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Healthcare It Solutions For Clinical Decision Support

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Abstract
This research aims to utilize relevant characteristics to develop a machine learning-based prediction algorithm and propose a diagnostic system for diabetes that leverages medical data and various machine learning algorithms to enhance the accuracy of diabetes diagnoses and predictions. The study outlines three proposed methodologies, with a common pre-processing step that involves eliminating null values, converting data types, normalizing data, conducting exploratory data analysis, among other tasks. The pre-processed data is then utilized across the three methodologies. The dataset for this research was collected from multiple hospitals in South Kashmir through a direct questionnaire administered to individuals who have recently been diagnosed with diabetes or those who do not yet have diabetes but display some or all symptoms associated with the condition. This dataset encompasses various attributes of individuals, including age, family history, and depression. The first proposed methodology focuses on improving classification accuracy and early detection of diabetes, distinguishing between diabetic and non-diabetic individuals. It presents a diabetes prediction algorithm based on machine learning techniques that address several limitations of conventional classifiers and establish a robust connection between clinical conditions and blood glucose levels.
Keywords: *Pre-processing, classification, direct questionnaire, WHO*

1. INTRODUCTION

Decision support is a vital necessity in contemporary healthcare delivery systems. Through the evaluation of a vast volume of patient information, the process allows the derivation of solutions or actionable knowledge that can be employed to enhance patient outcomes and management of healthcare processes. The process equips clinicians, patients, employees, and other stakeholders with information and person-specific knowledge at the appropriate moment to enhance patient outcomes and healthcare processes [2]. A clinical decision support system (CDSS) refers to a computer system that can aid physicians when making clinical decisions while treating patients [1]. CDSS can be described as "a connection between health observations and health-related knowledge that affects treatment decisions by clinicians, for enhanced healthcare provision". CDSS is an automatic system used to help clinicians in the formulation of clinical decisions and in managing data, for a number of reasons, such as improving quality of care, prevention of diagnostic errors, anticipation of adverse events, similarity-based outcome prediction, etc [9]. The term 'Healthcare' refers to a broad spectrum of services designed to meet the health needs of the public. The prognosis of diseases within a community plays a crucial role in enhancing healthcare systems. Collaboration among patients, physicians, suppliers, healthcare institutions, and IT companies is essential for maintaining and restoring patient health records [3]. Over the past decade, the Indian healthcare sector has emerged as one of the fastest-growing industries globally [1]. Machine learning technologies are increasingly applied in healthcare analytics to address various diseases, including cancer, diabetes, and strokes. The World Health Organization (WHO) identifies diabetes as a prevalent and challenging chronic disease worldwide [10]. Irregularities in insulin secretion lead to severe hyperglycemia, a condition associated with long-term damage to the retina, kidneys, nervous system, heart, and blood vessels [13].

2. REVIEW OF LITERATURE

CDSS have been categorized and subcategorized into a range of categories, depending on intervention time and mode of delivery. Nonetheless, CDSS can be generally categorized as knowledge based systems or non-knowledge based systems (Berner, 2010). Knowledge based systems attempt to mimic an expert clinician/human's thought process through a series of if-then-else rules. Rules can be formulated from

literature, practice, or patient-directed evidence. For instance, a clinician may have recommended drug Y when a specific drug X is prescribed, according to a set of rules that were already given [5]. Non-knowledge based systems are constructed through statistical pattern recognition, artificial intelligence based methods (machine learning, deep learning) that glean the knowledge (identifies the pattern) from electronic health records (EHR) in the training phase and make decisions automatically in the inference phase, thereby not requiring and relying on pre-defined and complex rules [4]. While EHR data becomes abundant, CDSSs have found their way more and more into the contemporary healthcare system's workflow, where system-generated suggestions could be readily received and taken into action by stakeholders in the health sector. EHRs represent a monumental achievement in facilitating patient data storage, management, and transmission in hospitals [6]. The EHR includes essential multimodal patient data like medical history, diagnosis, prescriptions, treatment plans, dates of vaccination, allergies, images, and lab test results. EHRs may be structured or unstructured in terms of the type of information [11]. A structured EHR has patient information in a predefined, standard form, usually as rows and columns (e.g., relational data or csv files), with keywords defining and analyzing data values. The organized EHR contains quantitative factors like age, gender, height, weight, and laboratory test results. Research has shown that employing retinal photography as a screening method for diabetic retinopathy can effectively reduce the risk of blindness among diabetic patients [7]. There is substantial evidence supporting the implementation of a nationwide diabetic retinopathy screening program in the United Kingdom, which led to the launch of a comprehensive national screening initiative in 2000, utilizing digital photography to screen for various diseases, a program that remains operational today. Advanced image analysis algorithms can enhance the transmission process by improving efficiency in the grading process, thereby increasing capacity as demand rises[14].

