cancer that will help the "younger" gynaecologists.

1.2. Structure

In the first two introductory chapters are being showcased what is gynaecology and what is health IT and HIM. This will help every reader to get the general reasoning and information around the topic. Then, the following chapter presents and explains the process of the creation of the system, with details of implementation and the requirements. Next the system of the evaluation process is being presented, with details such as the methodology used, web interfaced and data evaluation. The last chapter is the conclusion with some final thoughts. `

Chapter 2

Hysteroscopy

2.1 Gynaecology

Gynaecology as a branch of medicine dates to Greco-Roman civilization, if not earlier. The renewal of interest in diseases of women is shown in the huge encyclopaedia of gynaecology issued in 1566 by Caspar Wolf of Zürich [4]. Gynaecology is the area of medicine that focuses on women and specifically on their reproductive organs (vagina) and breasts.

There are many examinations and operations that are part of gynaecology. One of the most know examinations and operations of gynaecology is the PAP test (test Papanicolaou) where it's an examination of a woman's cervix to check whether she has cancer, as well as, the Breast Examination where the gynaecologist using different methods checks whether a female has any diseases, lumps or skin change at her breasts and the Annual Wellness Exam that includes various small examinations to check the health of a woman regarding her reproductive system and her breasts. The aforementioned examinations have saved the lives of thousands of women as well as helped them in early stages to detect illnesses such as cancer.

2.2 Hysteroscopy

Hysteroscopy is one of the operations that is carried out in the field of gynaecology. This procedure is used to examine the inside of a female's womb for any diseases or pathologies that might occur, and it is carried out due to a variety of reasons. It enables direct sight of the whole uterine cavity and the opportunity to biopsy suspicious abnormalities that dilatation and curettage may miss [5].

Hysteroscopy was first performed on a patient in 1869 by Pantaleoni, who, using a cystoscope developed by Desormeaux, discovered, and treated an endometrial polyp in a 60-year-old patient who presented with postmenopausal bleeding. In-office hysteroscopy was introduced into clinical practice in the early 1980s with the improvement of distension media options and operative techniques [6]. There are two types of hysteroscopies. The diagnostic hysteroscopy and the operative hysteroscopy.

Diagnostic Hysteroscopy can be used to investigate symptoms or problems. If a female patient has unusual vaginal bleeding, pelvic pain, heavy periods or feels unease her gynaecologist will go through with a hysteroscopy operation. Additionally, if a woman is unable to get pregnant or has had many miscarriages that is also a valid reason to execute a hysteroscopic exam [7].

Operative Hysteroscopy is used in cases to remove or treat problems. These problems could occur through an MRI (Magnetic Resonance Imaging) or an ultrasound. The above examinations can find polyps, fibroids, adhesions and other diseases and pathologies that are related with the womb.

The focus of this paper is the diagnostic hysterectomy. The following chapter describes in detail what is diagnostic hysterectomy.

2.3 Diagnostic Hysteroscopy

Diagnostic Hysteroscopy as mentioned previously is used for the investigation of a woman's womb. This procedure is usually conducted by a skilled gynaecologist and a team of nurses including an anaesthesiologist in case the Diagnostic Hysteroscopy turns out into an Operative one.

During this examination, a small telescope is used to insert the uterus, called hysteroscope. A camera is attached to the end of the hysteroscope which transmits the image on a monitor that the gynaecologist uses to be able to guide and review the uterus. [8]

In Diagnostic Hysteroscopy the gynaecologist checks four parts of the woman's reproductive genitals. Those parts are, Vagina, Cervical Os, Cervical Canal/Cervix, and

the Endometrium. Each part of those has different anatomical locations which must be reviewed by the gynaecologist in case of diseases or pathologies that could occur in them. Additionally, the gynaecologist can check the shape of the uterus and the overview and close up view of the endometrium and compare it with the current LMP (Last Menstrual Period).

Gynaecologists use Diagnostic Hysteroscopy to find the causes of abnormalities such as heavy bleeding, pain, miscarriages, difficulty of getting pregnant. All abnormalities are usually connected to diseases or pathologies that are found in the uterus. Most common findings in a Diagnostic Hysteroscopy are fibroids, polyps, adhesions and sometimes cancer.

Chapter 3

Health IT

3.1 Health IT / HIM

Health IT or Health Information Technology is the area of Information Technology (IT) involving the design, development, creation, use and maintenance of information systems for the healthcare industry. Automated and interoperable healthcare information systems will continue to improve medical care and public health, as it lowers costs, increases efficiency, reduces errors, and improves patient satisfaction, while also optimising reimbursement for ambulatory and inpatient healthcare providers [9].

Health IT is the evolution of Health Information Management (HIM) over the past years. The roots of the Health Information Management (HIM) industry can be traced back to the 1920s when healthcare professionals started using medical records to document details, complications, and outcomes of patient care. The system of keeping records, as mentioned above, was used by physicians until computers were invented. By the mid-1980s, the Institute of Medicine (IOM) started studying health records and the benefits of electronic medical records. The study wouldn't be published until 1991, but it found security issues, lack of standards and cost were the primary barriers to adopting electronic health records at the time[10]. Today, HIM has turned to Health IT where most physicians, clinics and hospitals around the world use systems, personal computers, and other electronic forms to keep track of their medical data.

There are many reasons why Health Information Management has changed vastly over the past 100 years. Some of them are, firstly, the ability to keep data safe even when natural disasters occur, secondly, being able to assure patients that their personal information are not able to be leaked with the use of various Security Systems,

and lastly the ease of keeping and being able to track said data which increases the productivity time of a physician. The biggest reason for Health Information Management turning to digitalization today is to be able to use all the data kept by physicians, to create new systems that can further help them in both productivity, accuracy.

3.2 Health IT and Gynaecology

Health IT, as aforementioned, is the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of healthcare information, data, and knowledge for communication and decision making. HIT, technology represents computers and communications attributes that can be networked to build systems for moving health information. With the use of HIT over the past years, many data on gynaecological examinations/tests and surgeries were able to be digitised.

All the digitised data occurred are being used to create “big data”. “Big data " is a vast amount of stored data that is being used by AI in the Machine Learning process to be able to develop “intelligence” or used as preferences and logic passed to an AI. With the use of the above some experts on the gynaecology field with help of AI integration/implementation teams, were able to conduct AI systems.

There are many examples of AI systems that have been or are being developed that are being associated with parts of examination of the field of gynaecology. An example of that is the “GAIA”, which uses information given in the system from a gynaecologist about a certain patient and is able, with the use of Decision-Making process to pinpoint possible pathologies and provide the results to the gynaecologist. The above system is very useful since it helps the gynaecologist validate their findings (of some sorts, depending on the current accuracy of the system) and to be able to check other possible pathologies or diseases that the gynaecologist may not have found but the system can pinpoint, with the use of the explanation given by the system on how it concluded to each result based on the information it received and the knowledge it was given.

With the use of Health Information Technology to digitise data procured by gynaecologists around the world, Gynaecology systems will be evolved much more. That does not include only AI systems but many other sorts of systems such as, faster and easier systems for gynaecologists. Which could be able to save the data procured by examinations and surgeries, as well as, advanced technologies to be used during examination and procedures and even new or developed surgeries and examinations for increasing the quality and accuracy of results procured.

Chapter 4

Requirements and Implementation

4.1 Requirements and Specification

The overall aim of this project is to provide an easy-to-use system by gynaecological doctors, to be able to save all their data in a general used format, faster and safer than the already used methods of data being stored on papers or word files.

This system is also a structured guide for both young and senior gynaecologists. Part of the requirement of the system was to generate a certain architecture of storing data and User Interface so that all gynaecologists that do hysteroscopic examinations will follow the same guidelines, examine every part of a woman's uterus to be able to fill in the data required by the system and thus making sure that everything has been examined properly and have a base of reference by adding images and videos to justify their findings and conclusions thus making it easier to be able to handle any case and prevent misplaced data and rough written reports due to the massive amount of work gynaecologists have each and every day.

Purpose of this system is to be used in the future for the generation of other systems. With the use of the data that will be stored using this system, an AI – based system can be created to be able to handle uterus diseases that are found in hysteroscopic images with the method of screening and AI Learning (e.g. to find malicious cancer tissues in the endometrium and compare it to the already known cancerous tissues that have been stored in the system previously by gynaecologists that were using it along with explanation and descriptions). Additionally, another AI-based system can be created to advise younger gynaecologists or "remind" more experienced

ones to various aspects of the hysteroscopic examination based on prior data added such as what level of anaesthesia to use based on added patient information, whether the endometrium looks normal for the nth day of its cycle based on the recorded LMP (Last Menstrual Period) of the patient, possible findings during the examination based on Indication provided by the patient and much more.

Considering the need to make the system respond to the above overall aim, a list of expected requirements and specifications has been extracted where it describe more specifically what is needed to be done, how to do it and what are the means to achieve it. Making the system respond to these requirements and specifications is a must to meet the expectations of the users.

Requirements and Specifications:

1. *Create a complete system that gathers all required data of a hysteroscopic examination.*

This is done by interviewing the doctor and gathering all the medical information needed so that the system can operate as expected. Information as what patient information is needed, what is expected to be examined during a diagnostic hysteroscopy examination, the exact process a doctor follows during such examination to be able to follow through it and collect the data types and format each needed field has.

Since medicine is a field that is always being updated over the years, the system should be reviewed once every few years to add or modify fields in it to keep it up to date. By doing so, this will keep the system frequently updated on the information needed to keep during the diagnostic hysteroscopic examination and will also help its users to keep up with the new discoveries of the field since they will be included during its update.

2. *Enhance the accuracy and speed of a doctor's diagnostic & saving process*

Enhancement of diagnostic accuracy is succeeded through the forms that must be filled by the doctor users. The forms are used as a guideline and as a manual to the users to make sure that everything is checked and recorded down without any information being left out.

Speed is enhanced by the creation of an easy-to-use web interface so that the doctor users can fill in the data recorded during the hysteroscopic examinations faster without the need of typing down entire sentences and paragraphs to keep up with their reports.

3. *Reduce "inconsistency" in the reporting of diagnostic hysteroscopy*

Explanations on conclusions of hysteroscopic examinations, data to back up a conclusion, images and videos that show images of findings while a hysteroscopic examination and much more needed data are needed to have a thorough report of a diagnostic examination. Due to the lack of structured forms for such an examination so far, there are many inconsistencies in the data that are mentioned above.

With the use of the web-based user interface in structured and complete forms that include fields for all the data needed in a report for a complete hysteroscopic report, will help doctors to not miss relevant information that were needed to close a patient's case.

4. *Follow a Natural Interaction Process with users, that simulates a diagnostic process in real-life*

The interaction process should represent a real-life diagnostic process, where:

I. Firstly, the doctor collects the patient's information and history
II. Secondly, the doctor collects all the hysteroscopic examination information divided in 3 groups Demographics, Setting Operation Team, Hysteroscopy Protocol.
III. Thirdly, start the hysteroscopic examination by checking the patient's vagina and saving any possible findings.

IV. Fourthly, the doctor continues by moving further and collecting information on the Cervical OS for any possible diseases.

V. Fifth, the doctor gathers information on the Cervical Canal for any possible diseases.

VI. Sixth, the doctor collects information on the endometrial cavity shape.

VII. Seventh, the doctor collects information on the endometrium and confirms the check of every possible part that should be checked during the endometrial examination part of diagnostic hysteroscopy.

VIII. Lastly, the doctor gives data on the mode of care of the patient along with any files (images, videos) that were captured during the hysteroscopic examination to justify the findings.

5. *Design of User-Friendly Interface*

The User Interface should be easily understandable by any user and easy to use, without the need of excess information or huge forms that complicate the system.

To achieve this many hours have been spent with the doctor, constantly modifying the system to keep it as easy and fast to use as possible while incorporating the needed fields to have a thoroughly complete report of a diagnostic hysteroscopic examination and creating as many selection boxes as possible to make it much helpful for the users to add long text of data with the use of only one click.

6. *Use methods to increase performance*

By using Query Optimization techniques in both the middleware and back-end to execute only lines of code needed by each form thus decreasing the resources needed to handle each form of the User Interface which increases the performance of the system by a lot.

7. *Follow a Modular Architecture*

It is important that the system is implemented in a way that is easy to make changes, to replicate parts of it or to extend it with additional functionality or knowledge, without affecting the operation of the rest of the system. This is done by separating the processes in front-end (web-based user interface and user-system interactions while incorporating the data), middleware (running processes, handling requests and linking the various pieces together)

4.2 Technologies and Tools

The website that acts as the Graphical User Interface of the system was designed and implemented by combining various popular web development tools, specifically the following:

- HyperText Markup Language (HTML): client-side markup language for designing the components of the pages.

- Cascading Style Sheets (CSS): client-side styling language for styling the pages and the fields of them.

- Bootstrap: an open-source framework which enhances the styling abilities of CSS with ready libraries to be used.

- JavaScript (JS): client-side scripting language for writing scripts that make the page interactive, such as popping up windows, showing alerts, revealing or hide fields in a page based on inputs of the user, etc.

- jQuery: a JavaScript library which enhances event-handling, as well as other abilities of the scripting language .

- PHP: server-side scripting language used to program the dynamic changes in the website, the redirecting from one page to another and acting as the middleware which connects the DB with the User Interface.

Additional tools for implementing the DB and hosting the website include the following:

i. Apache Server for hosting the Website:
   - Locally: XAMPP
   - Online: Department of Computer Science provided a repository on a web server

ii. SQL Server Data Base for data storage of the system:
   - Locally: SQL Server DB
   - Online: Department of Computer Science provided a database in an SQL Server

Information on the technical side of the system, such as installation steps or configurations needed to run the system are displayed in Appendix B.

4.3 Architecture

The system, as described in previous sections of this chapter, incorporates various tools, methods, technologies, algorithms. The architecture is to have the SQL Server Database to store the data in with the use of Store Procedures. PHP and HTML is used to create the website pages and to be able to connect the database with the website with the use of the Store Procedures mentioned, with the addition of some simple queries when needed to get only the results that are needed to keep the runtime as low as possible. JavaScript functions are used for the view and modification of pages based on previous interaction with the system by the user. CSS or Styles are used for the view of the system to keep its simplicity. This architecture of the system is also shown below in a more generic view in Figure 1.

Although the main requirement of the system, is to work as expected by the users, another big requirement of the system is that it should be extensible. This means that at any given time parts of the system can change (since requirements or fields get updated over time) without the need of changing the whole system or recreating the system from scratch just to make a few changes.

For this to be achieved, the dependency of each component was held to as minimal as possible. This means that each part of the system depends on another part only where or when it's needed without any excess as to keep the system dependable-free. Below is a simplified example of the architecture.

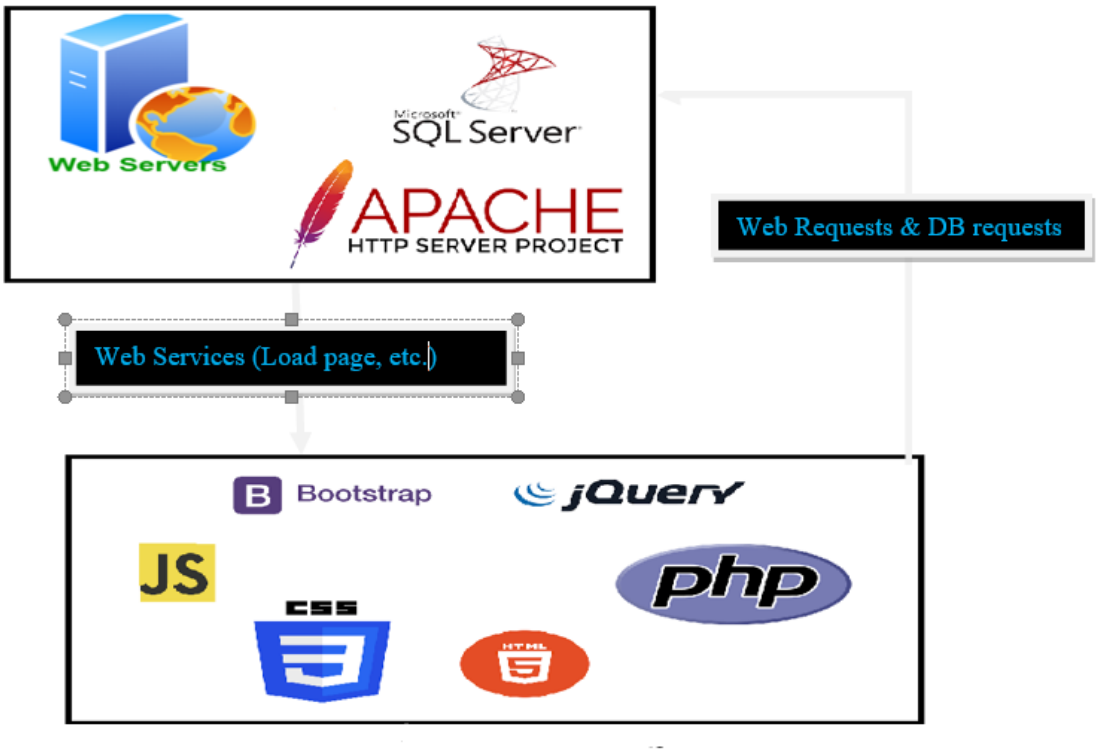


Figure 1. Architecture

4.4 Graphical User Interface

The Graphical User Interface (GUI) of this system is the website that the users will use to insert data of the hysteroscopic examination. The website was created based on the knowledge and guidance of the doctor while continuously changing it and evolving it while the testing was ongoing to better suit the examination's needs and simplicity. In this section, we will go through the GUI, while describing and providing information related to it and the hysteroscopic examination.

