

BRAIN. Broad Research in Artificial Intelligence and Neuroscience

e-ISSN: 2067-3957 | p-ISSN: 2068-0473

Covered in: Web of Science (ESCI); EBSCO; JERIH PLUS (hkdir.no); IndexCopernicus; Google Scholar; SHERPA/RoMEO; ArticleReach Direct; WorldCat; CrossRef; Peeref; Bridge of Knowledge (mostwiedzy.pl); abcdindex.com; Editage; Ingenta Connect Publication; OALib; scite.ai; Scholar9; Scientific and Technical Information Portal; FID Move; ADVANCED SCIENCES INDEX (European Science Evaluation Centre, neredataltics.org); ivySCI; exaly.com; Journal Selector Tool (letpub.com); Citefactor.org; fatcat!; ZDB catalogue; Catalogue SUDOC (abes.fr); OpenAlex; Wikidata; The ISSN Portal; Socolar; KVK-Volltitel (kit.edu) 2026, Volume 17, Issue 3, pages: 199-214

Submitted: May 24th, 2026 | Accepted for publication: July 3rd, 2026

Mobile Multiplatform Applications Development for Ultrasound Exams-Generated Information Management, Storage, Retrieval and Analysis — A Wrist Ganglion Test Case

Cosmin Tomozei

Vasile Alecsandri University of Bacău, Romania.

cosmin.tomozei@ub.ro,

<https://orcid.org/0009-0006-6605-2964>

Iulian Furdu *

Vasile Alecsandri University of Bacău, Romania.

ifurdu@ub.ro,

<https://orcid.org/0000-0002-7682-8213>

Bogdan Patrut

Alexandru Ioan Cuza University of Iași, Romania. bogdan@edusoft.ro

<https://orcid.org/0000-0003-1756-6468>

Florinela Floria

Vasile Alecsandri University of Bacău, Romania.

floria.florinela@ub.ro,

<https://orcid.org/0009-0007-2873-8874>

Dan Trofin

Grigore T. Popa University of Medicine and Pharmacy Iași, Romania

trofin.dan@umfiasi.ro,

<https://orcid.org/0000-0002-1480-3467>

* Corresponding author

Abstract: *The objective of this paper is to conduct a comprehensive analysis of the development process of multiplatform mobile applications, for the efficient processing of ultrasound images by means of software engineering technologies. A representative case analysed is the synovial ganglion of the wrist, a problem often encountered among software engineers, generated mainly by the vicious position of the arms and hands. Using a set of state-of-the-art software development technologies and relying on a Mindray Z60 ultrasound device, we developed a mobile application to streamline the ultrasound examination process. We tested it for an appropriate time tracking of the evolution of wrist ganglion morphology, size and symptoms towards either healing or augmentation. A prototype mobile application was developed, demonstrating improved efficiency in the ultrasound examination workflow, as an essential part of diagnosis and treatment. Thus, the information becomes ubiquitous and can be studied as it evolves over time, improving both the anamnesis process and doctor-patient communication. Customised multiplatform mobile applications for ultrasound image data management can contribute in assisting medical decisions and better communication.*

Keywords: *ultrasound examinations, mobile applications development, C#, wrist ganglion cyst.*

How to cite: Tomozei, C., Furdu, I., Patrut, B., Floria, F., & Trofin, D. (2026). Mobile multiplatform applications development for ultrasound exams-generated information management, storage, retrieval and analysis—A wrist ganglion test case. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, 17(3), 199-214. <https://doi.org/10.70594/brain/17.3/13>

1. Introduction

The evolution of technology and the subsequent implementations in medicine have led to very large volumes of data, and the need for more efficient and up-to-date patient information management systems. These systems are costly and difficult to maintain at the institutional level and in some cases, they become overloaded with data and are very time-consuming regarding medical specialists. Furthermore, for many medical conditions, historical patient and/or disease records are needed, which in some cases can be in the form of moving ultrasound images, which highlight the dynamics, physiological aspects. These aspects emphasise the need for storage space and optimisation is becoming increasingly important for the advancement of an optimal diagnosis and treatment process and for academic teaching and research.

The ultrasound data volumes are constantly increasing, mainly because each examination generates high-frame-rate cine loops, 3D and 4D large images, multimodal datasets including B-mode, Doppler and elastography. These types of examinations create very large raw data volumes due to high frame rates, creating growing demands on storage and data management. At the same time, ultrasound examinations have become essential tools for a wide range of practitioners, and even more importantly for hand surgeons who were able to correctly identify the anatomical structures of the hand with a very high degree of accuracy (Vigny et al., 2024). In recent studies the relevance of ultrasound image processing for medical education and research (Dissaux et al., 2023). This underlines the importance of historical images and the need for the availability of data and metadata. Ultrasound examinations could also be enriched through Artificial Intelligence and Machine Learning technologies that may further optimise the overall process, while taking into consideration cost-effectiveness, precision and portability as it may contribute to increased patient confidence. Moreover, communication between the medical practitioner and the patient becomes more straightforward, by significantly reducing the levels of confusion and uncertainty (Tomozei et al., 2021; Hoder et al., 2026).

2. Materials and Methods - Experimental Setup and Initial Scenario for Ultrasound Image Mobile Application Development

Our study is based on the creation of an experimental setup, using mixed reality to develop mobile applications for processing ultrasound image data. In the first phase, the ultrasound scanner was connected via a VGA adapter (ultrasound output) to HDMI (interactive screen input) to ensure that the images will be maximized for optimal visualisation.

From a hardware and software point of view, the following elements are highlighted:

- Mindray Z60 ultrasound machine
- Newline Model TT-7523QA interactive display
- ASUS Expert Center computer with Intel Core I7 CPU and Nvidia GeForce RTX graphics card
- Canon EOS 250 D camera with 18-55 IS STM objective
- Visual Studio 2026 Enterprise Edition with Android and iOS device emulators.

