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Application Designed for Detecting Foetal Deformities and Congenital Defects by Comparing Ultrasound Images Using ORB Algorithm

Safa H. Qaratem[1]*, Hadya S. Hawedi[2], Omran A. bin Taher[2]

[1]Department of Computer Science, Basic Sciences School, Libyan Academy, Zliten, Libya.
[2]Department of Information Systems, Faculty of Information Technology, Asmarya Islamic University, Zliten, Libya.

*Corresponding author email: Safa1994hasan@gmail.com

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ABSTRACT

Abstract- This research aims to design and implement an Application that significantly aids in early detection of fetal deformities and congenital defects by comparing ultrasound images taken for the case with images stored in a large database using artificial intelligence. Additionally, some pregnant women face risks of fetal deformities, necessitating early detection to reduce health impacts and expedite intervention. Moreover, the application addresses the issue of relying on traditional screenings, which are often prone to human errors. By employing artificial intelligence techniques to analyze images, using the ORB algorithm because it is fast and unaffected by noise, lighting, and rotation, the application enhances diagnostic accuracy and assists healthcare professionals in making appropriate medical decisions. The research objectives include early diagnosis, supporting healthcare professionals, and reducing medical costs for patients.

Keywords: Application, ORB algorithm, fetal deformities, congenital defects, Ultrasound.

تطبيق مصمم للكشف عن تشوهات الجنين والعيوب الخلقية من خلال مقارنة صور الموجات فوق الصوتية باستخدام خوارزمية ORB

صفاء حسن قرطم[1]، هدية هويدي[2]، عمران علي بن طاهر[2]

[1]قسم علوم الحاسوب، مدرسة العلوم الأساسية، الأكاديمية الليبية، زليتن، ليبيا.

[2]قسم نظم المعلومات، كلية تقنية المعلومات، جامعة الأسمرية الإسلامية، زليتن، ليبيا.

ملخـــــص البحـــــث

يهدف هذا البحث إلى تصميم وتنفيذ تطبيق يساهم بشكل فعّال في الاكتشاف المبكر للتشوهات الجنينية والعيوب الخَلقية، وذلك من خلال مقارنة صور الأشعة فوق الصوتية المأخوذة للحالة مع صور مخزنة في قاعدة بيانات ضخمة باستخدام تقنيات الذكاء الاصطناعي. بالإضافة إلى ذلك، تواجه بعض النساء الحوامل مخاطر الإصابة بتشوهات جنينية، مما يستلزم الاكتشاف المبكر للتقليل من الآثار الصحية وتسريع التدخل العلاجي. كما يعالج التطبيق مشكلة الاعتماد على الفحوصات التقليدية، والتي غالبًا ما تكون عرضة للأخطاء البشرية. ومن خلال توظيف تقنيات الذكاء الاصطناعي في تحليل الصور باستخدام خوارزمية **ORB** التي تمتاز بالسرعة وعدم تأثرها بالضوضاء أو الإضاءة أو الدوران، يعزز التطبيق دقة التشخيص ويدعم الكوادر الطبية في اتخاذ القرارات الطبية المناسبة مثل، ودعم المتخصصين وتقليل التكاليف الطبية على المرضى.

الكلمات الدالة: تطبيق، خوارزمية ORB، التشوهات الجنينية، العيوب الخَلقية، الأشعة فوق الصوتية.

1. INTRODUCTION

Most Congenital disorders can be defined as structural or functional anomalies that occur during intrauterine life. Also called birth defects,, as estimated by the World Health Organization [1].

Non-severe congenital cases caused approximately 260,000 deaths in 2004, accounting for around 7% of global neonatal deaths. Their significance lies in their contribution to mortality rates in regions with lower overall death rates, such as the European region, where 25% of new-born deaths are attributed to congenital non-severe cases. Currently, there are no accurate estimates of the number of children born with serious congenital disorders resulting from genetic or environmental causes. Congenital heart defects, neural tube defects, and Down syndrome are among the most common severe congenital disorders. The World Health Organization has implemented several interventions aimed at reducing deformities through prevention and treatment, including preconception, prenatal, and neonatal care [2].