The first screen of the GUI (the one the users will have once the website opens up) is the Sign-In Screen. A register user provides their credentials (in this case email and password), which are used in an SQL Server query that connects to the Database, which stores every user credential, to validate the user and let them in the system. If the credentials are validated, then the users are prompted to the menu or else an error message pops up.

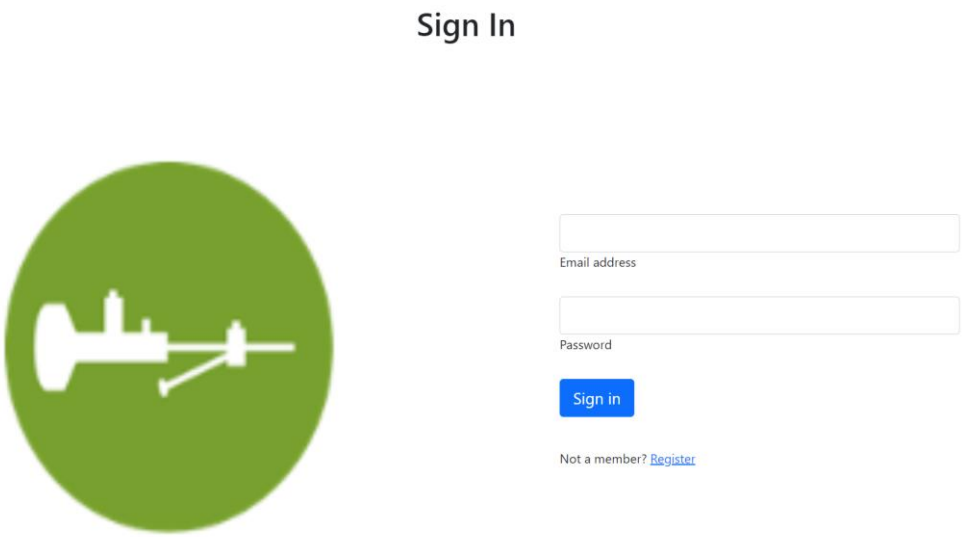


Figure 2. GUI Sign In

Before moving on to the second screen of an authorized user, below is the Sign Up page where a user can register to use the system. As shown in Figure 3 the user must enter their Name, Surname, Email, Nationality, Password to create a user account for the system. In the system's current release, the users are automatically accepted to the system but that can change in the future since a field (Validated bit), which can be set to 0 once the users register and then the admin of the system can validate them. This method is used so not any unrelated users enter the system and using it with false data inputs. Additionally, the Nationality field is there so that in the future the system can be used for statistical purposes to generate statistics based on Countries.

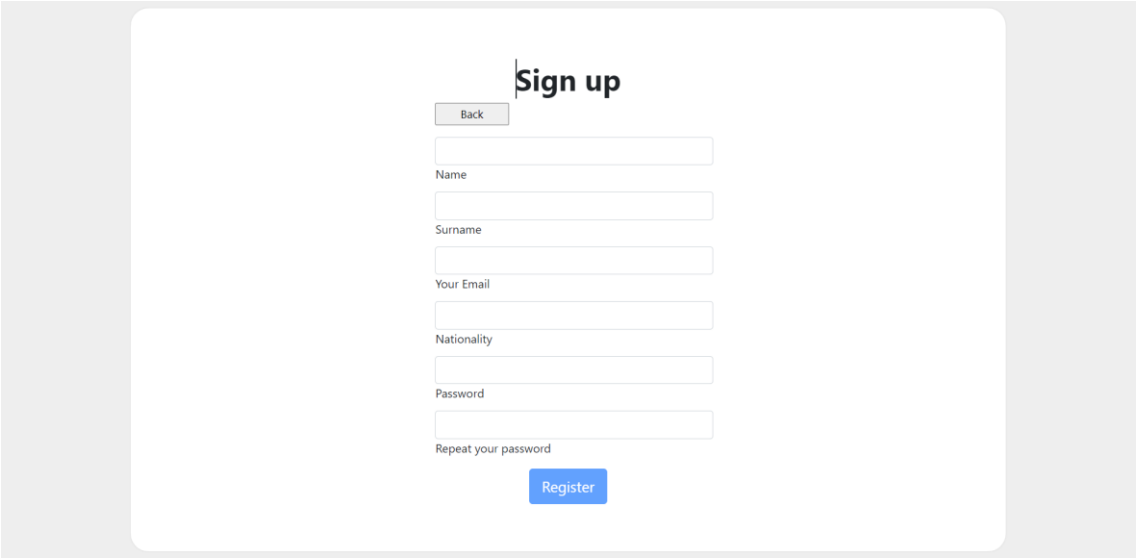


Figure 3. GUI Sign Up

The second screen is the Menu, and this is the first screen a user views once authorized into the system. As shown below in Figure 4 the user can Add Record of a new hysteroscopic examination, view Patients or General Reports , or Log Out.

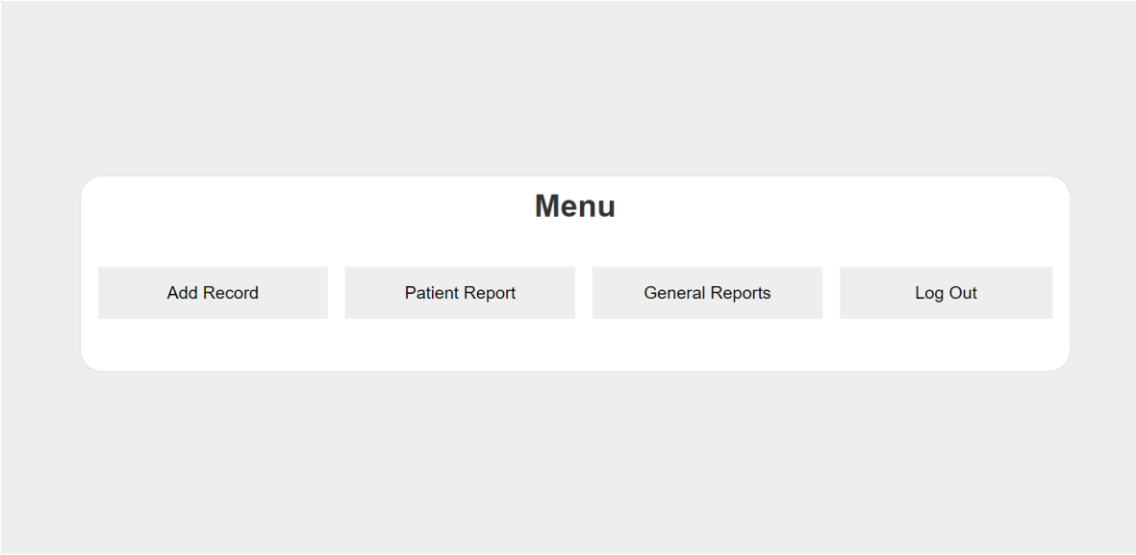


Figure 4. GUI Menu

By clicking on the “Add Record” button the user is prompted to the first page of the new record, the Demographics. Demographics consist of two separate parts. First

part is the Patient's basic information such as ID, Name, Surname, Nationality, DOB (Date of Birth), and information about their pregnancies such as Gravity (The numbers a woman is or has been pregnant), Parity (The number of times a woman has given birth to an infant), Abortions and number of Children. The second part is the Hospital information such as the name of the Hospital and Clinic, Hospital's Serial Number, and the Date that the hysteroscopic examination occurred. It should be noted that since this are real data provided by actual hysteroscopic examinations all sensitive data concerning a Patient such as their ID, Name and Surname are encrypted in the DB as per the GDPR (General Data Protection Regulation) and are decrypted only on the Report which can be accessed by the Doctor user that inserted their entry or knows their ID. Additional feature is the Existing PatientID which if a Patient's ID that has already been inserted in the past is used and then "Search" then the system provides in the fields below all their stored data.

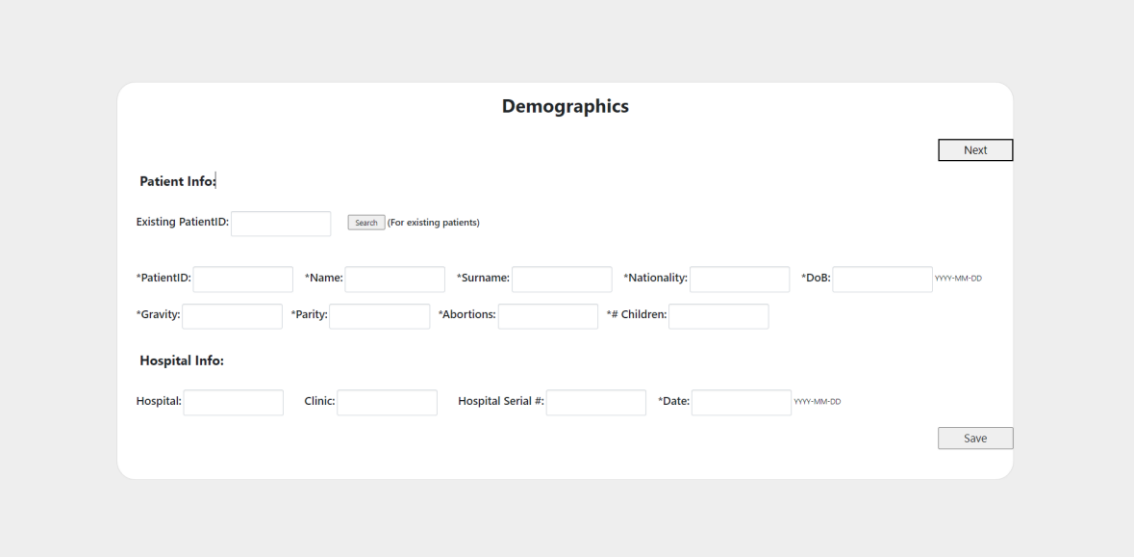


Figure 5. GUI Demographics

Once the user Saves the Demographic data and everything is correct then they are prompted to the next page. The next page as shown in Figure 6, is the Patient Info where the user provides more specific information on the user such as their ASA (American Society of Anaesthesiology) score, their LMP (Last Menstrual Period) and information on the History of the Patient, as shown in Figure 6, Habits, Operations,

Allergies, Family History, Health Status, Medication History. Since the History information can contain of multiple information for each field, every time the user Saves the history data that they inserted the system prompts them to the same page in case there are more data to be added. Additionally, this page shows all the Historic data the specified user has stored in the Database.

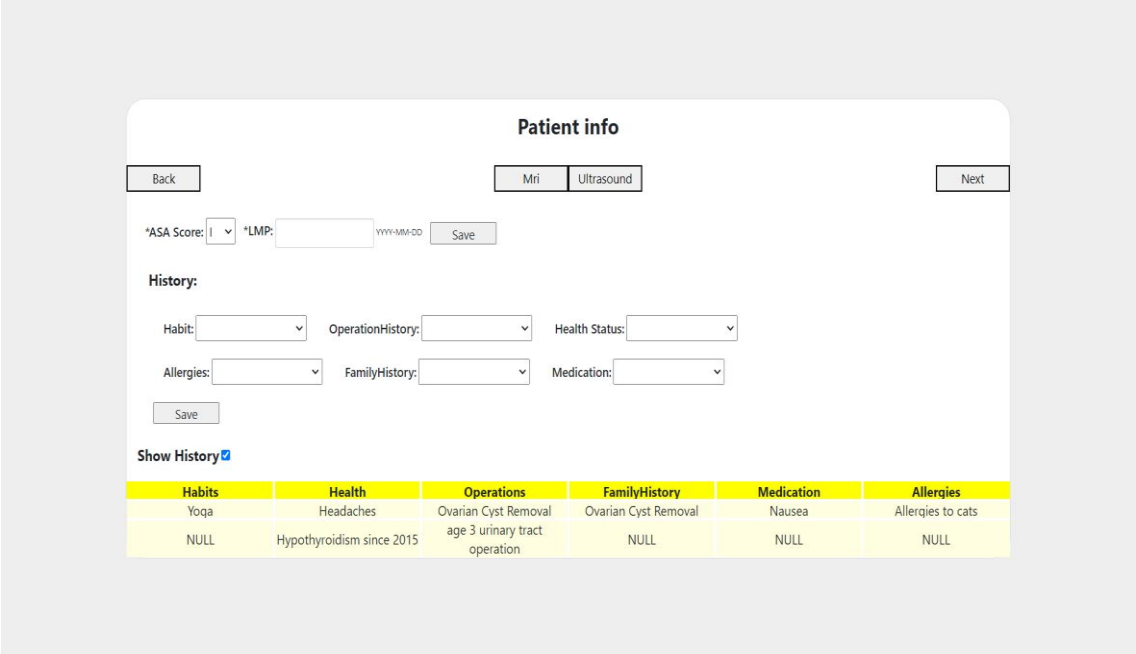


Figure 6. GUI Patient Info

Once the user is done with the data inputs in this page and click “Next” they are prompted to the page of Setting – Operation Team data. This page consists of two parts. First part is the Settings data of the hysteroscopic examination which are the location that the examination takes place and checkboxes on whether the examination is diagnostic, operative or both. The second part of this page contains the Operation Team information. This consists of the Surgeon, Assistant, Assistant Nurse, Running Nurse, Anaesthesiologist, and all Students that are there during the hysteroscopic operation (up to 6 according to the doctor can be there). By selecting the number of students, the system provides text boxes to insert in their names (text boxes= number of students) as shown in Figure 7.

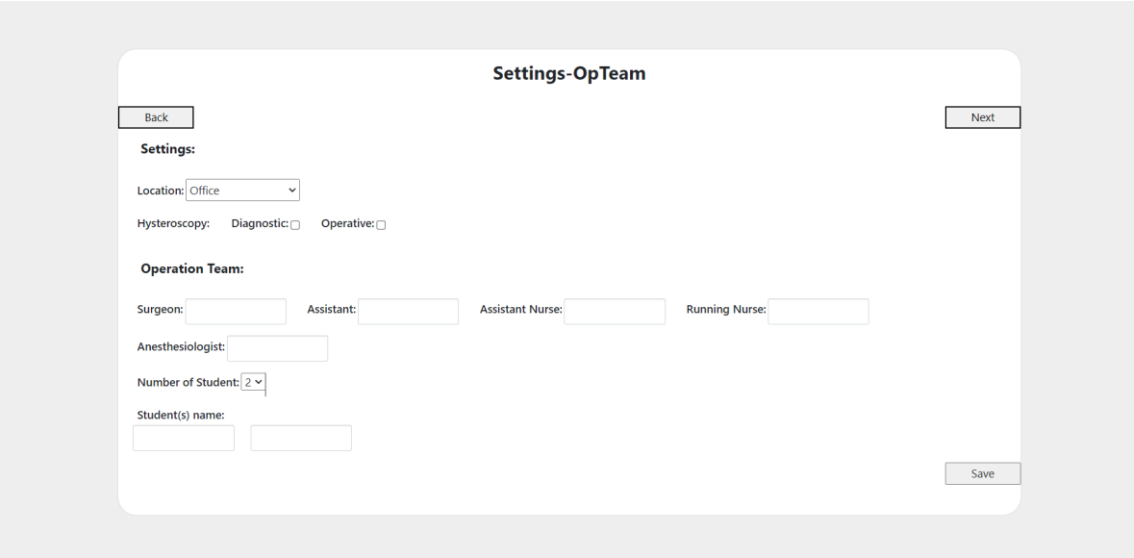


Figure 7. GUI Setting-OpTeam

Once the user Save the data in the previous page the system prompts the user to the next page Hysteroscopy Protocol. This page contains all the data needed prior to the hysteroscopic examination. This data consists of the Indication (the indication that led to the hysteroscopic examination), the instruments that are used during the examination such as the Camera & Monitor, Hysteroscope, Distending Medium and Destention Device, Energy Device and Type. Additionally, as shown below in Figure 8, in this form the user can insert data on the Approach that they will use during the hysteroscopic examination and the level of anaesthesia the anaesthesiologist will use on the patient. Data are saved using the “Save” button as shown below.