We started by collecting the images regarding a wrist ganglion case, very frequently identified in the branch of software engineers, especially because of the vicious position of the hand, wrist and arm, while holding the mouse, either in the right hand or left hand. The process continued gradually until we obtained a prototype of a mobile application for the management of the results of the ultrasonographic examination process, developed on the .NET platform and using MAUI (Multiplatform Application User Interface) technology.



Figure 1. Initial status quo of patient with wrist ganglion cyst

Figure 1 presents the right arm posture of a software engineer which puts stress on the arm, wrist, tendons and nerves.



Figure 2. Ganglion Cyst of the wrist – Right arm, Newline display exposed ultrasound image



Figure 3. Ganglion Cyst of the wrist zoomed in – Right arm, Newline display exposed

The images from Fig.2 and Fig. 3 show an example of synovial ganglion cyst, a type of benign structure, encapsulated fluid reservoirs containing viscoelastic, mucin-rich material, mechanically coupled to a joint capsule or tendon sheath through a narrow membrane that acts as a fluid conduit.

These structures represent the most frequently observed soft-tissue masses of the hand and wrist, comprising approximately 50–70% of all tumours in this region (Ramirez et al. 2024). Gelatinous mucinous material is often produced by repetitive stress on the structures and supporting ligaments, which stimulates fibroblasts that generate hyaluronic acid. In the case of software engineers, due to the posture at the office and the high volume of typing and holding the mouse, these types of structures tend to appear more frequently, while applying repetitive stress on the wrists. Literature reports that spontaneous regression often occurs but there is also a risk of recurrence in cases where enucleation is not completely possible (Lemhoefer & Loudovici-Krug,2025; Aprilya et al., 2023).

3. Ultrasound in Peripheral Pathology

Throughout the last decade, ultrasound (US) explorations have emerged as a useful tool to complete nerve conduction studies (NCS) within electromyography (EMG) protocols. These complementary tools in neuromuscular evaluation prove utility across a wide range of conditions, providing imaging-based structural/functional information from the US that relates and completes the electrophysiological measures from EMG. Within this context, US demonstrated high concordance with surgical outcomes in follow-up assessments, supporting its utility in preoperative planning and postoperative evaluation alongside EMG/NCS data. Specifically, these findings matched surgical findings in 98% of cases, underscoring US's value in identifying entrapment, disruption, or scar-related impingement relevant to nerve recovery strategies. EMG data in the same cohort showed residual reduced compound muscle action potentials (CMAPs) in a subset, illustrating complementary information between US and EMG in prognosis (Microsoft, 2026).

In pediatric traumatic nerve injuries, US findings combined with electrophysiology can be used to guide management, improving outcome prediction in surgical versus conservative pathways. US and EMG results are often more concordant in more severe pathology, implying that when EMG signals are profoundly abnormal, US abnormalities align more clearly with the final diagnosis (Microsoft, 2025).

In carpal tunnel syndrome (CTS), divergent EMG and US findings can occur, but large meta-analytic trends show that CSA (median nerve cross-sectional area) from high-frequency US is

a robust discriminator for CTS and correlates with electrophysiological severity in many cases, though not universally. Savage & McKell suggest divergent findings in some limbs, where US and generally electrodiagnosis (EDX) disagree, highlighting the need for integrated interpretation rather than reliance on a single test (Floria, 2014). Moreover, Chen et al. report high diagnostic concordance between CSI-based EDX criteria and US measurements (in CSA, by the wrist–forearm ratio parameter) but note the limited ability of US to grade CTS severity according to CSI categories, suggesting US utility is greatest for diagnosis rather than grading severity compared with EMG/NCS (Chen et al., 2021).

Usually, US parameters are strong for CTS detection and often align with EDX diagnoses, but discordance exists, reinforcing the value of a combined US-EMG approach for ambiguous cases show that conventional US and shear-wave elastography (SWE) correlate with EDX severity in CTS and with postoperative recovery, indicating that US (structural CSA and stiffness) tracks with electrophysiological severity and functional outcome after surgery (Floria, 2014; Chen et al., 2021; Wu et al., 2022).

US applications extend the diagnostic capabilities of EMG to more specific clinical conditions, as pelvic floor and other related muscles can benefit from the differential diagnosis from EMG–US correlations. This is the case of 4D translabial US in pelvic floor assessment, showing correlation with surface EMG (sEMG) during contraction alongside digital palpation, indicating that US-derived morphological/functional parameters relate to electrical muscle activity. This is a domain where EMG and US offer convergent information about muscle function, though the strongest correlations are with dynamic pink-of-view measures (levator plate angle changes) rather than a direct one-to-one mapping of EMG amplitude to a single US parameter (Martinho et al., 2020).

In another field of applications, Varol et al. report convergent validity among EMG, US muscle thickness, and dynamometric force during fatigue tasks in forearm muscles, finding significant correlations between EMG slope and US-measured thickness changes, indicating that concurrent EMG and US measures reflect related physiological processes (muscle activation and morphology). This supports the utility of simultaneous US and EMG to study muscle function and fatigue in healthy and clinical populations (Varol et al., 2023).

In Zhan et al. authors go beyond common applications, suggesting that in rat models US-measured diaphragm and rectus abdominis thickness correlate with histology, supporting the general principle that US-derived morphometrics can reflect underlying muscular structure and, when paired with EMG data (as in their broader discussion), can provide integrated structural–functional insights. While animal data require caution in extrapolation, they underpin the premise that US measures can correlate with physiological activity captured by EMG when examining respiration-related muscles (Zhan et al., 2022).

US is useful as a predictor of functional outcomes in nerve injury, and especially in peripheral nerve injuries and compressive neuropathies, where a combined US-EMG/NCS approach provides the most comprehensive information for diagnosis, surgical planning, and prognosis. The high concordance between US and intraoperative findings in some studies supports using US to triage surgical candidates and plan interventions, with EMG/NCS providing functional verification (Microsoft, 2026; Microsoft, 2025; Chen et al., 2021; Wu et al., 2022). This may facilitate the integration of these complementary measures in research and rehabilitation, as simultaneous US and EMG enable nuanced analyses of muscle fatigue, contraction mechanics, and structural adaptation, offering convergent metrics that can improve our understanding of neuromuscular health and guide therapeutic strategies (Winter et al., 2025).