Definition of the ORB Algorithm

The ORB (Oriented FAST and Rotated BRIEF) algorithm is a feature extraction algorithm that uses oriented corner points. It is designed to be fast and efficient, providing multi-scale features.

Key Features of the ORB Algorithm

High Efficiency: ORB is considered fast in feature computation compared to other algorithms like SIFT and SURF. Robustness to Illumination Changes: The ORB algorithm provides good resistance to illumination changes, making it suitable for use in varying lighting conditions. Robustness to Viewpoint Changes: ORB has a good ability to recognize features from different angles, enhancing its accuracy [1].

Therefore, the researcher aims to reduce fetal congenital defects by using the ORB algorithm to compare the diagnosis of the condition with other cases through ultrasound images. This is done to take the most appropriate action for the deformity and provide early treatment before the condition worsens.

1.1 *Problem Statement*

Embryos, the essence of life's canvas, embody the inception of creation. However, monitoring their condition from the early stages is crucial to identify early deformities and congenital defects, track them, and explore treatment methods to mitigate their progression in some cases. This diagnosis is challenging with traditional methods, which often require substantial medical expenses, as their effectiveness greatly depends on the expertise of the diagnosticians (specialized doctors).

1.2 Research Questions

This dissertation seeks to answer the following three questions:

1.Can the application offer early diagnosis of fetal deformities and congenital defects?

2.Will the application aid physicians and specialists in early diagnosis?

3.Is it feasible to streamline multiple diagnostic stages and reduce medical costs through the use of this application?

1.3 Research Objectives

The primary goal of the application is early detection of deformities and congenital defects. This study aims to develop a specialized mobile application for Android smartphones that utilizes artificial intelligence techniques to compare ultrasound images, enhancing diagnostic accuracy and facilitating informed medical decisions.

In summary, the objectives are:

1.Early diagnosis of deformities and congenital defects.

2.Assisting specialists in diagnosis for prescribing appropriate treatment.

3.Streamlining diagnostic stages and reducing medical costs.

1.4 Previous Studies

Due to the fact that deformities and defects are common congenital disorders in fetuses and children, many studies have been conducted on the causes, as well as some methods and attempts to reduce and treat them. Diagnosis is typically done through ultrasound imaging, aiming to provide quick outputs with precise results. Artificial intelligence has been utilized in most recent studies to enhance the speed and accuracy of these diagnoses, as noted and summarized by the researcher

a Toward point-of-care ultrasound estimation of fetal gestational age from the trans-cerebellar diameter using CNN-based ultrasound image analysis The lack of easy-to-use, portable ultrasound equipment in low- and middle-income countries (LMICs), as well as the steep learning curve required to master radiology screening.
The accuracy of the main image analysis algorithms was evaluated, and the results showed that they can.. be successfully applied in clinical care settings[3].

b Technology trends and applications of deep learning in ultrasonography: image quality enhancement, diagnostic support, and improving workflow efficiency The need to improve image quality, aid in diagnosis, and increase the efficiency of ultrasound workflow using deep learning techniques.
Significant improvements in diagnostic accuracy, work efficiency, and reduction in medical costs, in addition to the need to adopt standard educational models to ensure the effectiveness of the application in different environments[4].

c Research on image feature point matching based on ORB and RANSAC algorithm
The traditional ORB algorithm has problems with matching accuracy, as it contains a lot of false information, which affects the ability to resist interference. Experiments show that combining ORB with RANSAC improves matching accuracy by 22.96% and reduces time consumption by 24.38% compared to the traditional ORB algorithm [5].

d Smart login system using face detection and recognition by ORB algorithm Traditional login systems such as passwords and attendance cards can be vulnerable to unauthorized use. There is a need for a more secure and effective login system.The system is efficient and fast in facial recognition, with a face being recognized within 6-10 seconds on regular computers, and 2-3 seconds on high-performance servers. False rejections have been reduced, but errors may occur in certain cases such as changes in facial features [6].

e Artificial intelligence in prenatal ultrasound diagnosis The need to improve diagnostic efficiency and image quality in the use of prenatal ultrasound, and the challenges associated with relying on the experience of clinicians and available equipment.
Developments in the use of artificial intelligence to improve the efficiency and reliability of measurements, and successful applications in measurements such as head circumference and automated examination of fetal tissue, despite some challenges in widely applicable measurements[7].