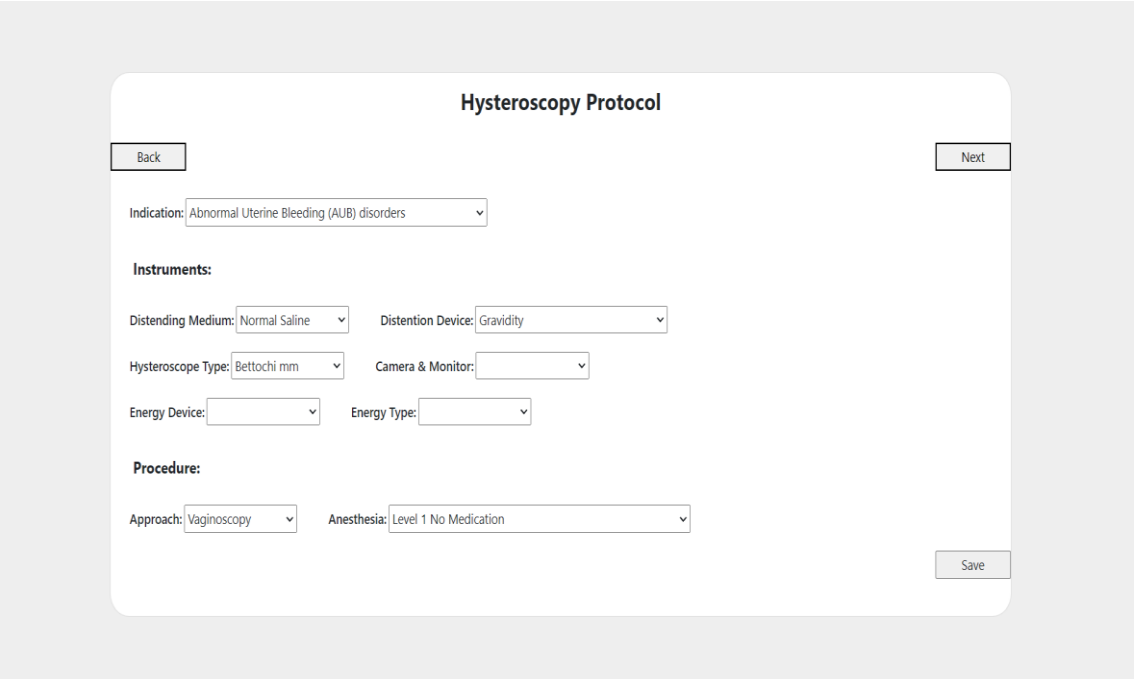


Figure 8. GUI Hysteroscopy Protocol

Moving on from the page above, the system enters the stage of the data collected during the hysteroscopic examination. Firstly, as shown in Figure 9, where the system collects data on the findings in the vagina. In this page, based on the finding selected in the first field “Vagina” the system uses JavaScript function to enable or disable fields corresponding to the finding selected. As shown below in Figure 9, the fields concerning the findings in the vagina, are the exact location of the finding in the vagina, the size and volume of the finding (based on the finding), primary and secondary morphology (if there are any), distribution of the finding through out the vagina and other characteristics that give further details on the finding (if needed). By saving the data the system prompts the same page back to the user since there might be more than one finding in the vagina. Furthermore, the user can add images of the vagina and its findings by clicking in the “Vagina Photos” button, the page in Figure 10 is prompted by the system, which by clicking on the choose files, the system opens a pop up of file explorer of the user’s computer where the user can select any number of images that were captured during the patient’s hysteroscopic vaginal examination. The files are stored on the server of the system in the folder that is being generated with the Hysteroscopy Serial number – Patient Serial Number (e.g., 12-1).

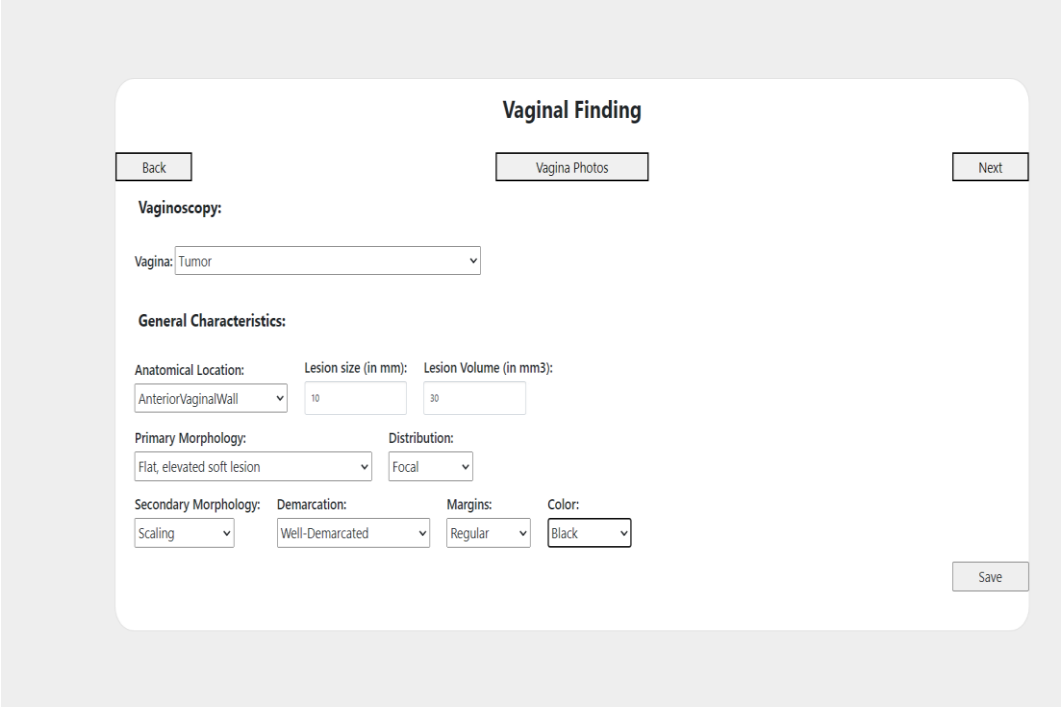


Figure 9. GUI Vaginal Finding

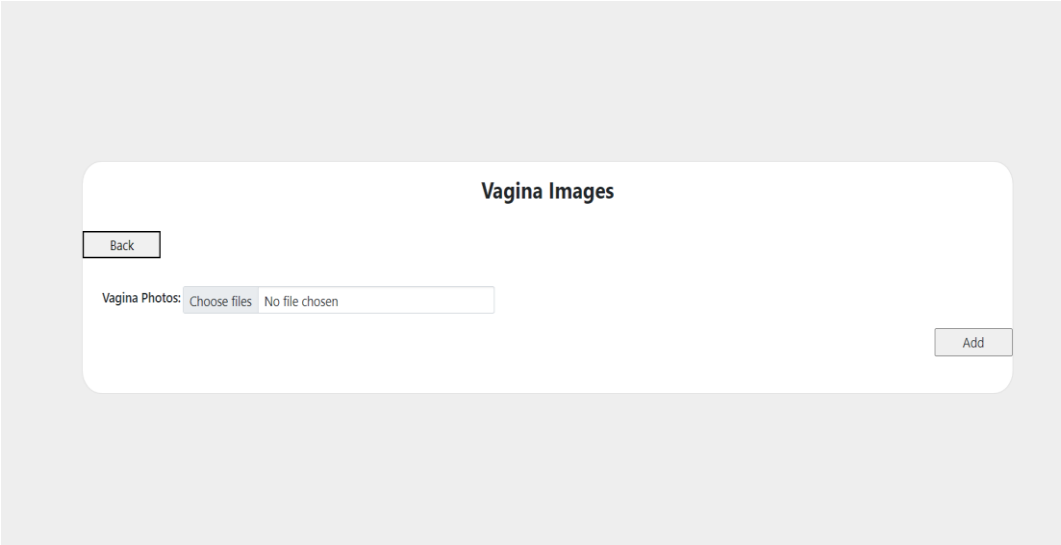


Figure 10. GUI Vagina Image

By clicking on Next in the Vaginal Finding page, the system moves on to the Vaginoscopy Report. As shown below in Figure 11, this is where the user provides information on whether the vaginoscopy was successful or had any issues moving from the vagina to the Cervical Os.

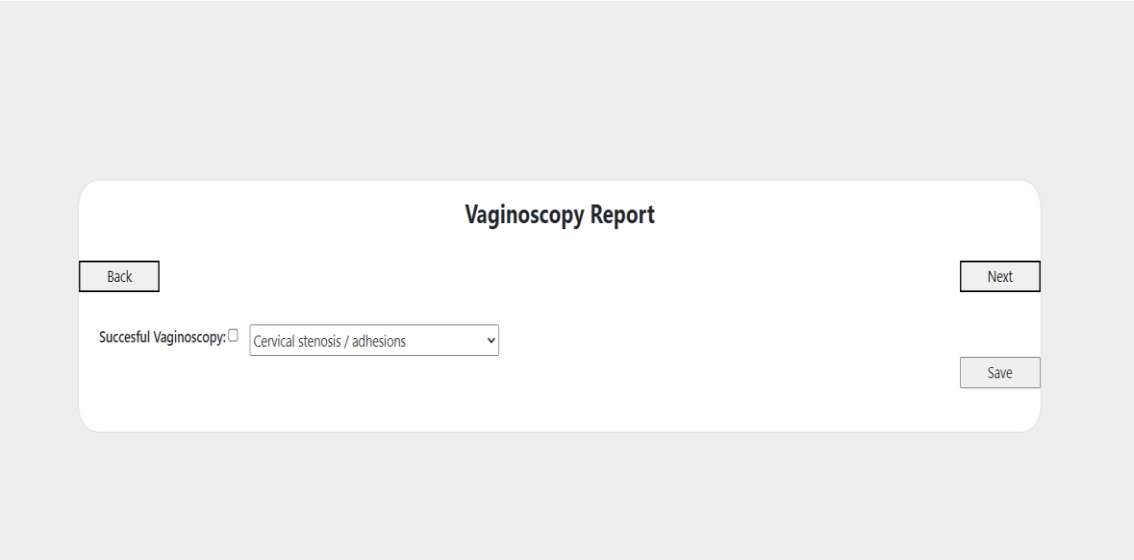


Figure 11. GUI Vaginoscopy Report

In the next page, the system collects data on the findings of the Cervical Os. This page follows the same structure as Vaginal Finding page. The difference between them is the options prompted in some of the selection boxes. Additionally, by clicking on the CervicalOs Photos button as show in Figure 12, the system prompts the Cervical Os Images page. In that page the user can enter images captured during the hysteroscopic examination of the cervical Os and it saves them in different folders according to the Anatomical Location that is selected for each image as shown in Figure 13.

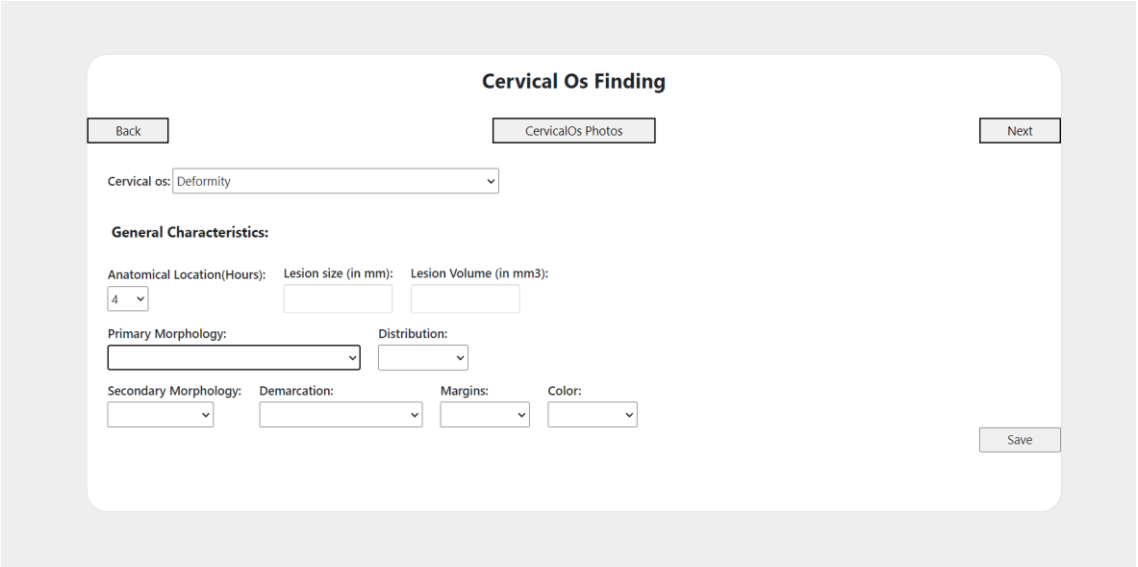


Figure 12. GUI Cervical Os Finding

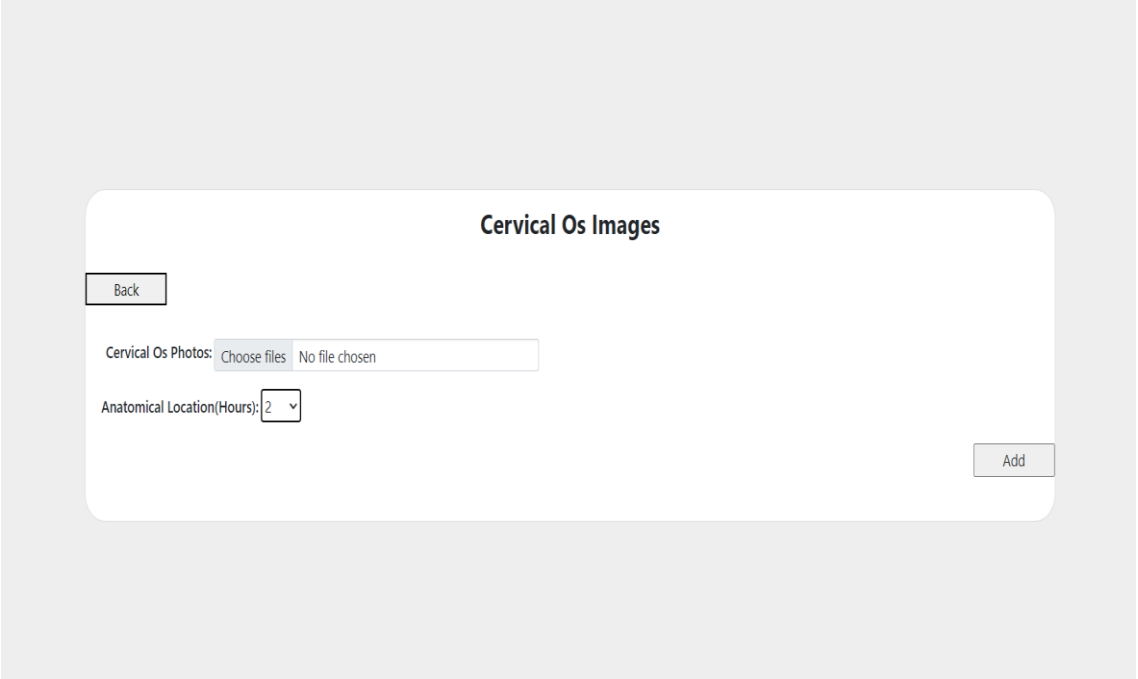


Figure 13. GUI Cervical Os Image

Next the system prompts and collects data on the Cervical Canal Findings. As the previous page of the website, this follows the same structure as shown in Figure 14, but there are some differences between the options of the selection boxes fields of the page, the consistency field of the finding and some findings in the Cervical Canal have

a “Special Characteristics” field which is being reloaded with only the finding’s special characteristics that were selected in the first field. Adding to that, by clicking on the Cervical Canal Photos the system prompts the Cervical Canal Images page as shown in Figure 15, where the user can save images captured during the hysteroscopic cervical canal examination that can be used as explanation or emphasis on the findings that were provided in the Cervical Canal Finding page.