4. Ultrasound-EMG Correlations in Pathologies of the Wrist

Several studies identify the cross-sectional area (CSA) of the median nerve at the carpal tunnel as a valuable US parameter that correlates with EDX and, in many cases, with severity criteria. In particular, optimized US measurements achieve high diagnostic concordance with

CSI-based EDX criteria, underscoring CSA as a central US correlate for CTS diagnosis (Chen et al., 2021; Wu et al., 2022; Osiak et al., 2022; Norbury & Morrison, 2019). However, some studies highlight that US and EMG assess different pathobiological facets (morphology vs. conduction abnormalities) and should be integrated rather than used in isolation (Floria, 2014; Chen et al., 2021; Norbury & Morrison, 2019; Żyluk et al., 2014).

In a prospective CTS cohort, the CSA demonstrated strong diagnostic performance and often aligned with EMG, supporting US as a complementary diagnostic modality that can aid in screening and characterisation of CTS (Chen et al., 2021; Osiak et al., 2022; Norbury & Morrison, 2019).

Some investigations report limited or no correlation between sonographic CSA and electrophysiological measures, particularly in mild CTS or in cases where US and EDX yield discordant results. This pattern indicates that a subset of CTS cases may present with morphological changes in the US without overt electrophysiological impairment, and vice versa. Consequently, reliance on US alone for staging severity or definitive diagnosis can be inadequate, and EMG/NCS remains essential for objective functional assessment in ambiguous cases (Chen et al., 2021; Norbury & Morrison, 2019; Żyluk et al., 2014).

In a recent study focusing on divergent findings, median nerve CSA was a key discriminator in limbs with disagreement between EDX and USI, reinforcing the value of integrating both modalities for diagnostic confidence, especially when clinical suspicion remains high despite discordant tests (Petrover et al., 2017). Shear-wave elastography (SWE) adds a functional dimension by quantifying nerve stiffness, which correlates with severity and with postoperative recovery. Wu et al. demonstrated that both conventional US metrics (CSA) and elastography measures show relationships with electrophysiology severity and with postoperative outcomes, suggesting US elastography can serve as a prognostic adjunct alongside EMG/NCS (Martinho et al., 2020; Savage & McKell, 2025).

US has also demonstrated utility in identifying anatomical variations relevant to CTS surgery (e.g., anatomical variations, transected/transligamentous courses) and structural factors that may influence nerve compression. Petrover et al. showed high accuracy of US in mapping median nerve variants and the thenar motor branch, which is clinically relevant to CTS pathology and to interpreting EMG findings in the context of anatomical variability (Lu et al., 2014). Such anatomical correlation can aid EMG/NCS interpretation by clarifying potential sites of focal conduction disturbance or denervation patterns. Correlations go beyond CTS at the wrist, especially through the assessment of cubital tunnel and other entrapments in the forearm, where US-detected structural abnormalities often accompany or explain EMG findings. Kowalska's assessment of high-frequency US in entrapment neuropathies reported high concordance between US-detected abnormalities and surgical or clinical outcomes, with US frequently identifying pathology even when EMG findings were inconclusive in some cases, underscoring US's complementary role in wrist/forearm entrapments (Kowalska, 2014).

As already mentioned, strain elastography and sonoelastography continue to show correlation with EMG in CTS and related conditions, with elastography ratios correlating with EMG severity and with electrophysiologic impairment. Karatay et al. reported significant correlations between EMG findings and median nerve stiffness measured by elastography, supporting elastography as a complementary tool to EMG in CTS evaluation (Karatay et al., 2020). Liao et al. similarly found preoperative and postoperative median nerve stiffness by sonoelastography to correlate with neurophysiological improvements after CTS surgery, highlighting complementary information between structural/morphological US and electrophysiology (Liao et al., 2023).

Mondelli et al. note that in mild CTS, US and NCV/EMG may yield complementary results, with some patients showing normal findings on one test and abnormality on the other, again emphasising multimodality testing for comprehensive assessment (Mondelli et al., 2008).

Given the heterogeneity of CTS and wrist neuropathies, a strategy that combines high-resolution US with EMG/NCS (sensory/motor latencies, CMAP or sensory nerve action potential (SNAP) amplitudes) provides a comprehensive assessment. This approach aligns with guidance suggesting neuromuscular ultrasound as an adjunct screening test before or alongside EDX, rather than a replacement, to inform diagnosis, prognosis, and surgical planning (Norbury & Morrison, 2019; Goldberg et al., 2016).

Nuances and practical implications

Correlations are context-dependent, as strong US-EMG correlations are more consistently observed for CTS diagnosis than for precise severity grading, and discordant results are not uncommon. Therefore, clinicians should interpret US and EMG/NCS together, considering clinical presentation and anatomic context. When US suggests CTS in a patient with normal EDX, or when EDX shows CTS without clear US changes, integrated interpretation and possibly further imaging or repeat testing are warranted (Floria, 2014; Chen et al., 2021; Norbury & Morrison, 2019; Żyluk et al., 2014).

Elastography-based measures correlate with severity and postoperative outcomes but remain supplementary. They should be viewed as additional biomarkers of tissue properties that reflect underlying neuropathic changes and recovery potential rather than standalone severity markers (Wu et al., 2022; Karatay et al., 2020; Liao et al., 2023).

All these arguments are in favor of a multimodal diagnostic framework that integrates US findings with EMG/NCS, clinical evaluation, and anatomical considerations, in order to optimise accuracy in diagnosis, staging, and management decisions for various wrist pathologies (Chen et al., 2021; Norbury & Morrison, 2019; Mondelli et al., 2008; Goldberg et al., 2016).

5. Results: Testing Procedures for Ganglion of the Wrist Image Processing

For current ultrasound devices, although they are very efficient in terms of generating high-resolution images, precise focus and overall quality, it is necessary to develop other types of software applications that facilitate efficient information management. This includes both storage, particularly the subsequent retrieval and association with various categories of conditions.