3. MATERIALS AND METHODS

The incidence of diabetes is rising globally. Type 2 diabetes primarily results from poor dietary choices and a lack of physical activity. Individuals with diabetes who fail to manage their blood sugar levels are at a higher risk for additional health complications.

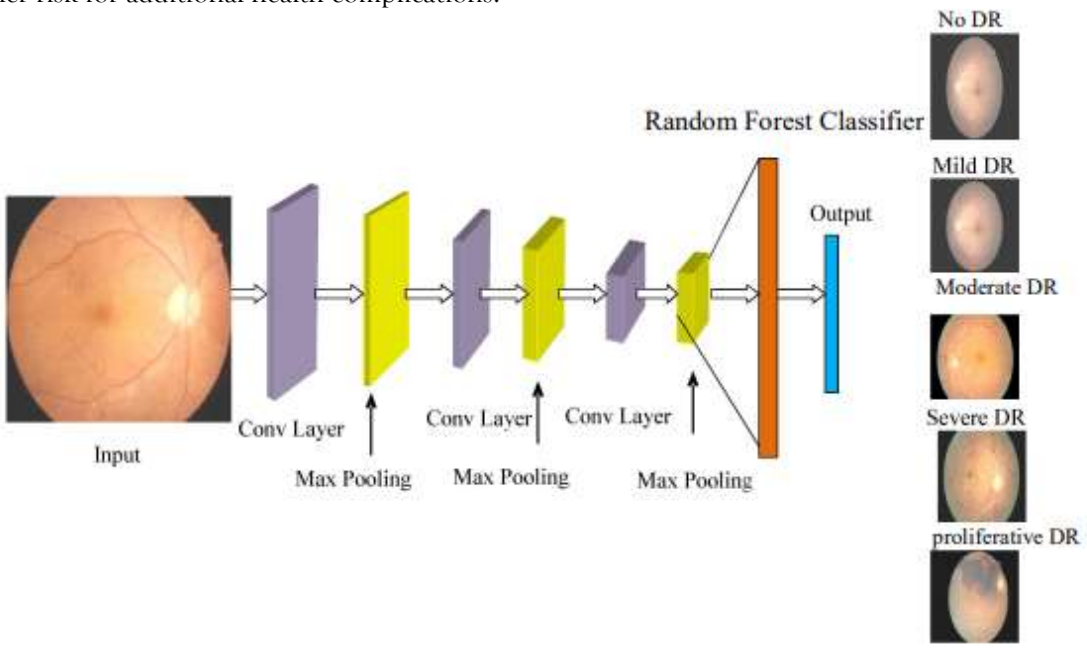

Figure 1: Proposed framework

The primary objective of this study is to discover a novel approach for blood vessel identification and segmentation in retinal images of diabetic patients [12]. Detection of blood vessels in retinal images is the cornerstone in the planning and development of DR screening systems based on automation [8]. Accurate classification of the blood vessels into vessels and non-vessels is the key objective and forms the important initial step in the retinal image processing for analysis of the characterisation of retinal images in DR screening [15].