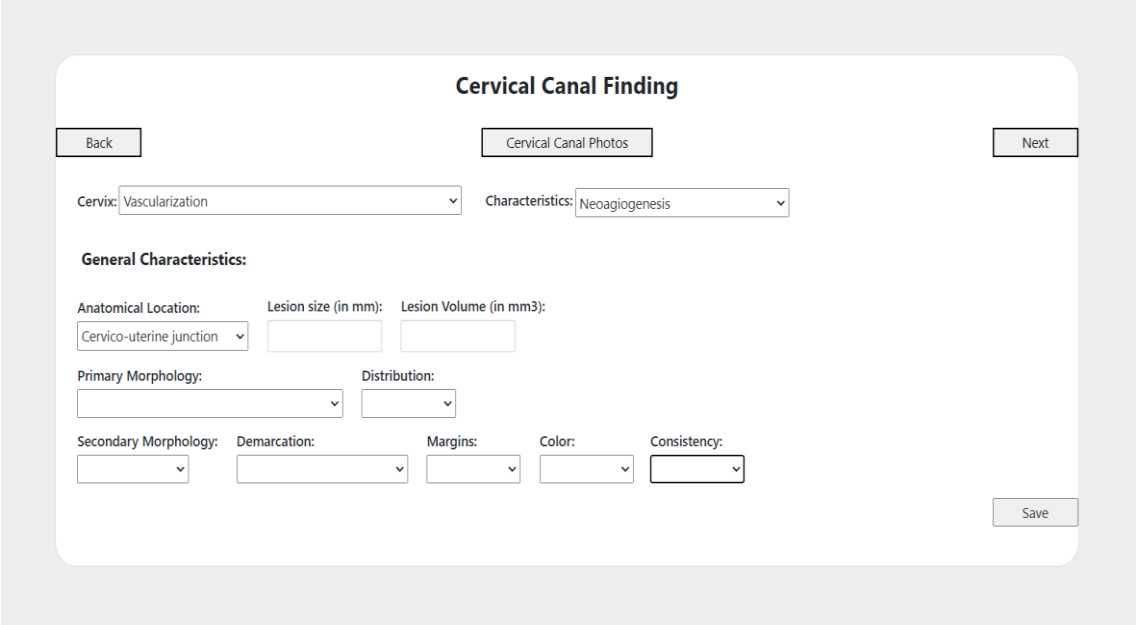


Figure 14. GUI Cervical Canal Finding

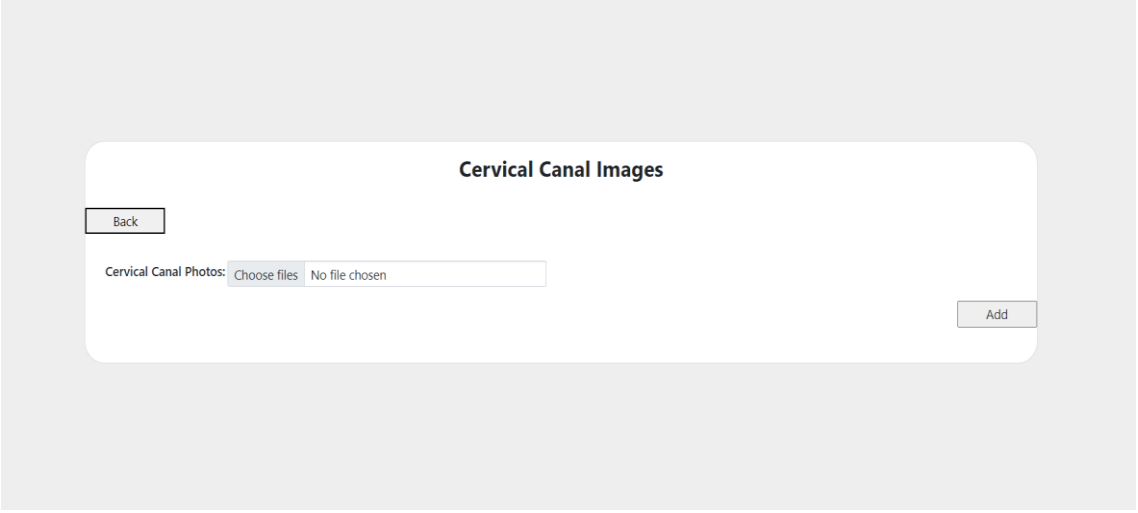


Figure 15. GUI Cervical Canal Images

The next page of the system is the “Panoramic View” page. This page consists of two parts. Firstly, the user is required to check all the boxes corresponding to the areas of the endometrium that were checked during the hysteroscopic examination. Secondly, the user needs to select one of the uterus shapes that corresponds to the shape of the uterus the patient has (By clicking on an image the system provides below the corresponding type of uterus that image points to.) as shown below in Figure 16.

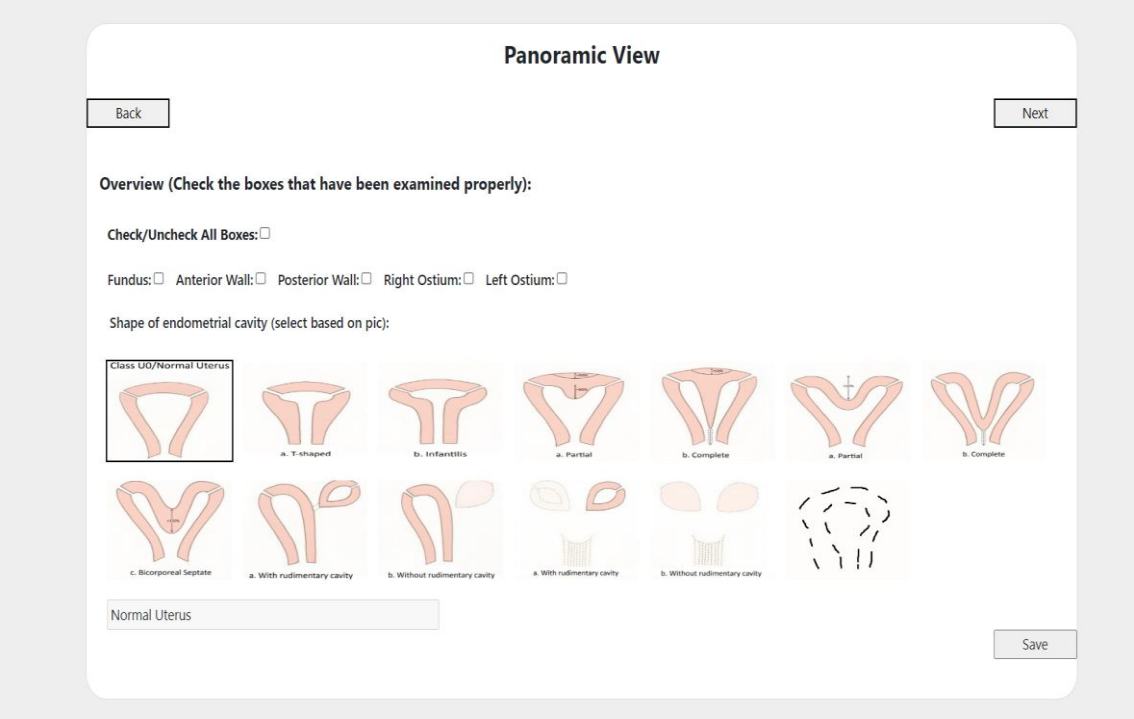


Figure 16. GUI Panoramic View

The following page of the website is the Close up View page. In this page, as shown in Figure 17, the user needs to check all the boxes of the corresponding endometrium areas that were thoroughly examined during the hysteroscopic examination.

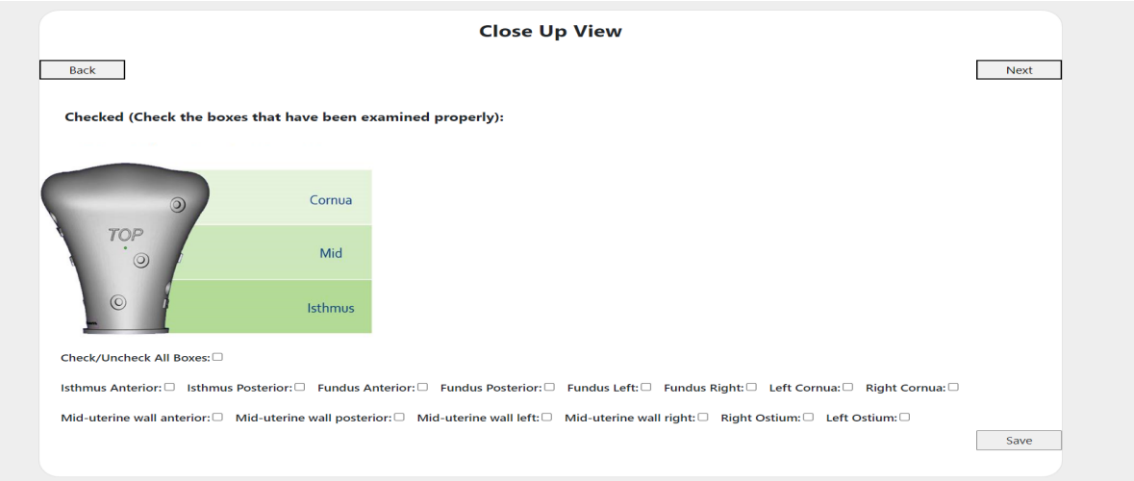


Figure 17. GUI Close Up View

Moving on, the system enters the stage where it collects data on the endometrium in the Endometrium Finding. In the other “Finding” pages, when the user selects the normal option in the finding then no further fields are added. In this page, if the normal option is selected, as shown in Figure 18, the user must also select among five images the one corresponding to the endometrium walls that the patient has. This is used by the doctor to check whether the stage of the walls match the days since the patient’s LMP. If any other option is selected in the first field, then the page follows the same structure as the Cervical Canal Finding page as shown in Figure 19. Moreover, by clicking on the Endometrium Photos Button the user is prompted to the “Endometrium Images” Page, as shown in Figure 20, where based on the Anatomical Location selected the user can save images of the endometrium that were captured during the hysteroscopic examination of the endometrium to further enhance the findings (in the server folder /files./<HysteroscopyID>-<PatientSerialNumber>/Endometrium/<Anatomical Location>/). This page also consists of a button “Intra Operative Ultrasound” that when is clicked the page for Ultrasound Images is prompted, where the user can add images captured during the Ultrasounds operation that was operated during the hysteroscopic examination for further clarification and information that was not able to be captured during the hysteroscopic examination as shown in Figure 23.

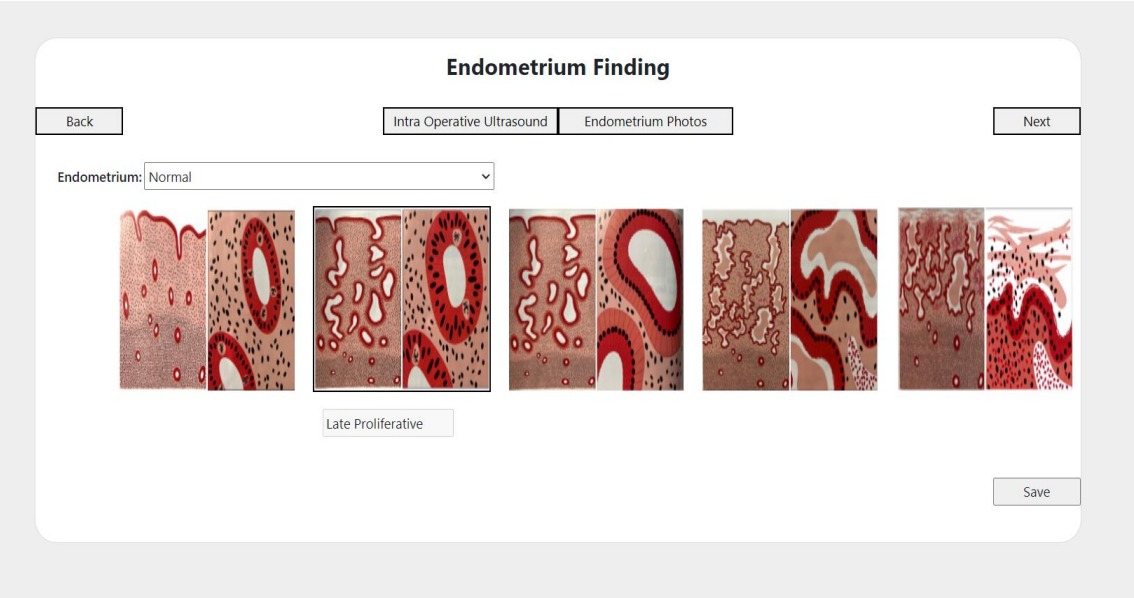


Figure 18. GUI Endometrium Finding (Normal)

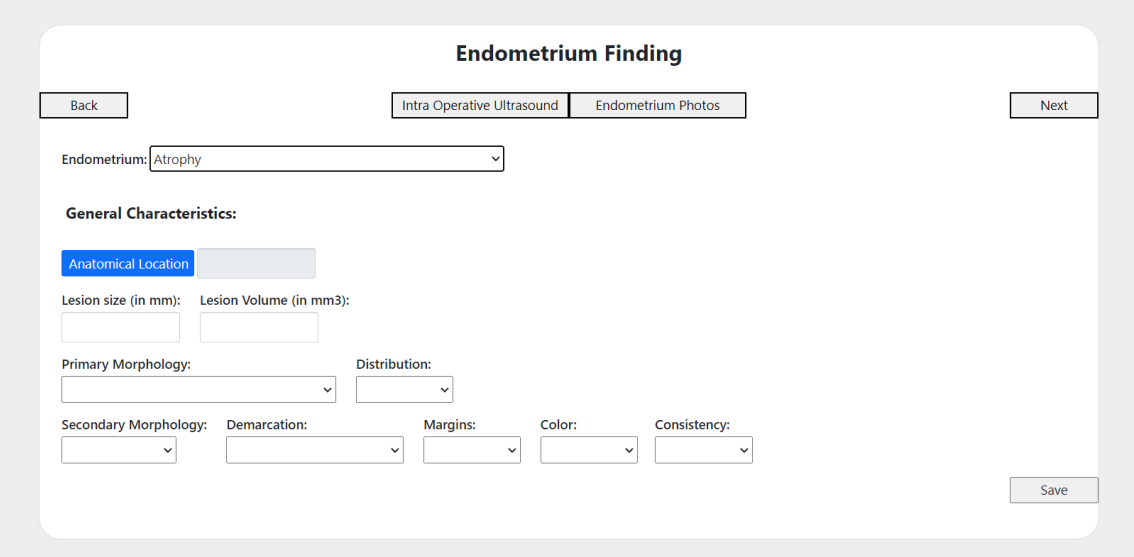


Figure 19. GUI Endometrium Finding(Not Normal)

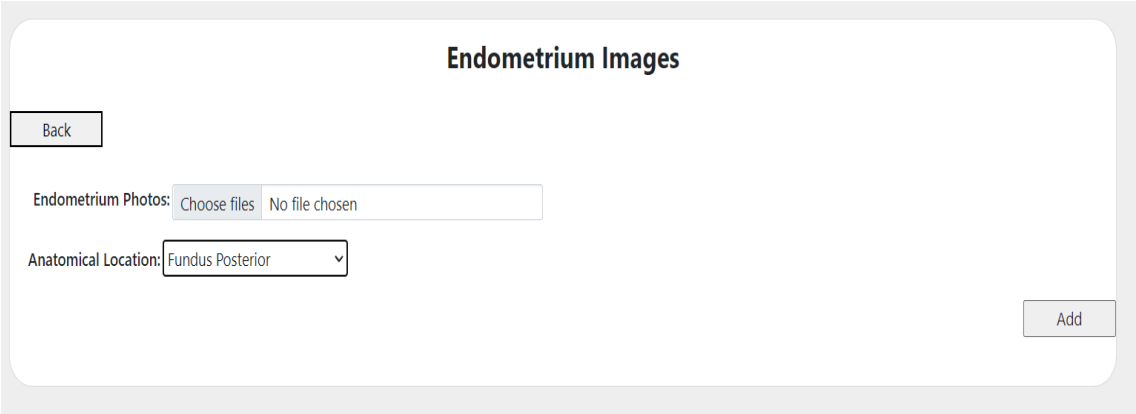


Figure 20. GUI Endometrium Images

By moving on from the Endometrium Finding the system prompts the user to the Mode of Care page, as shown in Figure 21, where the user enters information on which mode of care approach they chose for the patient.

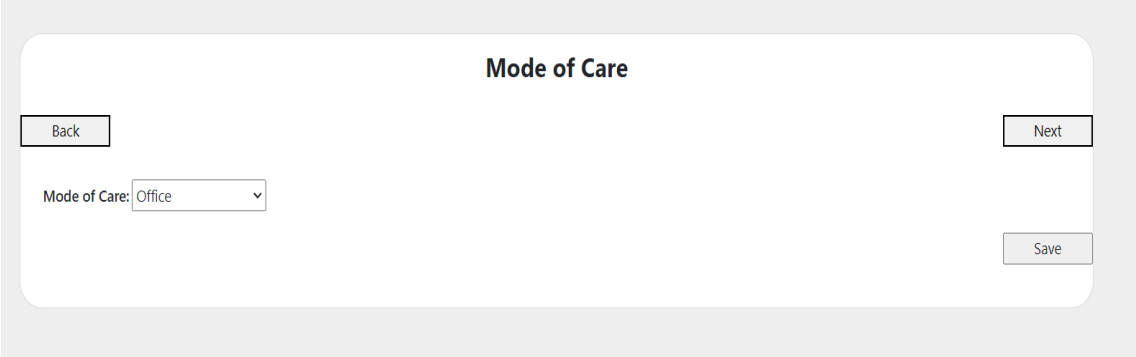


Figure 21. GUI Mode of Care

Next up, the system prompts the Imaging Report page. As shown in Figure 22, this page contains four buttons which redirect to the corresponding page for the insertion of video and images that were captured during the Ultrasound or the Hysteroscopic examination that weren't added before. Additionally, as shown in Figure 23 & Figure 24 each have a description field where the user can add any description that correlates to the images or video, they have inserted to the system to further enhance any conclusions or findings that the user has already used as an input in the system.