These applications can also have an instructional character, helping practitioners both as students and as self-directed learners to acquire new knowledge regarding medical imaging.

It is also important to consider the dynamics of certain conditions and their evolution over time, including remission, exacerbation, recurrence, or the implementation of additional therapeutic intervention.

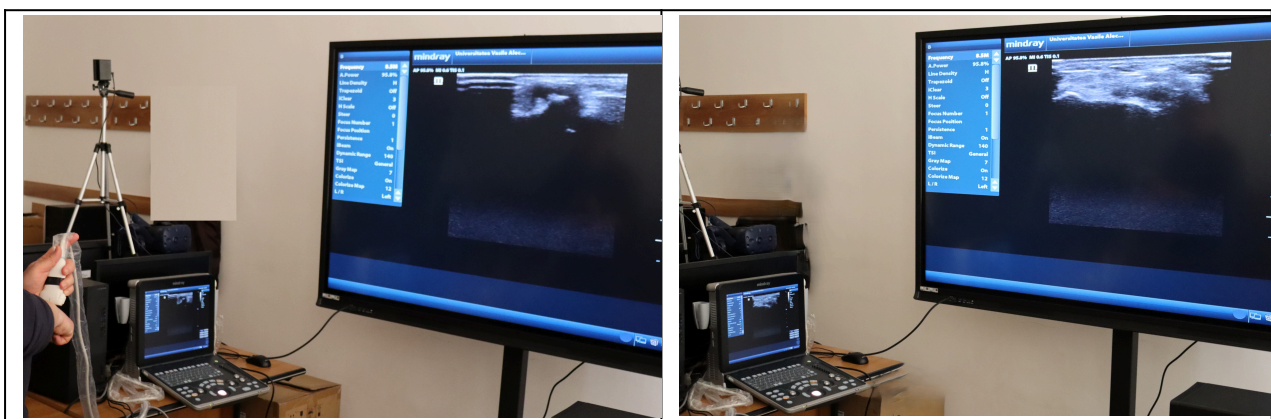


Figure 4. Ultrasound images projections on Newline interactive display

In Figure 4 and 5 the initial setup for ultrasound image optimisation is presented, considering the representative situation analysed, a ganglion cyst of the right wrist. These two

scenarios reflect in antithesis an ultrasound image of the right wrist with a synovial ganglion and an ultrasound image of the left wrist, with a normal configuration and structure.

The process continues by developing the prototype that manages the images obtained, both as image data and as metadata.

The first step involved creating the laboratory context and defining the use case, namely the projection of an ultrasound image of a synovial ganglion, so that the images could be subsequently transmitted and stored through a computer application. The images will be captured either using the camera of a mobile device, or by transmitting data over the network, using a service with access to a relational database, such as SQL Server or SQLite. This means that a model should be created, in the shape of a class that describes the patients' data that is necessary for being stored and later retrieved.

In this way, the doctor can notice the evolution or the decrease of the synovial ganglion as time passes by.

```
public class UltraSoundPatient
{
    [PrimaryKey, AutoIncrement]
    public int ID { get; set; }
    public bool Done { get; set; }
    public string Name { get; set; }
    public int Age { get; set; }
    public string Gender { get; set; }
    public string HealthIssues { get; set; }
    public string Email { get; set; }
    public string UltrasoundImage { get; set; }
    public byte[] UltraSoundImageData { get; set; }
    public string UltraSoundVideo { get; set; }
    public byte[] UltraSoundVideoData { get; set; }
    public ImageSource UltraSoundPhotoSource
    {
        get
        {
            if (UltraSoundImageData == null || UltraSoundImageData.Length == 0)
            {
                return null;
            }
            return ImageSource.FromStream(() => new
MemoryStream(UltraSoundImageData));
        }
    }
    public ImageSource UltraSoundVideoSource
    {
        get
        {
            if (UltraSoundVideoData == null || UltraSoundVideoData.Length == 0)
            {
                return null;
            }
            return ImageSource.FromStream(() => new
MemoryStream(UltraSoundVideoData));
        }
    }
    public DateTime DateOfExamination { get; set; } = DateTime.Now;
}
```

Figure 5. C# Model implementation for a patient with an associated ultrasound image

This model could be extended to a class diagram, in which we may see the relationship between the Patient entity and the UltrasoundModel entity, but for this scenario it is better to keep things simple. The extension of the model could bring a one-to-many relationship, in a way that a certain patient may be associated with a specific set of ultrasound images. However, a set of ultrasound images may be also stored as a generic collection, such as ArrayList and consequently the model becomes considerably simplified. This initial model consists of the minimal information that should be considered during an ultrasound examination of a patient, such as name, age, gender,

previous health issues and contact details. Having a mobile application, which the patient may install on their own device may significantly reduce the time and the complexity of future ultrasound examinations, made either by the same or another practitioner. Once the information is stored, it should offer the possibility of future updates while the number of items, as ultrasound images from the ArrayList collection may be as well updated, bringing considerable benefits in comparison with the printing on thermal paper or just handwriting or typing the data.