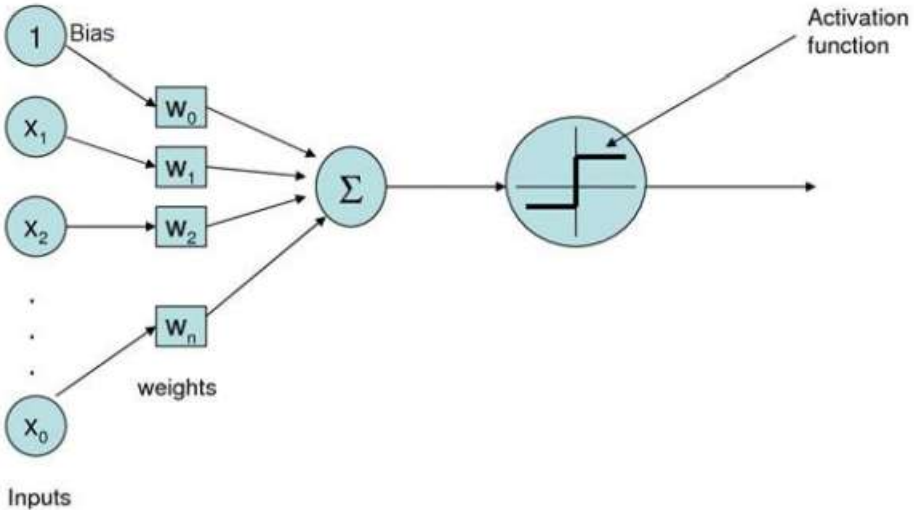

Figure 2: general structure of proposed architecture

The retinal vessels are vulnerable to the abnormal glucose metabolism, and over a period, the metabolic dysfunction, known as diabetes alters the structure and eventually changes the general functioning of retinal vessels. The changes occurring in the blood vessels induce a series of lesions to the retina itself and together form diabetic retinopathy. DR in its initial stages is defined by retinal abnormalities such as exudates, which are far more apparent in retinal photographs of diabetic patients. Such exudates are one of the common signs in the most primitive stages of the disease. Thus, their identification becomes increasingly important for the diagnosis of DR. The ultimate objective of this research is to build an automated system to identify and count the presence of exudates in retinal images, which serve as a clinical aid for DR diagnosis and help the ophthalmologists in DR screening programs.

4. RESULT AND DISCUSSION

The abnormal increase in blood glucose level is the principal cause of DR, which damages the endothelium of the vessels as well as the permeability of the retinal vessels. The earliest sign of DR is the appearance of very small dilatations of capillaries known as microaneurysms. The progression of DR results in the appearance of neovascularization, hemorrhages, macular edema and at an advanced stage results in retinal detachment. Early detection of DR can avoid serious vision loss through the application of laser photocoagulation.