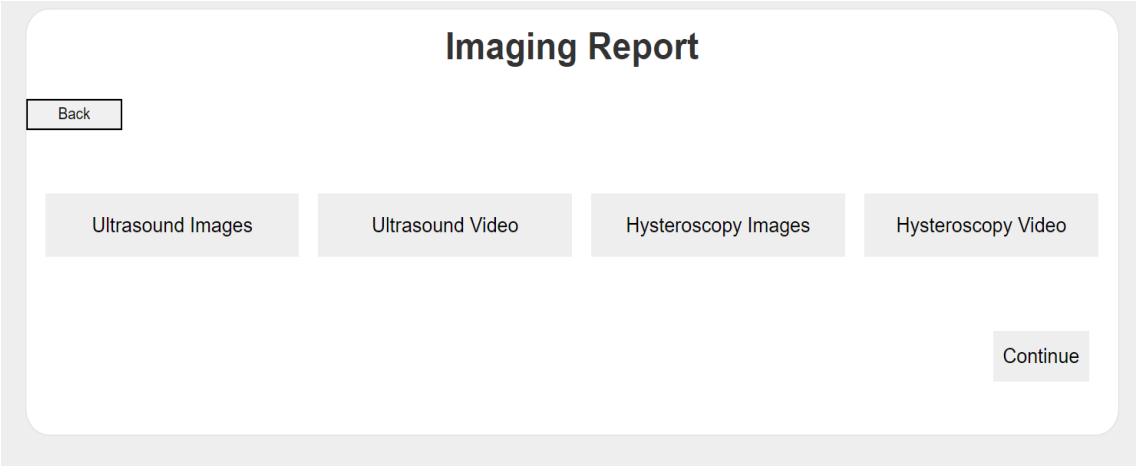


Figure 22. GUI Imaging Report

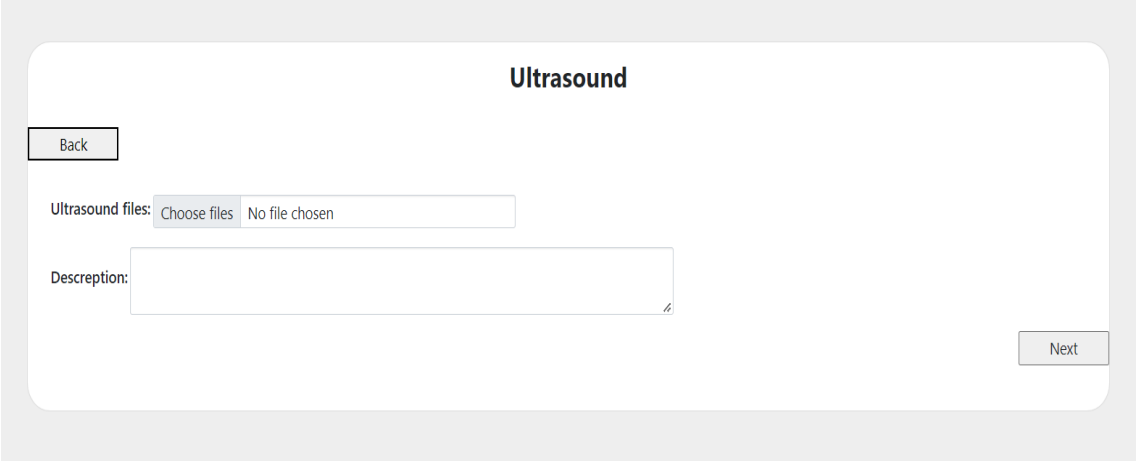


Figure 23. GUI Ultrasound

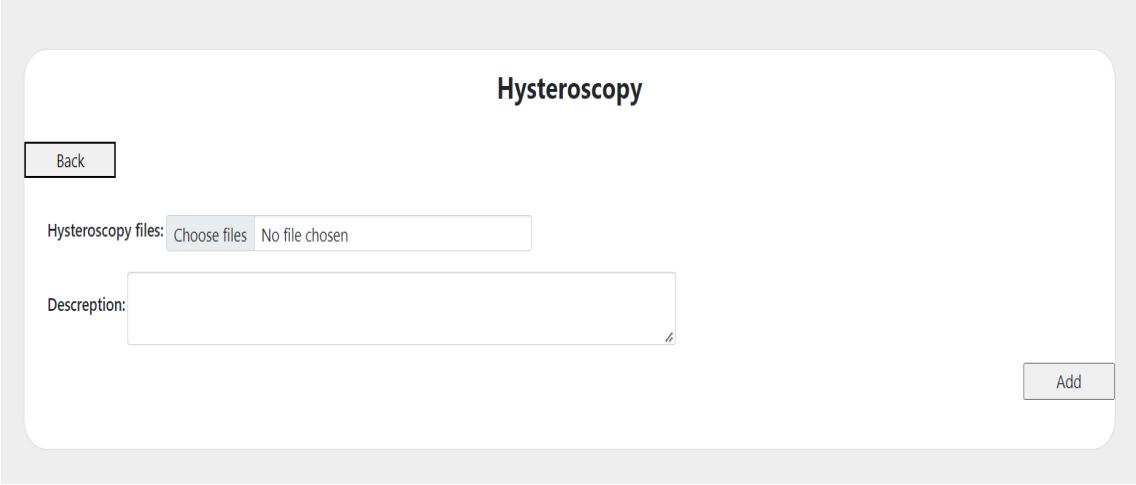


Figure 24. GUI Hysteroscopy

Finally, the system reached the last page of the “Add Record” option, the Report which shows all the data that were inserted into the current record. As shown in Figure 25, the page has check boxes which when are clicked, they show the corresponding data added for each part of the hysteroscopic examination. Each area’s data is shown in table form with scrollers and adjustable view if the data exceed the given space by the form. The user then can click on the “End” button which pops up an alert informing the user that once they confirm to close the current record it cannot be modified further (Ok or Cancel options to decide whether it will close the record). Additionally, if the user clicks on the buttons listed on the top of the screen “Descriptions/Conclusions” the user will be prompted to another page of the system where all the descriptions and conclusions (for MRI ,Ultrasound ,Hysteroscopy) are shown based on the user’s input through the system. Furthermore, “Images” Button will prompt the user to the page as shown in Figure 26.

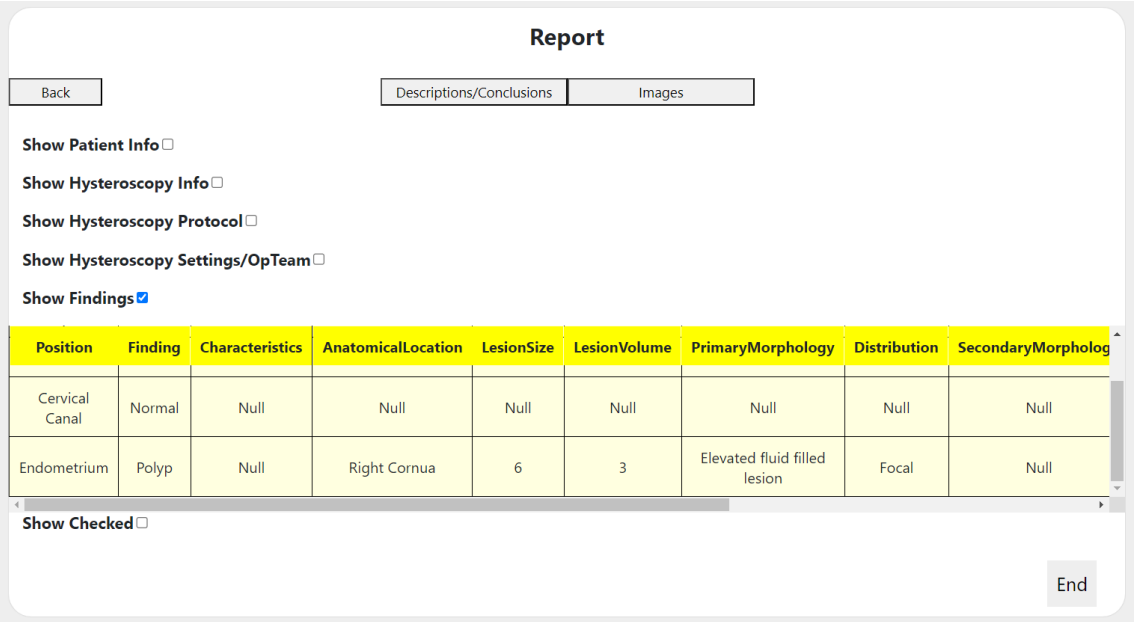


Figure 25. GUI Report

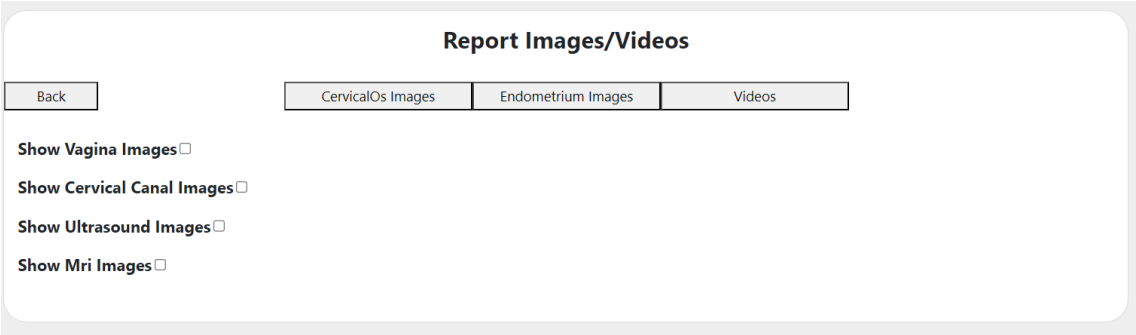


Figure 26. GUI Report Images/Videos

As shown in the above Figure, the user can view here all images for the specific record that were added throughout the system, based on the location the image was inserted to and if Endometrium or CervicalOs were the locations then based on the anatomical location shown in other parts of this section. Additionally, the user can view the videos that were added into the system for the specific record, by clicking on the "Videos" button, they will be prompted to another page that shows all videos that were added through the system (when the system designated a video addition) for Ultrasound and Hysteroscopy.

Another Menu option is the "Patient Report" as shown previously. By clicking on that option, the user is prompted to the Patient Report where they are provided with a list of all the records that have been added by set user as shown in Figure 27 (some data are blurred due to the sensitive of set data).

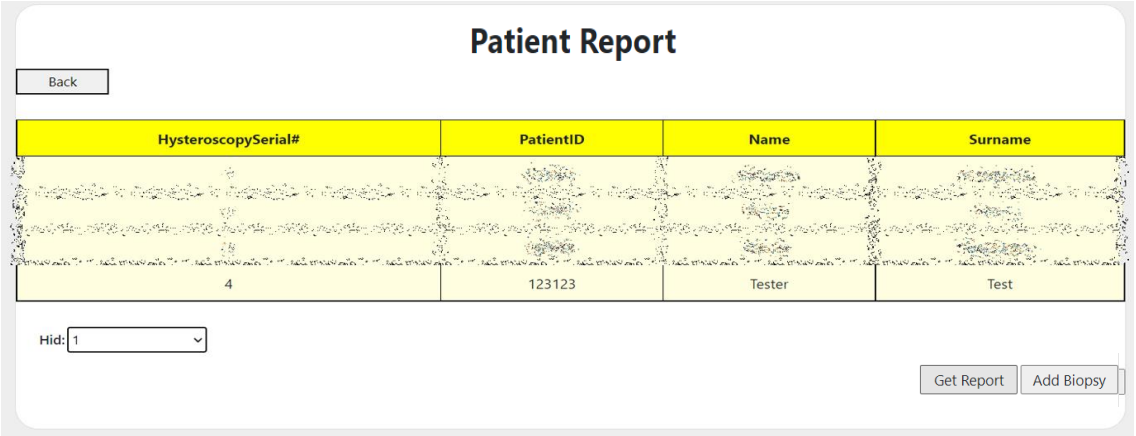


Figure 27. GUI Menu Report

By selecting a Hid (Hysteroscopy ID) and then clicking on Get Report the user is prompted to the page of Figure 25 and with the use of JavaScript some buttons are enabled and changed to move back and forth to the Menu Report and not the "Add Record" forms. Additionally, by selecting Hid and then clicking on "Add Biopsy" the user can add the biopsy report for the designated hysteroscopic examination.

The other option is the "General Reports" as shown previously. By clicking on that option, the user is prompted to the General Reports as shown in Figure 28. There are 4 general reports "Users Reports", "Hysteroscopy Reports", "Vaginoscopy Reports" and "Pathologies Reports". In the below figures (Figure 29- Figure 32) are shown the pages of each button in details on the reports they include with temporary data in the screenshots.