The second step involves defining user interfaces, so as to quickly and efficiently access ultrasound images associated with users (patients) at different stages in time. We are building the MAUI interface through XAML (eXtensible Application Markup Language), which will be available on the three operating systems Windows, Android and iOS.

```
<?xml version="1.0" encoding="utf-8" ?>
<ContentPage xmlns="http://schemas.microsoft.com/dotnet/2021/maui"
  xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
  xmlns:models="clr-namespace:ULTRASOUND_FINAL_SIMPLU.Models"
  xmlns:local="clr-namespace:ULTRASOUND_FINAL_SIMPLU"
  x:DataType="models:UltraSoundPatient"
  x:Class="ULTRASOUND_FINAL_SIMPLU.MainPage">
  <ScrollView>
    <VerticalStackLayout x:Name="LayoutPatients" Spacing="20" Padding="20">
      <Label Text="Patient Name" />
      <Entry x:Name="nameEntry" Text="{Binding Name}" />
      <Label Text="Patient Age" />
      <Entry x:Name="ageEntry" Text="{Binding Age}" Keyboard="Numeric" />
      <Label Text="Patient Gender" />
      <Entry x:Name="genderEntry" Text="{Binding Gender}" Keyboard="Text" />
      <Label Text="Email" />
      <Entry x:Name="emailEntry" Text="{Binding Email}" />
      <Label Text="UltraSound Image" />
      <Image x:Name="UltraSoundImage" HeightRequest="100" WidthRequest="100" />
      <Button x:Name="selectUltraSoundImageButton" Text="Select Ultrasound Picture"
        Clicked="selectUltraSoundImageButton_Clicked" />
      <Button x:Name="takeUltraSoundImageButton" Text="Take Ultrasound Picture"
        Clicked="takeUltraSoundImageButton_Clicked" />
      <Button x:Name="selectUltraSoundVideoButton" Text="Select Ultrasound Video"
        Clicked="selectUltraSoundVideoButton_Clicked" />
      <Button x:Name="takeUltraSoundVideoButton" Text="Take Ultrasound Video"
        Clicked="takeUltraSoundVideoButton_Clicked" />
      <Button x:Name="saveButton" Text="Save" Clicked="saveButton_Clicked" />
      <Button x:Name="deleteButton" Text="Delete" Clicked="deleteButton_Clicked"
        IsVisible="False" />
    </VerticalStackLayout>
  </ScrollView>
</ContentPage>
```

Figure 6. XAML Model implementation for a patient with an associated ultrasound image

The provided XAML code defines a multiplatform user interface using .NET MAUI for managing patient data and associated ultrasound media. The layout is clear, functional, and aligned with the requirements of a medical data management application. It follows a form-based design paradigm, suitable for structured data input and retrieval. Figure 6 indicates the following aspects of user interface design:

- the use of ScrollView ensures usability across devices with different screen sizes;
- verticalStackLayout provides a simple and readable top-down structure;
- appropriate for mobile environments where vertical navigation is expected;
- use of data binding ({Binding ...}) suggests a MVVM-oriented architecture;
- proper keyboard configuration (Numeric) improves user input efficiency;
- fields correspond to essential patient metadata (name, age, gender, email).

This set of features contributes to a user-friendly and portable interface that can be deployed across mobile devices running different operating systems.

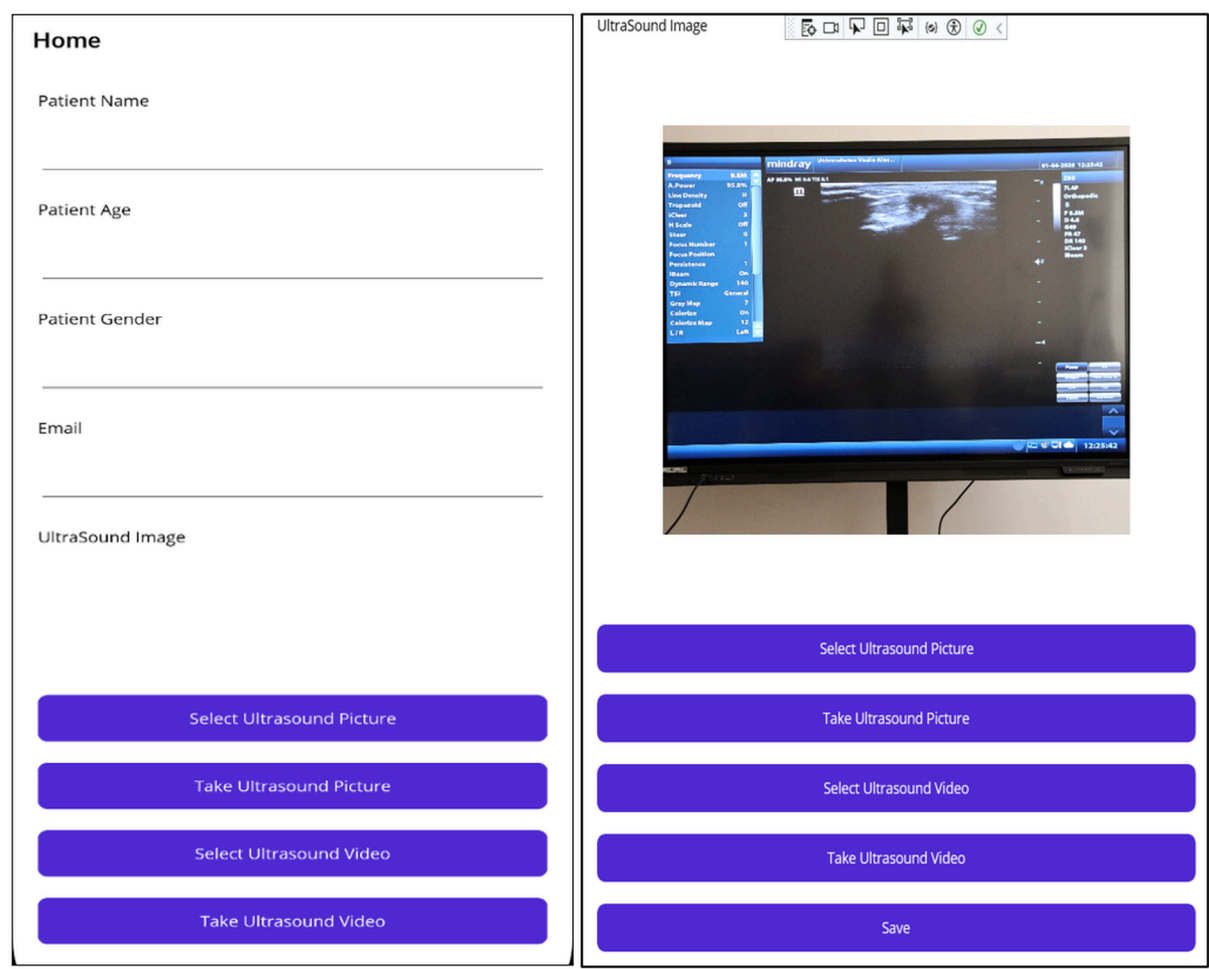


Figure 7. Android mobile application user interface with an associated ultrasound image

The third step involves the actual development of the source code, writing classes, defining services, and designing the database, as described in Microsoft (2025, 2026) based on the algorithms identified within the requirements analysis process. For each functional module of the application, a specific algorithm should be identified and implemented within the corresponding application modules.