f Intelligent interactive multimedia systems for electronic healthcare applications
Issues related to security, privacy, and trust in healthcare records, as well as the challenges of using machine learning techniques in analyzing production data from IoT devices in healthcare.Providing insights into the applications of artificial intelligence and machine learning methods in improving healthcare data and security, and existing challenges with proposed solutions [8].

g Applications of artificial intelligence-powered prenatal diagnosis for congenital heart disease Congenital heart disease (CHD) is difficult to diagnose during pregnancy, due to the inaccuracy of ultrasound examinations and the complexities associated with collecting multidimensional information.The results

demonstrate significant progress in the use of AI to improve image quality, analysis, and infer risks associated with CHD, while highlighting current limitations of this technology [9].

2. MATERIALS AND METHODS

This part should contain sufficient detail to reproduce reported data. It can be divided into subsections if several methods are described. Methods already published should be indicated by a reference [7], only relevant modifications should be described.

3. THEORY AND CALCULATION

The theory should extend, not repeat, the background to the article already dealt with in the introduction and lay the foundation for further work. In contrast, calculations represent a practical development on a theoretical basis.

3.1 Mathematical Expressions and Symbols

Mathematical expressions and symbols should be inserted using the equation tool of Microsoft Word. References may be added for used

4. GENERAL STRUCTURES

4.1 Data Collection

Utilize a ready-made database containing images of various deformities.

Store the metadata associated with each image, such as details of the deformities and congenital defects, within the database.

A dataset consisting of 1,646 images obtained from the Kaggle platform was used, from which 120 images were selected under the name 'Classification.' These images include various cases of congenital malformations and birth defects, providing sufficient diversity to enhance the model's accuracy.

4.2 User Interface Design

Design an interactive interface that allows users to easily upload images.

4.3 Image Processing and Analysis

Image Upload:Use OpenCV to upload user input images (either captured or selected).

Image Conversion: Convert images to grayscale to enhance the performance of the algorithm.

Applying the ORB Algorithm: Use Open CV to implement the ORB algorithm on the images. The algorithm will detect key points and descriptors for each image. Image Comparison: Compare the input image with the images stored in the database.

$$F1 = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}$$

Fig 1 Modified F1.

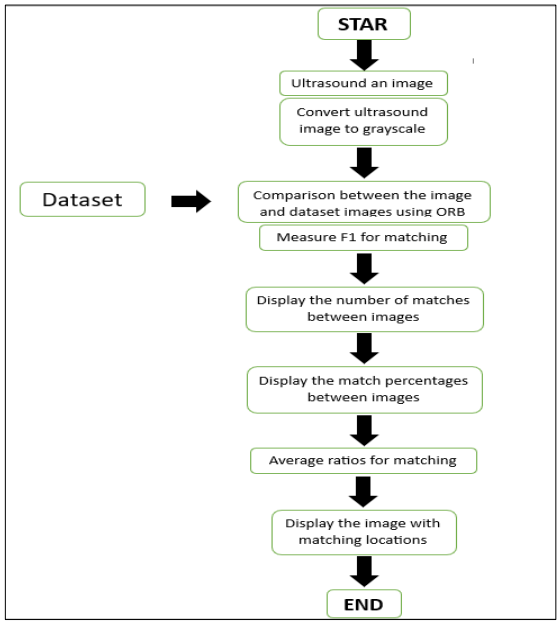

Fig 2. Operations flow chart.

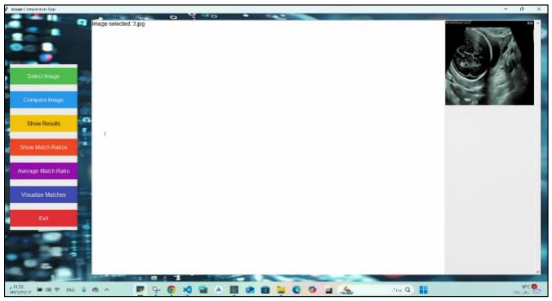

Fig 3. Ultrasound image selection and display.