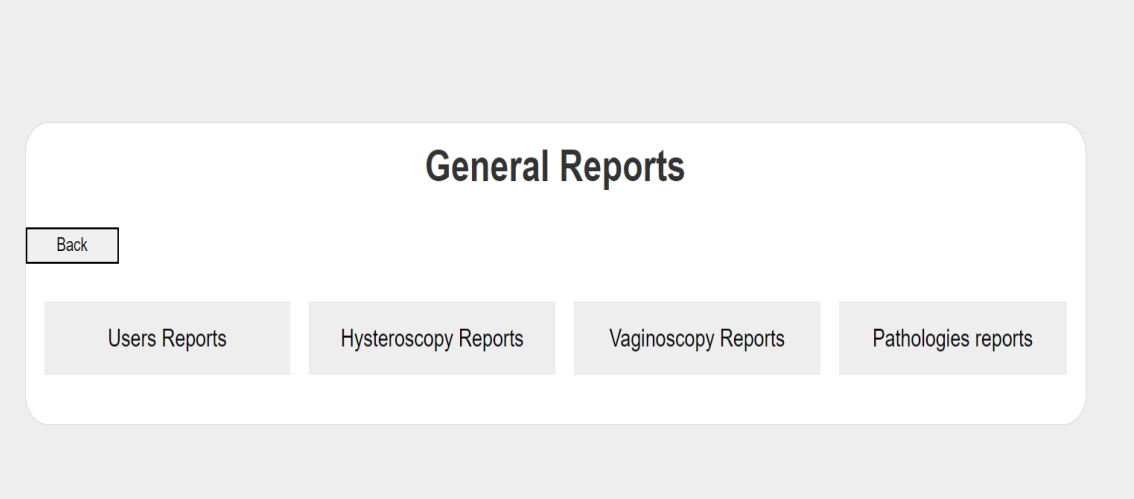


Figure 28. GUI General Reports

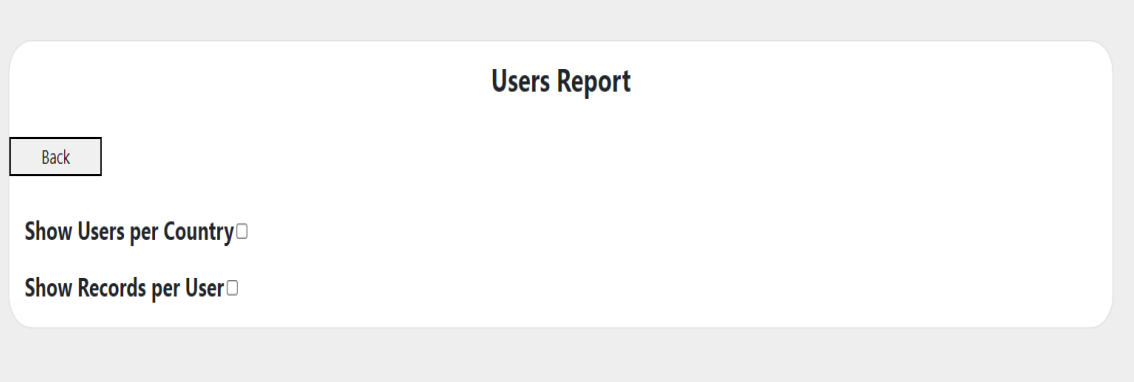


Figure 29. GUI Users Report

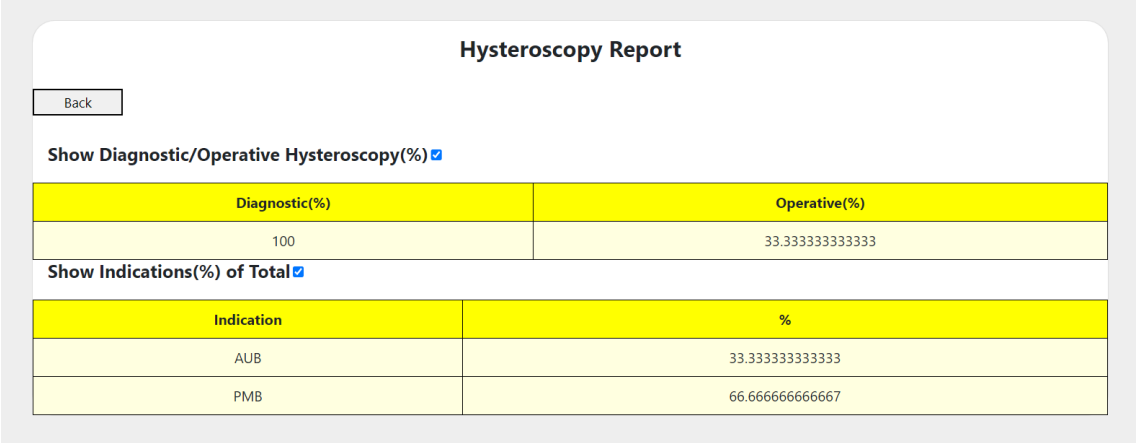


Figure 30. GUI Hysteroscopy Report

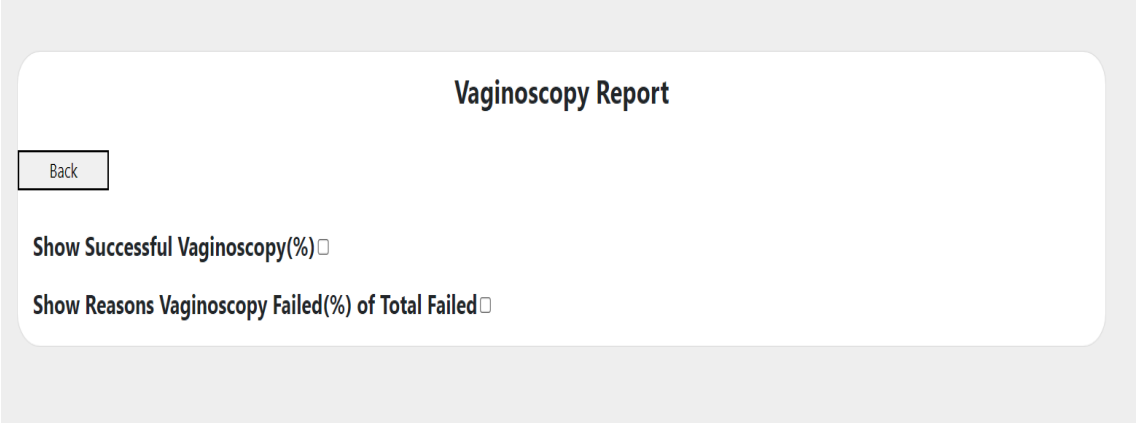


Figure 31. GUI Vaginoscopy Report

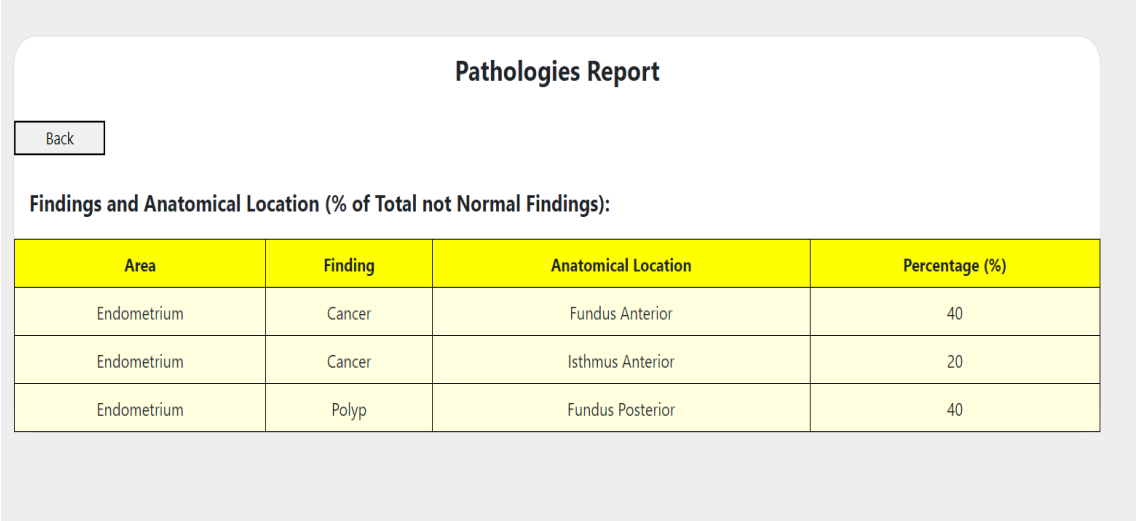


Figure 32. GUI Pathologies Report

Lastly by clicking on the “Log Out” the user can exit the system.

As shown so far, the GUI has been created to be simple to use and without any fancy designs. This style was followed since this system is to be used by doctors of any age, so the system should be as simplified as possible for older doctors with less experience on computer systems and programs to be able to use this system to store data that they have collected throughout their hysteroscopic examinations. Furthermore, the style of the website pages and its view was created according to the aim of this system. Since this system is to be used by professionals to be able to do their jobs more accurately, I concluded that a more simplistic, less fancy template should be used not to distract the users in any way than their main aim in using the system.

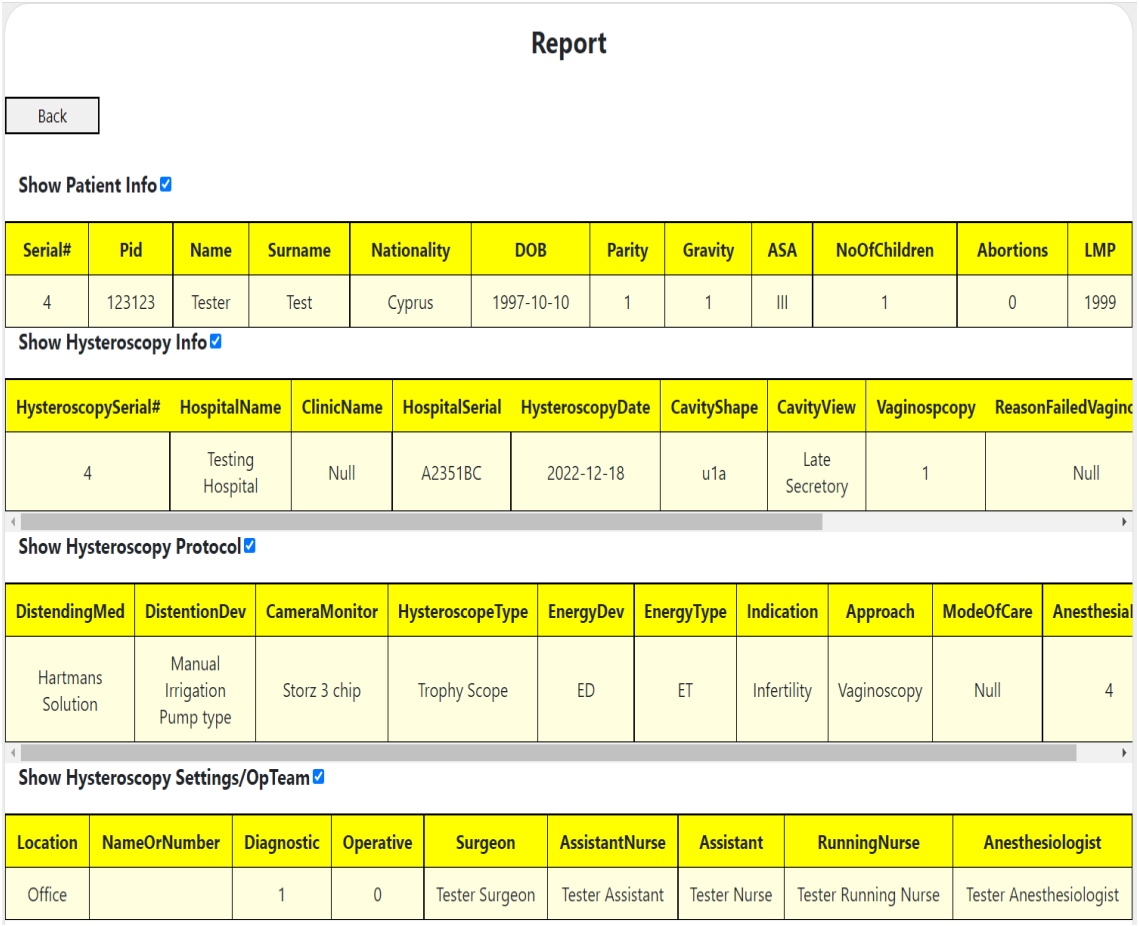
Finally, as shown over the sub chapter 4.4 this system follows a specific walkthrough with the minimization of menu options. This, structure of the system was proposed by the doctor to create a more “realistic” way of how a hysteroscopic exam is being conducted. In addition, according to the doctor the structure of the GUI serves also as a guideline to the doctors that will use it, on how a hysteroscopic examination data collection should be done and to emphasis further than no steps or areas of this guideline should be skipped at any part of the process, especially during the hysteroscopic examination, to have a clear and fully validated (by data and files) examination and conclusion of it.

Information on the exact workflow of the system can be found in Appendix A.

4.5 Use in real-life scenarios

Over the course of implementation and configuration of the system, the system has been used by Dr. Tanos with real-life inputs to test the system. Due to the sensitivity of the data and GDPR screenshots or any further information of the scenarios cannot be provided in this document.

Due to the above, I have used the system with real-life cases to create a testing scenario with real-life hysteroscopic examination data with the replacement of “testing” data inputs when needed to provide a clear report on how the system works and stores data. Various screenshots of the report have been placed together to be able to check the entire report. Below is found the Report of the real-life testing scenario that was created in Figures 33-35.



Report

Back

Show Patient Info

Serial#	Pid	Name	Surname	Nationality	DOB	Parity	Gravity	ASA	NoOfChildren	Abortions	LMP
4	123123	Tester	Test	Cyprus	1997-10-10	1	1	III	1	0	1999

Show Hysteroscopy Info

HysteroscopySerial#	HospitalName	ClinicName	HospitalSerial	HysteroscopyDate	CavityShape	CavityView	Vaginospcopy	ReasonFailedVaginc
4	Testing Hospital	Null	A2351BC	2022-12-18	u1a	Late Secretory	1	Null

Show Hysteroscopy Protocol

DistendingMed	DistentionDev	CameraMonitor	HysteroscopeType	EnergyDev	EnergyType	Indication	Approach	ModeOfCare	Anesthesial
Hartmans Solution	Manual Irrigation Pump type	Storz 3 chip	Trophy Scope	ED	ET	Infertility	Vaginoscopy	Null	4

Show Hysteroscopy Settings/OpTeam

Location	NameOrNumber	Diagnostic	Operative	Surgeon	AssistantNurse	Assistant	RunningNurse	Anesthesiologist
Office		1	0	Tester Surgeon	Tester Assistant	Tester Nurse	Tester Running Nurse	Tester Anesthesiologist

Figure 33. Real Life Report_1

Show Findings

Position	Finding	Characteristics	AnatomicalLocation	LesionSize	LesionVolume	PrimaryMorphology	Distribution	SecondaryMo
Vagina	Tumor	Null	Posterior Vaginal Wall	10	30	Flat elevated soft lesion	Focal	Erosio
CervicalOs	Normal	Null	Null	Null	Null	Null	Null	Null
Endometrium	Normal	Null	Null	Null	Null	Null	Null	Null

Show Checked

PosteriorWall	AnteriorWall	OverviewFundus	RightOstium	LeftOstium	RightCornua	LeftCornua	AnteriorFundus	PosteriorFundus	RightFund
1	1	1	1	1	1	1	1	1	1

Figure 34. Real Life Report_2

Show Findings

esionVolume	PrimaryMorphology	Distribution	SecondaryMorphology	Demarcation	Margins	Colour	Consistency	Extent	Severity	Type
30	Flat elevated soft lesion	Focal	Erosion	Well	Regular	Black	Null	Null	Null	Null
Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null
Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null

Show Checked

LeftFundus	RightMUW	LeftMUW	AnteriorMUW	PosteriorMUW	AnteriorIsthmus	PosteriorIsthmus	CloseUpLeftOstium	CloseUpRightOstium
1	1	1	1	1	1	1	1	1

Figure 35. Real Life Report_3

Chapter 5

System Evaluation

5.1 Method of Evaluation

The method of evaluation that was followed, to be able to get a thorough evaluation of the system was separated into two main parts. First part of the evaluation was to evaluate the web interface. Since this is a system that uses a web GUI (Graphical User Interface) so the users can interact with the system, evaluation methods that apply to web interfaces had to be used.

Evaluation criteria for the web interface are as listed below:

a. Match between interface and real world: This indicates whether the web interface that the user will use, has the same process-based structure that they would use in real world to gather information on the hysteroscopic examination.
b. Aesthetic and Minimalistic Design: This evaluates whether the web interface is simple and smooth to the eye without the need of any extravagant interfaces that could intimidate the users.
c. Usability: This evaluates whether the system is usable by every possible user that the system will have. More precisely it evaluates if the web interface is easy to use and straight forward.
d. Consistency: Evaluate whether the web interface is consistent with its buttons that do similar tasks, and consistent in general processing and interaction with the user.
e. Loading/Process Time: Evaluation on the time intervals each page of the web interface needs to be loaded or process data captured and whether those intervals are in expected boundaries for a web user interface.

Second part of the evaluation method is the evaluation of the data captured in the system. This also had some criteria to be followed to be able to be thoroughly evaluated.

Criteria used for the evaluation of the data captured are:

a. Accuracy: This is the criteria that evaluates that the data stored in the Database, or the server (files for video or images) are the exact same data that the user inserted in the web interface.
b. Protection: This is the criteria that evaluates whether all the sensitive data (Patient ID, Name, Surname) and users' passwords are encrypted in the Database and can be accessed by the appropriate users only.
c. Data Usage: This is the criteria that evaluates the data usage in the Database. More accurately, it evaluates whether the Database stores only the requested data from the doctor and that the usage of those data are kept to the appropriate data size.

5.2 Web Interface Evaluation

This section of the report indicates how each criteria of the web interface evaluation, that was listed prior, was checked/evaluated and what its conclusions are for each section (if conclusion exist).

a. Match between interface and real world:

   This was achieved through the systematic examination by the doctor during the creation of the web interface. In each page creation, the doctor provided information on the exact process that he follows during the hysteroscopic examination and that was used to create a web interface structure that resembles the process that is being followed in the real world. When the general testing of the system was being conducted by the doctor, he validated that the structure follows the same structure that a doctor follows (or ideally should follow) during a real world hysteroscopic examination.

b. Aesthetic and Minimalistic Design:

As shown in the GUI section prior, the interface uses smooth colours as its template. Additionally, the whole template of the web interface resembles actual forms with fields that could be found in already used physical forms conducted during a hysteroscopic examination. This concludes that a minimalistic and aesthetic design was achieved.

c. Usability:

As shown in chapter 4 in the GUI section, the system was created to look and feel as simple as possible. Additionally, when needed some explanation was given on what was expected by the system in cases that it might not be clear. During the testing of the system the doctor pointed out some minor corrections on how to make the system easier to use to the user and those were followed to accomplish the latest web interface shown prior.

d. Consistency:

As shown in prior chapter, the system is being consistent with its templates, button formats and names, and general structure. This was approved by the doctor during the feel and look testing of the system.

e. Loading/Process Time:

This criteria evaluation was tested by me. To test and evaluate this I gathered data from all pages and different process that the web interface uses. Data that were captured during this evaluation include time that a page needs to load and time that a process needs to be executed. To accomplish a thorough report on the time intervals, I used microtime() function of PHP in the beginning and ending of the pages and run the test around 100 times to be able to get an accurate average response time. Below are the average times for each page (that the user views) of the web interface in milliseconds. As shown below the time intervals are within reasonable boundaries.

Sign In	0.015ms
Sign Up	0.016ms
Menu	0.014ms
Demographics	0.025ms
Patient Info	0.023ms
Setting-OpTeam	0.021ms
Hysteroscopy Protocol	0.021ms
Vaginal Finding	0.017ms
Vagina Image	0.015ms
Vaginoscopy Report	0.018ms
Cervical Os Finding	0.018ms
Cervical Os Image	0.019ms
Cervical Canal Image	0.018ms
Panoramic View	0.032ms
Close Up View	0.027ms
Endometrium Finding	0.023ms
Endometrium Image	0.021ms
Mode of Care	0.015ms
Imaging Report	0.021ms
Ultrasound	0.018ms
MRI	0.017ms
Report	0.029ms
Menu Report	0.040ms

5.3 Data Evaluation

This section provides information on how the Data Evaluation, that was mentioned in section 5.1, was conducted and its results.

a. Accuracy:

   As stated prior this part evaluates whether the data captured in the Database are the same data that the user inserted in the web interface. This was evaluated during the testing of both me and the doctor where the data were accurate. Additionally, as shown in the GUI Section of chapter 4, at the end of each "Add Record" the user can view the data that the system has kept from their inputs before ending the record so that they can be modified.

b. Protection:

   The system follows the GDPR. This means that all sensitive data of the patient that are inserted in the system are being encrypted and can only be viewed by the user who inserted those data. This way the sensitive data of the patient are protected by the system.

c. Data Usage:

   This criteria was evaluated by taking the requirements for each data field provided by the doctor and creating a maximum size of it, to keep the data usage as low as possible. Additionally, the database only stores data that are needed during the hysteroscopic examination.