The development process starts with the precise determination of input data and output data, which takes into account the model defined in Figure 5.

Algorithm 1: Ultrasound Data Management System Algorithm 1: Ultrasound Data Management System Input: Patient information, ultrasound images/videos Output: Persistent storage and retrieval of patient ultrasound records 1: Initialize application environment 2: Initialize database connection DB 3: while application is active do 4: action ← DisplayMainMenu() 5: 6: switch action do 7: case ADD_PATIENT: 8: P ← CreatePatient() 9: StorePatient(DB, P) 10: 11: case CAPTURE_ULTRASOUND: 12: img ← AcquireUltrasound() 13: pid ← SelectPatientID() 14: AttachImageToPatient(DB, pid, img)	16: case RETRIEVE_DATA: 17: pid ← InputPatientID() 18: P ← RetrievePatient(DB, pid) 19: DisplayPatient(P) 20: 21: case UPDATE_DATA: 22: pid ← InputPatientID() 23: UpdatePatient(DB, pid) 24: 25: case DELETE_DATA: 26: pid ← InputPatientID() 27: DeletePatient(DB, pid) 28: 29: case ANALYZE_HISTORY: 30: pid ← InputPatientID() 31: AnalyzeHistory(DB, pid) 32: 33: case EXIT: 34: Terminate application
--	---

Figure 8. Algorithm for the general objective of the multiplatform application

The algorithm from figure 8 has been determined using Microsoft Copilot, a generative artificial intelligence tool, by semantically analysing the text description of the application objectives. The input information is identified as patient information, ultrasound images and videos, which will be further stored and will provide the possibility of historical analysis.

Every use case is further detailed in a specific algorithm, that specifies the procedure previously described in general terms. Each case of data management is described separately, from obtaining information in the form of ultrasound images, to their storage, retrieval and updating. These use cases will be developed into independent modules, classes and methods in which the respective functionalities will be implemented in a clearly defined manner. Figure 9 presents two of the most significant cases, obtaining and retrieving images for patients, as the CAPTURE_ULTRASOUND and RETRIEVE_DATA mobile application requirements.

Algorithm 3: AcquireUltrasound() Input: Acquisition method selection Output: Ultrasound image img 1: option ← SelectAcquisitionMethod() 2: 3: if option = CAMERA then 4: img ← CaptureFromCamera() 5: else if option = FILE_IMPORT then 6: img ← LoadFromStorage() 7: else if option = NETWORK then 8: img ← ReceiveFromDevice() 9: end if 10: 11: img ← ConvertToByteArray(img) 12: return img	Algorithm 5: Retrieve Patient Data Algorithm 5: RetrievePatient(DB, pid) Input: Database DB, patient ID pid Output: Patient object P 1: Query PatientTable where ID = pid 2: if no record found then 3: return NULL 4: end if 5: 6: P ← ConstructPatientObject() 7: P.Images ← FetchAllImages(pid) 8: 9: return P
--	--

Figure 9. Algorithm for the specific objectives of the multiplatform application

The processes in Figure 9 are then transformed into code, using MAUI technology and the C# language so that they can be interpreted by the operating system of mobile devices, accessing their camera, sensors and external memory. The described application has been tested on Android and Windows and can also be ported to iOS devices.

```
private async void takeUltraSoundImageButton_Clicked(object sender, EventArgs e)
{
    try
    {
        if (MediaPicker.Default.IsCaptureSupported)
        {
            FileResult photo = await MediaPicker.Default.CapturePhotoAsync();
            if (photo != null)
            {
                await ProcessPhotoAsync(photo);
            }
        }
    }
    catch (Exception ex)
    {
        await DisplayAlertAsync("Error", $"Camera didn't start: {ex.Message}",
"OK");
    }
}
```

Figure 10. Method for image acquiring

The method takeUltraSoundImageButton_Clicked is a well-structured asynchronous event handler that implements the capture of an image using the device camera. It follows good practices such as exception handling and asynchronous execution, ensuring responsiveness of the user interface.

```
private async void selectUltraSoundImageButton_Clicked(object sender,
EventArgs e)
{
    try
    {
        FileResult photo = await MediaPicker.Default.PickPhotoAsync();
        if (photo != null)
        {
            await ProcessPhotoAsync(photo);
        }
    }
    catch (Exception ex)
    {
        await DisplayAlertAsync("Error", $"We could not open the gallery":
{ex.Message}", "OK");
    }
}
```

Figure 11. Method for image retrieval and analysis

The method selectUltraSoundImageButton_Clicked presented in Figure 11 is an asynchronous event handler designed to allow users to select an existing ultrasound image from the device gallery. It complements the capture functionality by supporting retrospective data integration, which is essential in medical imaging workflows.

The method incorporates validation mechanisms and exception handling to ensure reliability and usability, while maintaining a modular design by delegating image processing tasks to dedicated components. Such an implementation enhances the flexibility and practical applicability of the system in real-world clinical workflows.

```
private async void saveButton_Clicked(object sender, EventArgs e)
{
    if (string.IsNullOrEmpty(_patient.Name))
    {
        await DisplayAlertAsync("Name is compulsory", "Please write patient's
name.", "OK");
        return;
    }

    await database.SaveItemAsync(_patient);
    await Shell.Current.GoToAsync("..");
}
```

Figure 12. Method for patient data storage, including images

The method `saveButton_Clicked`, from Figure 12, is a concise and effective implementation of a data persistence operation within a .NET MAUI application. It ensures basic input validation, performs asynchronous database storage, and manages navigation flow, making it suitable for mobile medical data management scenarios.

The fourth step presumes application testing, in order to view, retrieve and analyse the information obtained through ultrasound examinations.