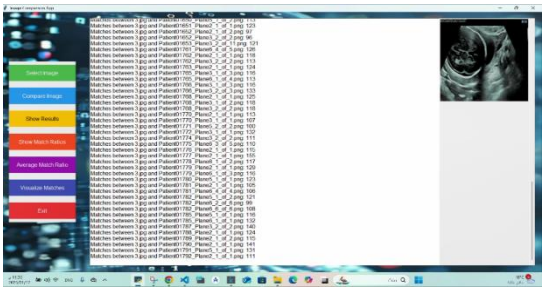

Fig 4. Displaying matches after comparison.

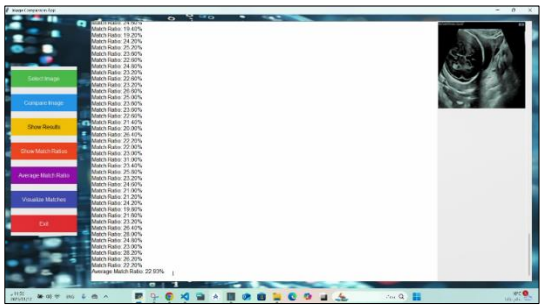

Fig 5. Showing the percentage of matches and their.

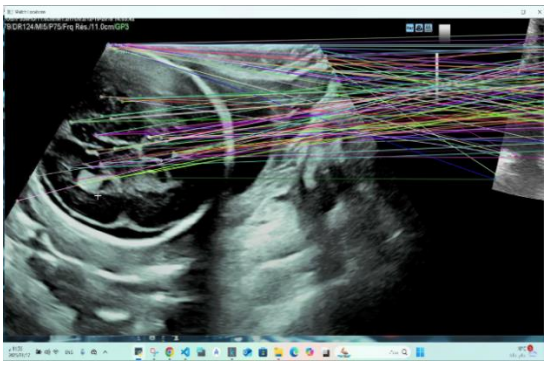

Fig 6. Displaying matches in the ultrasound.

5. RESULTS AND DISCUSSION

5.1 Early Detection of Deformities

- Matching Accuracy: The application demonstrated a high ability to identify fetal deformities with complete accuracy, achieving an F1 Score of 1.00. This means that all identified deformities were correct, with no classification errors.
- Effective Results: The findings indicate that the application is capable of recognizing defects with complete precision, facilitating quick and reliable medical decision-making.

5.2 Support for Physicians and Practitioners

- Processing Speed: The application provides rapid processing of ultrasound images, helping doctors make informed decisions based on accurate data in a short time.
- User-Friendly Interface: The interactive design of the application makes it easy for doctors to upload and analyze images, contributing to improved workflow and increased efficiency.

5.3 Reduction in Medical Costs

- Resource Savings: The application helps reduce reliance on traditional screenings, contributing to lower medical costs for patients.
- Decrease in Unnecessary Appointments: With the model's optimal performance, utilizing artificial intelligence in image analysis can reduce the need for unnecessary follow-up appointments.

6. CONCLUSIONS

This application is a drop in the sea of similar applications that utilize artificial intelligence for comparison, aiming to provide better outputs that benefit humans, whether on the scientific or practical side. We have adopted this approach to confront today's applications, most of which now employ artificial intelligence. Our goal is for the application to be robust and future-proof, with the ultimate aim of achieving superior results. The application has used precision and recall metrics to display the F1 score, which was 1.00, further enhancing the application's strength in comparison.

7. EVALATION

The verification and enhancement of the application are carried out through:

Using Open CV Testing Tools

Tests are conducted to ensure the accuracy of feature extraction and image matching using the OpenCV library.

User Interface Testing

The user interface is designed interactively to ensure ease of use, facilitating smooth image uploading and analysis for doctors.

Model Performance Optimization

Advanced image analysis techniques are employed to enhance the performance of the machine learning model, contributing to high accuracy in detecting fetal *deformities.*

8. RECOMMENDATIONS

This paper discusses ideas that have been implemented based on the data and results obtained from a valid database, which require

further research and study in the future. It also emphasizes the development of the application by integrating the existing database used in the application with different databases to enhance results and increase their reliability. It is expected to assist doctors in improving diagnostic accuracy and early detection for users.

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