Chapter 6

Conclusion & Future Work

6.1 Conclusion

From a generic perspective, this thesis provides a user-friendly system for doctors of any age, due to its simplicity, to use for the storage of data that are collected during a Hysteroscopic Examination. The system created from this thesis, can be generally used by any doctor in any environment or country since it has been created to be as generic as possible without any bias included in the data or fields that the system collects via its web interface.

Our goals as reflected in the requirements and specification area in previous chapters, a big part of which have been achieved. These include the creation of a user-friendly web interface where the users can interact with ease with the system and follow a Natural Interaction Process with users, that simulates a hysteroscopic diagnostic process in real-life. Another important goal was to enhance the accuracy and speed of the diagnostic process. This has been achieved with the creation of multiple selection boxes in the GUI with numerous options (that consist of the most common options of each field) to lower the need of the user typing in long phrases or text in order to have a complete thorough report of one hysteroscopic examination. Additionally, by providing the website structured that was shown in previous chapters, our goal of inconsistency in hysteroscopic reports, has high probability of decreasing, since now the doctors have a specific guideline with set fields and data for each part and area of the hysteroscopic examination to go over and fulfil their report. Finally, our biggest goal to create a system that can fully incorporate and save data of every aspect of the hysteroscopic examination was achieved. This was by far the most challenging task. As the doctor pointed out in the beginning, required fields of a hysteroscopic examination haven't

been documented before. This proved to be a challenge, even though many hours had been spent on the requirements and specifications of the fields of the system by both I and the doctor, because of the vast number of “small” details that should be recorded in each hysteroscopic examination.

In addition to the above goals, we also added the feature to the system were hysteroscopic images and videos can be added to the corresponding hysteroscopic record. With the use of this feature, the doctors can easily match a hysteroscopic examination to its corresponding files to justify or explain their findings. This can also be used by younger doctors to check weather possible findings that they have recorded into the system match the findings that were added in the images and videos.

Finally, the system evaluation was ongoing throughout the creation of the system. Due to the complexity of data that the system was required to have, an evaluation by the doctor was conducted to check whether the fields and the looks of each area of the system corresponding to the real-life examination was correct. While there are many phases planned and this was only phase 1 of the system to be generated, this has provided a good idea on the fields, process and needs of the final system.

6.2 Future Work

The system that was generated in this thesis is a suffice and acceptable program for gynaecologists to store their diagnostic hysteroscopic data. However, the system certainly has room for improvements since the great magnitude of the demanded task, coupled with the need to be completed within the time frames of the dissertation made it difficult to implement potential enhancements we had in mind.

During the discussions on my thesis with both the doctor and my supervisors, this system is only the first part of a larger system. There were at least 2 more system/expansions planned for this solution to reach its full potential and become an up-to-date modern system that will fully use all the data acquired from the system generated throughout this thesis.

One plan of the future work is to create an argumentation-based system to help doctors. This Logic based system is to be generated to act as a decision-making-process that provides suggestions or solutions for the current system in various parts. From the level of anesthesia to be used based on the data collected on the patient, to possible findings during the examination based on the indications that prompted to the hysteroscopic examination and the history of the patient (Habits, Operations, Family History, Past Medication, Health Status, etc.). This system is planned to advise and help "inexperienced" gynecologists or to help doctors by providing them with every possible aspect of a disease that could occur in a uterus.

Another planned system is the finding of cancer or other diseases based only on the hysteroscopic images/videos that were recorded into this thesis system. For this system to be generated, numerous images and videos that will be captured in the current system will be used to provide screening and machine learning AI so that it can pinpoint diseases based on just one picture. This would be useful in many areas of gynecology to be able to swiftly pinpoint serious diseases such as cancer.

Finally, on the knowledge that I have acquired during this thesis on both gynecology fields but also further enhancement of my computing knowledge I am positive that this future work is not far ahead of us. After viewing firsthand, how complicated it is a system to be generated that correlate both computing and medicine, I now share the vision that this system will be fully elevated to the planned functionality, and I hope that this will be the cause of swift discovery of serious diseases in patients that will affect their treatability.

Bibliography

1. Taylor, P.J. and Hamou, J.E. “Hysteroscopy”. *The Journal of reproductive medicine*, *28*(6), pp.359-389. 1983.

2. Van Dongen, H., De Kroon, C.D., Jacobi, C.E., Trimbos, J.B. and Jansen, F.W. “Diagnostic hysteroscopy in abnormal uterine bleeding: a systematic review and meta-analysis”. *BJOG: An International Journal of Obstetrics & Gynaecology*, *114*(6), pp.664-675. 2007.

3. Sabbagh, K., Friedrich, R., El-Darwiche, B., Singh, M., Ganediwalla, S.A.N.D.E.E.P. and Katz, R.A.U.L. “Maximizing the impact of digitization”. *The global information technology report*, *2012*, pp.121-133. 2012

4. Britannica, T. Editors of Encyclopaedia, “Obstetrics and Gynecology”. Encyclopedia Britannica, 2018. Available from https://www.britannica.com/science/obstetrics 17/11/2022

5. Centini, G., Troia, L., Lazzeri, L., Petraglia, F. and Luisi, S. “Modern operative hysteroscopy”. *Minerva Ginecologica*, *68*(2), pp.126-132. 2016.

6. Moore JF, Carugno J. “Hysteroscopy”. [Updated 2022 Oct 20]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022. Available from: https://www.ncbi.nlm.nih.gov/books/NBK564345/

7. Bettocchi, S., Nappi, L., Ceci, O. and Selvaggi, L. What does ‘diagnostic hysteroscopy’mean today? The role of the new techniques. *Current Opinion in Obstetrics and Gynecology*, *15*(4), pp.303-308. 2003.

8. N. A.“Diagnostic Hysteroscopy” Available from https://www.bcm.edu/healthcare/specialties/obstetrics-and-gynecology/ob-gyn-procedures/diagnostic-hysteroscopy

9. DelVecchio A, Wallask S, “**Health IT (health information technology)**” Available from https://www.techtarget.com/searchhealthit/definition/Health-IT-information-technology

10. N.A. “The History of Healthcare Technology and the Evolution of EHR” 2018 Available from https://www.baytechit.com/history-healthcare-technology/

Appendices

Appendix A – User guide

1. Assumptions

It is assumed that the reader of this document has access to use the hysteroscopy system that was created for the implementation of gathering all necessary data and documents related to a diagnostic hysteroscopic examination. Additional assumption, that the User of this system is certified Gynecologist that has the knowledge of the entire hysteroscopic examination, and the data acquired by such an examination.

2. Functionality Overview

Below a list of bullet points on what general functionality is provided to the users of this system:

- Addition and registration of data gathered during a Diagnostic Hysteroscopic Examination including documents (images, videos).
- View of previous data registered by the designated user.
- View generic statistical reports based on the entire data stored through the system, generic reports mentioned below:

    - User Reports:

      1) Provide the number of Users in the system based on their Country.

      2) Provide the number of Records in the system based on the User that registered them.
    - Hysteroscopy Reports:

      1) Provide the percentage of Diagnostic and Operative Hysteroscopic examinations.

      2) Provide the percentage of the Indications that led to a Hysteroscopic Examination.

- Vaginoscopy Reports:

  1) Percentage of Successful Vaginoscopies.

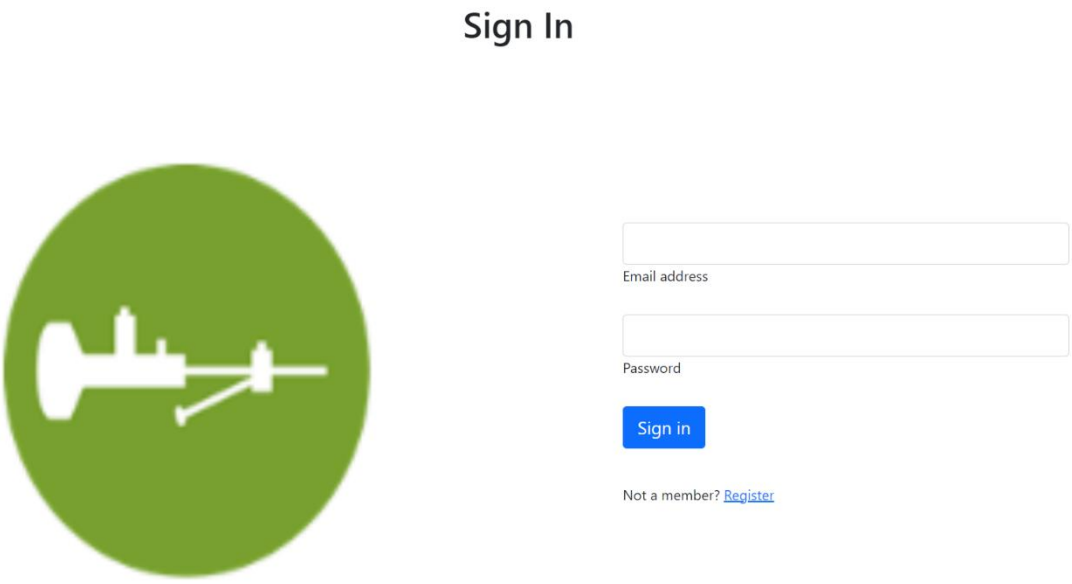
  2) Percentage of Reasons that a Vaginoscopy failed based on all the failed Vaginoscopies.
- Pathologies Report:

  Provide the percentage of a Finding (Pathology) and its Anatomical Location based on all not Normal Findings.

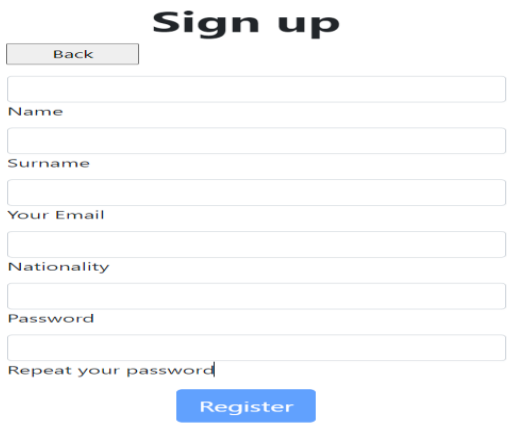
3. Workflow

3.1 Sing In/Up

In the main page as shown below fill in your account details to Sign into the system or create a new account by clicking on the Register link.

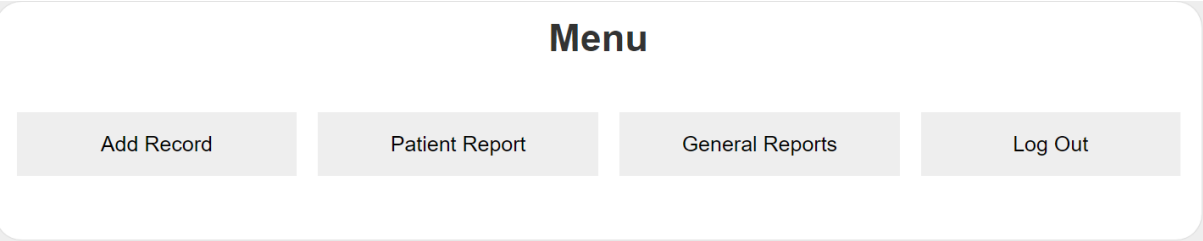


When Registering for a new account, make sure all the fields shown below are filled out and that the last 2 fields (passwords) match each other for the Register button to enabled.



3.2 Menu

Below you can see the first menu popping up when singing into the system. Through this menu you can navigate to the corresponding functionality of the system.

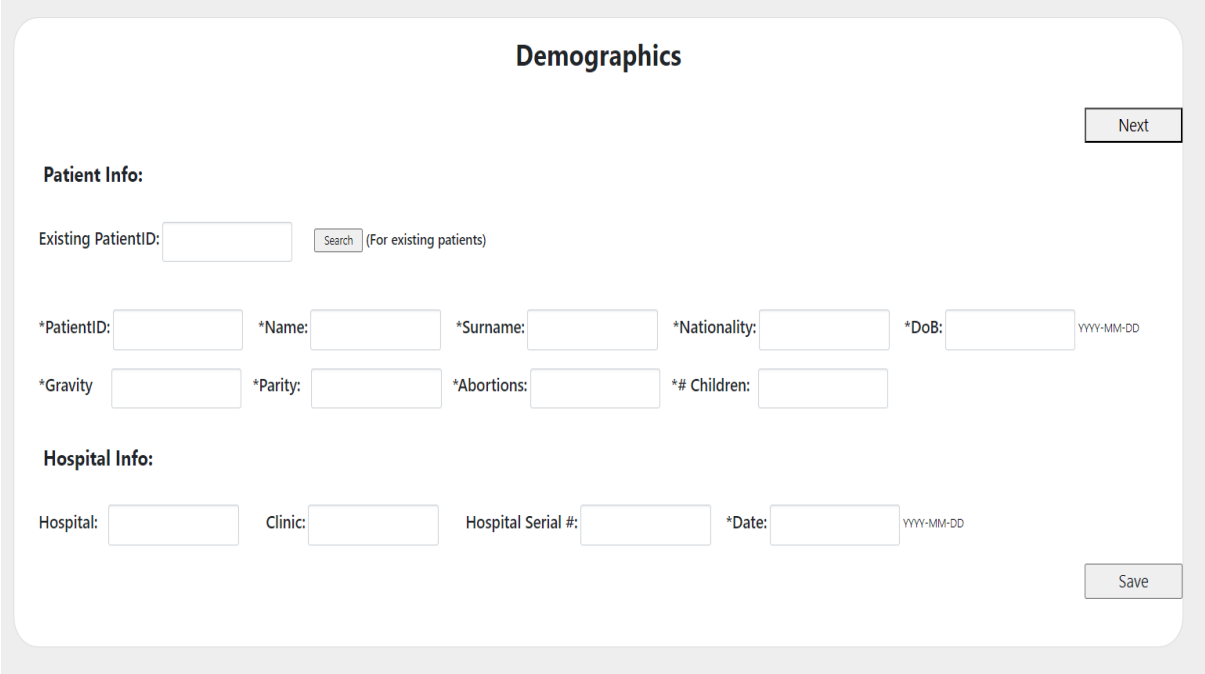


3.3 Add Record

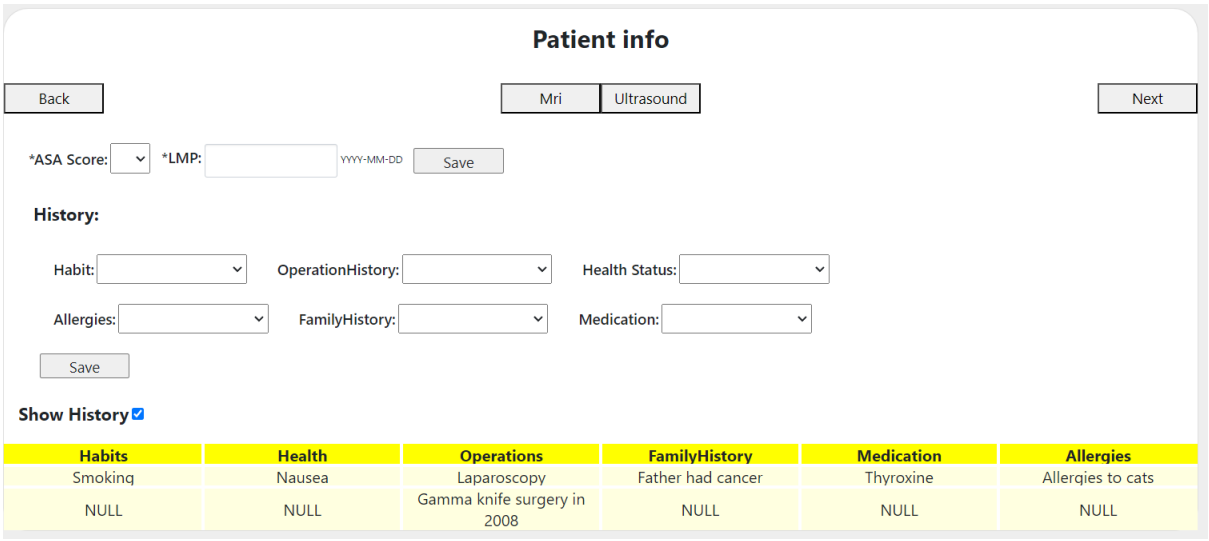
This section explains the entire “Add Record” process of this system with analytical explanation on fields when needed. General note that you must click on the button “Add” or “Save” on each form to make sure that the data you have inserted are saved into the system.

In the first screen shown below, you must fill out the demographics. Note that each field with an * before the field name means that the field is required by the system.