The tests carried out in tandem by the doctors and the software development team will identify any errors or possible use cases not covered by the application's functionalities. Determining errors and areas requiring improvement is an iterative process, which will be addressed at appropriate intervals.

6. Advancements in Medical Practitioner - Patient Communication

The state of health of both individuals and communities has consistently been regarded as a fundamental value of humanity. Within this conceptual framework, representations of alterity reflect the structured distribution of roles that institutionalise the relationship between the suffering individual and the agent entrusted with the alleviation of suffering. From a semiotic perspective, health may be construed as an object of value in the communication sense, situated within a complex narrative configuration in which physicians—designated by Klinkenberg as “health actors”—function as central subjects.

The communication model of the medical context delineates a narrative trajectory analogous to the heroic quest, wherein the physician assumes the role of the hero engaged in a struggle against the adversary, namely disease. In this endeavour, the physician is supported by auxiliary forces such as medical knowledge and altruism. Acting in accordance with the ethical principle of the good (as the implicit receiver), the physician directs his actions toward the patient, who embodies both an exemplary instance of humanity and the ultimate recipient of medical intervention.

The communication process, when images are taken into consideration, may generate entropy, indeterminacy or confusion for both actors in the communication process. Therefore, any debate on images can be improved by using metadata and descriptions in textual form.

The beneficiaries of health services should consequently be provided with a clear image of the present situation. The present information should be further placed in comparison with the patient's past states, from a historical perspective.

Practitioners are often faced with time restrictions. Having time restrictions may generate situations in which communication barriers or incomplete information, have an immediate effect on the quality of the diagnosis and treatment.

The use of mobile applications, which have user-friendly interfaces, facilitates communication for both doctors and patients. It also optimises the storage and subsequent management of information, and the understanding of complex concepts.

7. Conclusions

This research lies at the intersection of medical imaging and software engineering. The development of multiplatform mobile applications aimed at storing, processing and retrieval of ultrasound image data.

A representative situation was analysed, consisting of wrist ganglion pathology analysis, through musculoskeletal ultrasound images and mobile applications. The growing challenges associated with large volumes of ultrasound-generated data have been highlighted by this study. Insights into the need for accessible and scalable mobile applications for ultrasound image processing were also emphasized. These types of applications should support both clinical practice and research in software development.

This solution proved that mobile development frameworks, such as .NET MAUI, can enable the creation of flexible, heterogeneous data types, cross-platform applications.

The structuring of the data within a coherent application architecture facilitates not only real-time access but also a historical perspective regarding the evolution of pathologies. One particular situation is the need to monitor changes over time, which is essential for informed clinical decision-making. Using user-friendly mobile applications facilitates the communication between doctors and patients; it also optimises information storage and subsequent management, as well as the understanding of complex concepts. A further step should involve transitioning from the laboratory proof-of-concept to a real-world clinical testing environment.

Future research should consider the extension of the application's capabilities through cloud-based architecture, multimodal data analytics, and artificial intelligence driven diagnosis.

The communication process, when images are taken into consideration, may generate entropy, indeterminacy or confusion for both actors in the communication process. Therefore, any debate on images can be improved by using metadata and descriptions in textual form.

The beneficiaries of health services should consequently be provided with a clear image of the present situation. The current state should be further placed in contrast to the patient's past conditions, from an evolutionary perspective.

References

- Aprilya, D., Satria, O., Aminata, I. W., & Wahyudi, M. (2023). Intratendinous ganglion cyst of extensor indicis proprius tendon: A case report. *International Journal of Surgery Case Reports*, 106, Article 108274. <https://doi.org/10.1016/j.ijscr.2023.108274>
- Chen, Y.-T., Miller Olson, E. K., Lee, S.-H., Sainani, K., & Fredericson, M. (2021). Assessing diagnostic and severity grading accuracy of ultrasound measurements for carpal tunnel syndrome compared to electrodiagnostics. *PM&R*, 13(8), 852–861. <https://doi.org/10.1002/pmrj.12533>
- Dissaux, B., Ognard, J., Léger, B., Duigou, M., Lefèvre, C., Nonent, M., Berthou, C., & Seizeur, R. (2023). Assessment of using ultrasonography to teach abdominal and cervical anatomy in French medical curricula. *Surgical and Radiologic Anatomy*, 45(9), 1185–1189. <https://doi.org/10.1007/s00276-023-03219-3>
- Floria, F. (2014). *Retorica alterității*. Editura Universității „Alexandru Ioan Cuza” din Iași.
- Goldberg, G., Zeckser, J. M., Mummaneni, R., & Tucker, J. D. (2016). Electrosonodiagnosis in carpal tunnel syndrome: A proposed diagnostic algorithm based on an analytic literature review. *PM&R*, 8(5), 463–474. <https://doi.org/10.1016/j.pmrj.2015.11.016>
- Hodler, J., Kubik-Huch, R. A., & Roos, J. E. (Eds.). (2026). *Musculoskeletal diseases 2026–2029: Diagnostic imaging*. Springer. <https://doi.org/10.1007/978-3-032-17040-8>
- Jerome, J. T. J. (2025). Ultrasound as a diagnostic modality in hand and wrist musculoskeletal pathologies: A narrative review. *Indian Journal of Orthopaedics*, 59(1), 19–33. <https://doi.org/10.1007/s43465-024-01206-3>

- Karatay, E., Türkoğlu, Ö., & Mansız Kaplan, B. (2020). Assessment of diagnostic efficiency of real-time strain elastography by using the median nerve stiffness at females with carpal tunnel syndrome. *Cukurova Medical Journal*, 45(4), 1276–1282. <https://doi.org/10.17826/cumj.745698>
- Kowalska, B. (2014). Assessment of the utility of ultrasonography with high-frequency transducers in the diagnosis of entrapment neuropathies. *Journal of Ultrasonography*, 14(59), 371–392. <https://doi.org/10.15557/JoU.2014.0039>
- Lemhoefer, C., & Loudovici-Krug, D. (2025). Treatment of finger tendon sheath ganglion with extracorporeal shock wave therapy: A case report. *Hand Surgery and Rehabilitation*, 44(4), Article 102215. <https://doi.org/10.1016/j.hansur.2025.102215>
- Liao, K. H., Lin, Y. T., Wu, C. T., Lin, C. H., Chen, S. H., & Hsu, C. C. (2023). Preliminary prospective preoperative and postoperative evaluation of median nerve stiffness by using sonoelastography. *Annals of Plastic Surgery*, 91(2), 265–269. <https://doi.org/10.1097/SAP.00000000000003601>
- Lu, M., Wang, Y., Yue, L., Chiu, J., He, F., Wu, X., Zang, B., Lu, B., Yao, X., & Jiang, Z. (2014). Follow-up evaluation with ultrasonography of peripheral nerve injuries after an earthquake. *Neural Regeneration Research*, 9(6), 582–588. <https://doi.org/10.4103/1673-5374.130095>
- Martinho, N., Botelho, S., Nagib, A., Jales, R. M., Turel, F., Caagbay, D., & Riccetto, C. (2020). Four-dimensional translabial ultrasound concordance with digital palpation and surface electromyography during dynamic pelvic floor muscles assessment: A cross-sectional study. *Neurourology and Urodynamics*, 39(1), 403–411. <https://doi.org/10.1002/nau.24220>
- Microsoft. (2026, March 20). *Consume a REST-based web service*. Microsoft Learn. <https://learn.microsoft.com/en-us/dotnet/maui/data-cloud/rest?view=net-maui-10.0>
- Microsoft. (2025, July 31). *.NET MAUI local databases*. Microsoft Learn. <https://learn.microsoft.com/en-us/dotnet/maui/data-cloud/database-sqlite?view=net-maui-10.0>
- Mondelli, M., Filippou, G., Gallo, A., & Frediani, B. (2008). Diagnostic utility of ultrasonography versus nerve conduction studies in mild carpal tunnel syndrome. *Arthritis & Rheumatism*, 59(3), 357–366. <https://doi.org/10.1002/art.23317>
- Norbury, J. W., & Morrison, E. J. (2019). Palmaris longus tendinopathy diagnosed with ultrasound: A case report. *PM&R*, 11(4), 433–435. <https://doi.org/10.1016/j.pmrj.2018.09.037>
- Osiak, K., Elnazir, P., Walocha, J. A., & Pasternak, A. (2022). Carpal tunnel syndrome: State-of-the-art review. *Folia Morphologica*, 81(4), 851–862. <https://doi.org/10.5603/FM.a2021.0121>
- Petrover, D., Bellity, J., Vigan, M., Nizard, R., & Hakime, A. (2017). Ultrasound imaging of the thenar motor branch of the median nerve: A cadaveric study. *European Radiology*, 27(11), 4883–4888. <https://doi.org/10.1007/s00330-017-4882-0>
- Ramírez, M. T., Molina, G., Di Carlo, C., Fernández, V., Von Unger, S., Thumm, N., Anwandter, P., & Morgan, G. (2024). Intra-articular synovial ganglion of the wrist. *Journal of Hand Surgery Global Online*, 6(6), 911–914. <https://doi.org/10.1016/j.jhsg.2024.05.007>
- Savage, N. J., & McKell, J. S. (2025). Exploring divergent electrodiagnostic and sonographic findings in patients with suspected carpal tunnel syndrome: Role of median nerve cross-sectional area. *Journal of Clinical Ultrasound*, 53(6), 1221–1233. <https://doi.org/10.1002/jcu.23981>
- Tomozei, C. I., Nechita, E., & Lazăr, D. (2021). Deep learning solution for diabetic retinopathy diagnosis based on convolutional neural networks and image processing algorithms. In *2021 International Conference on e-Health and Bioengineering (EHB)* (pp. 1–4). IEEE. <https://doi.org/10.1109/EHB52898.2021.9657666>
- Varol, U., Navarro-Santana, M. J., Valera-Calero, J. A., Antón-Ramírez, S., Álvaro-Martínez, J., Díaz-Arribas, M. J., Fernández-de-las-Peñas, C., & Plaza-Manzano, G. (2023). Convergent validity between electromyographic muscle activity, ultrasound muscle thickness and

- dynamometric force measurement for assessing muscle. *Sensors*, 23(4), Article 2030. <https://doi.org/10.3390/s23042030>
- Vigny, S., Rubinstenn, E., Michelin, P., Sabatier, T., Dhellemmes, O., Duparc, F., Auquit-Aukbur, I., & Lalevee, M. (2024). Ultrasound identification of hand and wrist anatomical structures by hand surgeons new to ultrasonographic techniques. *Surgical and Radiologic Anatomy*, 46(6), 795–804. <https://doi.org/10.1007/s00276-024-03355-4>
- Winter, N., Grimm, A., Heinzel, J., Wittlinger, J., Kegele, J., Lieber, J., Urla, C., Schuhmann, M. U., & Hurth, H. (2025). Traumatic upper extremity nerve lesions in children: High-resolution nerve ultrasound can improve surgical outcome. *Journal of Brachial Plexus and Peripheral Nerve Injury*, 20(1), e87–e95. <https://doi.org/10.1055/a-2716-2279>
- Wu, H., Zhao, H.-J., Xue, W.-L., Wang, Y.-C., Zhang, W.-Y., & Wang, X.-L. (2022). Ultrasound and elastography role in pre- and post-operative evaluation of median neuropathy in patients with carpal tunnel syndrome. *Frontiers in Neurology*, 13, Article 1079737. <https://doi.org/10.3389/fneur.2022.1079737>
- Zhan, S., Zheng, B., Li, M., Xu, L., Chen, C., & Huang, P. (2022). Ultrasound analysis of respiration-related muscles in rats. *Frontiers in Genetics*, 13, Article 900168. <https://doi.org/10.3389/fgene.2022.900168>
- Żyluk, A., Walaszek, I., & Szlosser, Z. (2014). No correlation between sonographic and electrophysiological parameters in carpal tunnel syndrome. *Journal of Hand Surgery (European Volume)*, 39(2), 161–166. <https://doi.org/10.1177/1753193413489046>