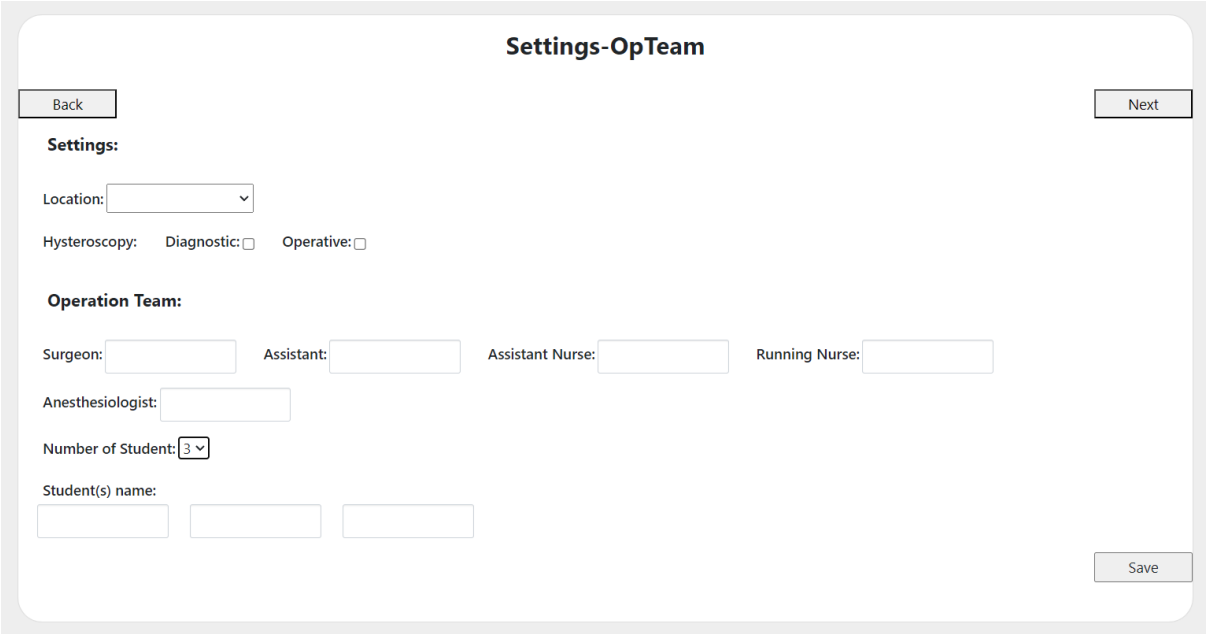
When this format is shown next to an input box “YYYY-MM-DD”, make sure that the date is added in that format year-month-day (e.g., 1998-12-28).



On the Patient Info screen, you can provide more information on the patient. To save the data related to ASA and LMP make sure to click on the save next to them. At the bottom of the page a table of all the previous historic information of the designated patient is shown. Additionally, you can provide mri and ultrasound related files to the patient using the buttons on the top of the screen.

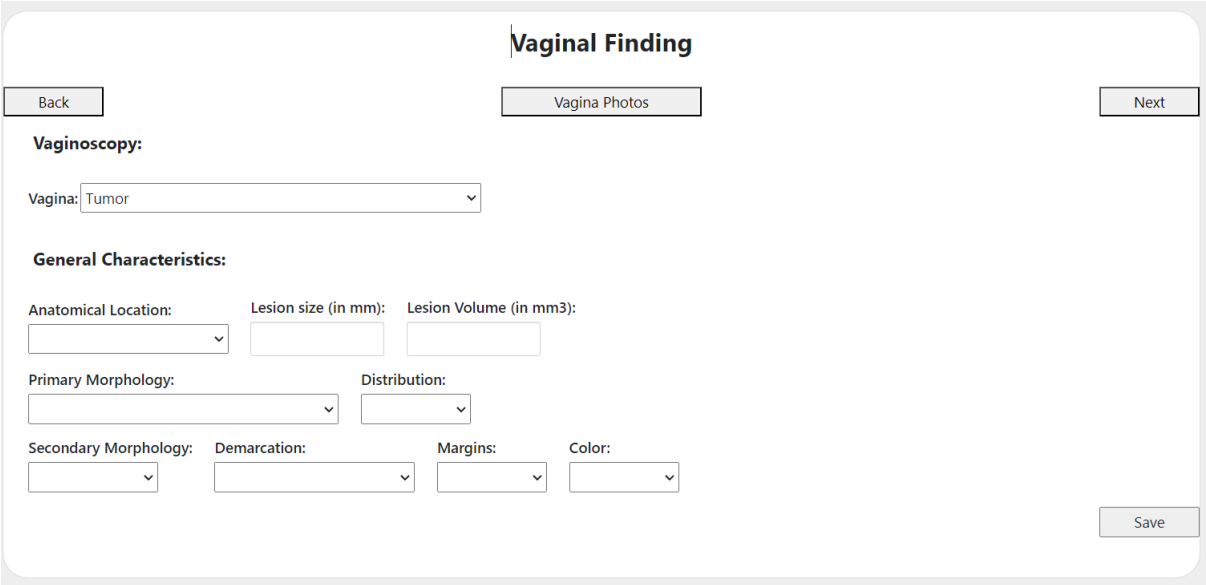


On the Setting/OpTeam screen, enter the data as shown below. By selecting the number of Students that were present during the examination the system will provide you with enough boxes to fill out their names.



For the Hysteroscopy Protocol screen, you can fill out the fields as you see fit.

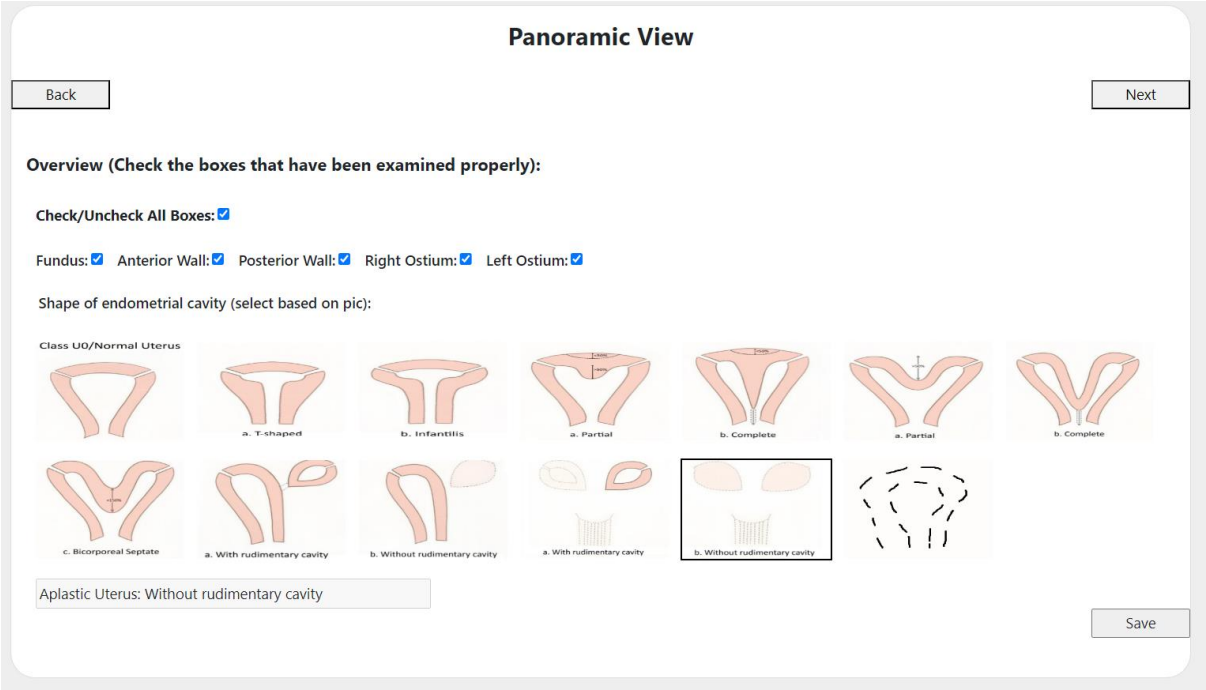
On the Vaginal Finding screen, by selecting the finding the corresponding boxes based on the finding will appear. As shown below by selecting anything else except “”, “Normal” the below fields appear where characteristics on the finding can be added. By clicking on Vagina Photos, you can insert images (gif, jpeg, tiff, bmp, png) related to the area of examination. Note that by clicking Save the finding is registered into the system but the system redirects you to the same page since there could be multiple findings in an area of examination.



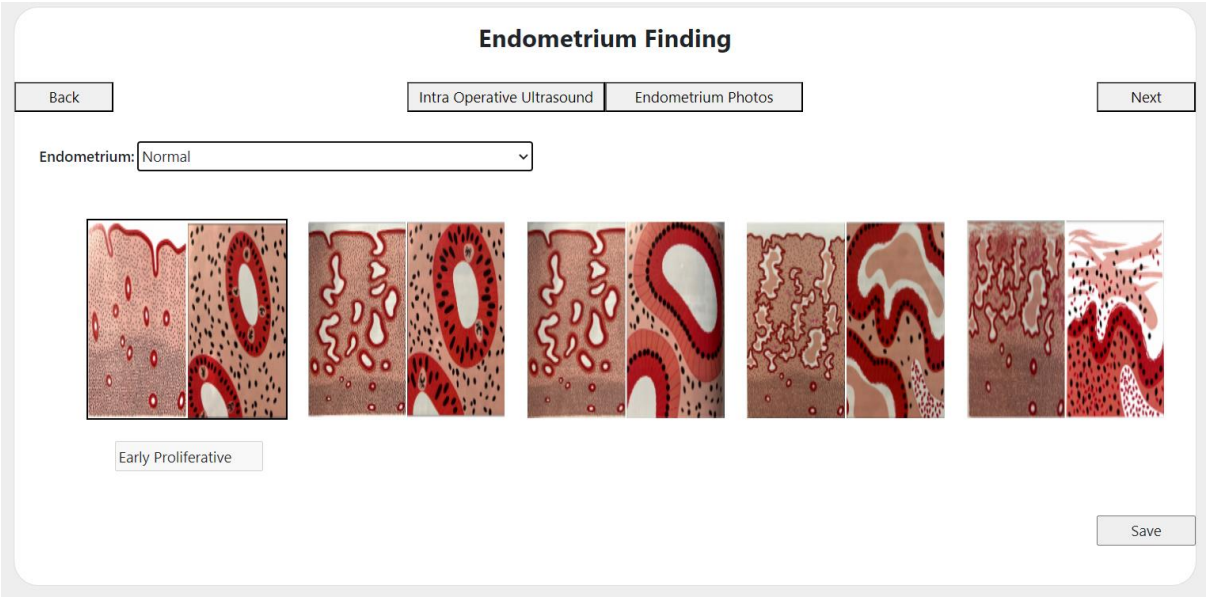
On the Vaginoscopy Report if the Successful Vaginoscopy is not checked then a selection box for the reason that it failed will be provided.

Cervical Os/Canal Finding follow the same structure as Vaginal Finding as explained in previous part of this subsection.

In Panoramic View (as in the next page Close Up View) the user is required to check all the boxes for the areas that have been examined thoroughly. Additionally, in Panoramic View the user can select the shape of the endometrial cavity for the patient, and a label of the name of the shape will be provided in the bottom of the pictures as shown below.



The Endometrium Finding screen follows similar structure as Vagina Finding mentioned earlier. The difference with this screen is that when "Normal" is selected then the below screen appears where the user must select which image corresponds to the view of the walls.



The Imaging Report screen lets you provide hysteroscopic files or descriptions that might not have been added earlier or provide the video captured during the hysteroscopic examination with a conclusion.

Lastly the user is prompted to the Report screen where they can view all the data and documents (images. videos) that were registered during the designated “Add Record”. By clicking the End on the bottom right on the screen the system lets you know that you won’t be able to further modify the certain record.

3.4 Patient Report

By clicking the Patient Report button on the menu shown in section 3.2 you are navigated to Patient Report screen where a list of all the hysteroscopic records that were added by the designated user are shown. Here you can view the entire reports by selecting the serial number of the report and clicking “Get Report” or adding the biopsy report by clicking “Add Biopsy” to the selected record.

3.5 General Reports

By clicking on “General Reports” button on menu mentioned in Section 3.2 you are navigated to General Reports screen where you can check various reports that are generated from all the data acquired into the system. (Reports provided in this screen are mentioned in section 2.).

3.6 Log Out

The system logs out your user, and validating your credentials is needed once again to enter the system.

Appendix B – Technical guide

1. Assumptions

Assume that the reader of this document has all files required for the installation of this system. Additional assumption that the reader of this has some technical and software knowledge and has used SSMS, SQL Server , PHP , Apache Server (or XAMPP) prior.

2. Prerequisites

List of all the prerequisites that are needed to install and run the system properly.

- Apache Server
- PHP v7.3.28 + (this has been tested with 7.3.28 and 8.1.6)
- MSSQL v14.0
- SSMS (MSSQL Management Studio) v18.10
- OpenJDK v1.8.0_272

3. Installation

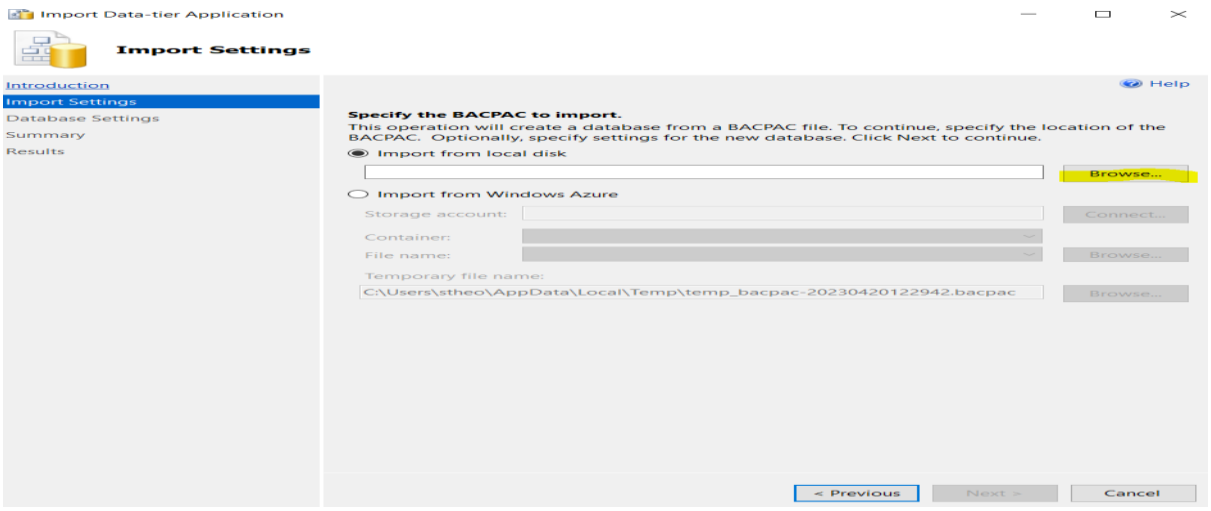
There are 2 add the Database needed to your MSSQL.

1)

a) Open your SSMS and connect to the SQL Server that this DB will be placed to.

b) Right Click on “Databases” and select “Import Data-tier Application”.

c) On the page below select Browse highlighted and select the hysteroscopy_DB.bacpac that can be found in the same folder as this document.



d) Complete the import.

2)

a) Create a DB in your SQL Server.
b) Open DB_Creation.txt and make sure to rename “hysteroscopy_DB” found on line 7 to match the DB that you have created.
c) Copy the entire text from DB_Creation.txt and run it on your DB through a query to add the tables, Store Procedures etc. needed by the system on your DB.

After adding or creating the DB to your server, create a user for the DB.

Additionally, make sure that your SQL Server has enable connectivity through 3rd party using SQL Authentication and all required settings and drivers to communicate between PHP.

Once the DB has been setup properly, extract XXX.7z into the folder that your Apache Server or XAMPP path to your web server. Make sure that all files and folders are there since this is essential for the aesthetic and correct functionality of the system.

Open login.php and register.php and change “$_SESSION[“serverName”] and $_SESSION[“connectionOptions”]” to match your DB (lines 18-23 as shown below).

```
1  <!--
2  @Author:    Stefanos Theodosiou
3  @Date:      18/04/2023
4  @Version:   1.2.0
5  @Desc:      This page adds the data required for a user creation into the system.
6  -->
7  <?php
8      session_start();
9      /*
10     $_SESSION["serverName"] = "localhost";
11     $_SESSION["connectionOptions"] = array(
12         "Database" => "hysteroscopy_DB",
13         "Uid" => "hysteroscopy_user",
14         "PWD" => "JzZWz"."$"."Rp6o"
15     );
16     */
17
18     $_SESSION["serverName"] = "mssql.cs.ucy.ac.cy";
19     $_SESSION["connectionOptions"] = array(
20         "Database" => "hysteroscopy_DB",
21         "Uid" => "hysteroscopy_DB",
22         "PWD" => "Pf3AxFc2"
23     );
```

After completing the above the web system should interact correctly with the DB.

Since this system allows the users to upload files such as videos and images the below attributes should be changes in php.ini to reflect the needs of the system:

file_uploads=On

upload_tmp_dir

post_max_size

upload_max_filesize

max_file_uploads

mssql.allow_persistent

mssql.max_persistent

mssql.max_links

mssql.min_error_severity

mssql.min_message_severity

mssql.compatability_mode

mssql.secure_connection

And include the drivers for mssql php.