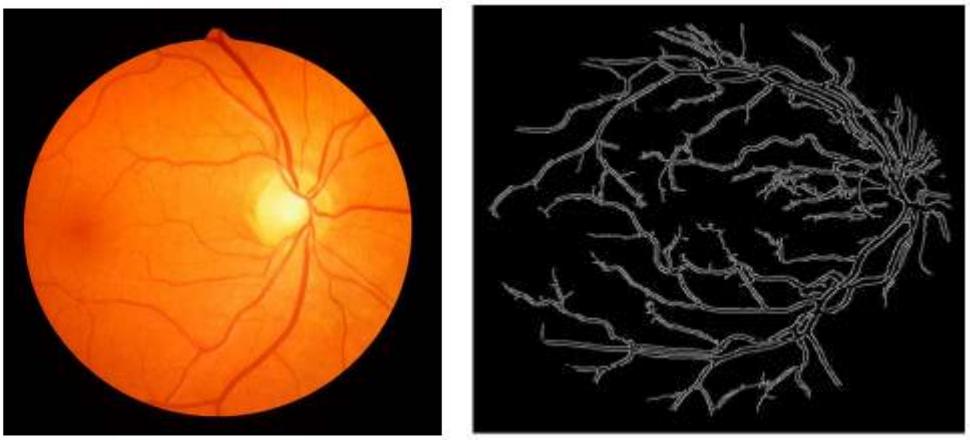

Figure 3: Input Image and Edge Detected Image

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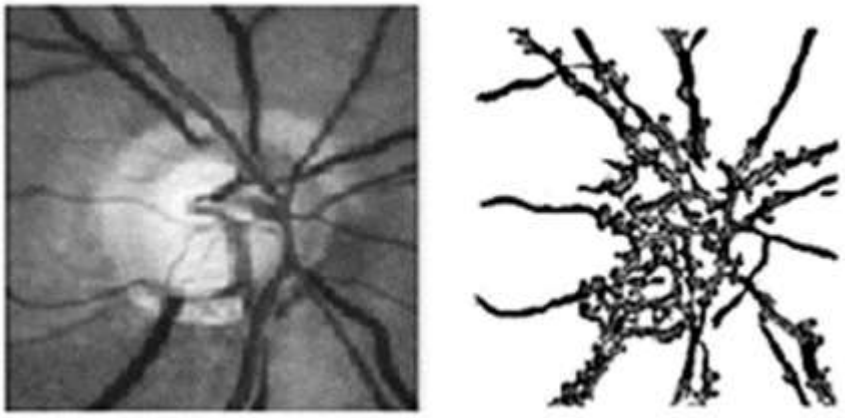

Figure 4: Segmented image

However, DR patients will not feel any symptoms until visual impairment occurs, when the treatment is less effective. Therefore, diabetic patients need to have regular eye-fundus check-up to confirm the existence of DR (Fong et al 2003). The acuity of vascular anomalies is the most critical presentation of DR, and the advent of computerized screening systems makes the automatic detection of DR possible.

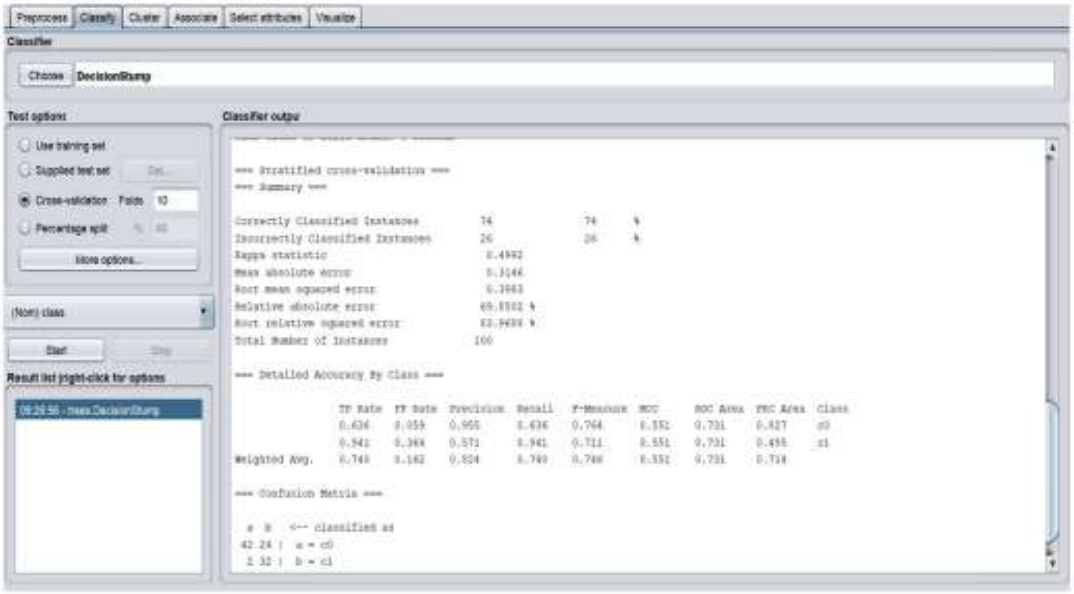

Figure 4: Classifier output

Computerized diagnosis of DR from digital fundus images is now a hot research area in the field of medical image processing. Early diagnosis and detection of DR by routine screening is crucial in preventing visual loss and blindness. Retinal imaging is playing an important role in the screening of DR since retinal disorders have become prevalent and their effects are serious. A few visual retinal pathologies manifest in the retinal fundus, such as white spots, i.e., exudates, which are most common in background retinopathy. Therefore, the identification of exudates becomes utmost important for the DR mass screening.

5. CONCLUSION

The initial phase of DR is defined by its unique characteristics such as leakiness and irregularities of blood vessels but can evolve to its severe manifestation that causes blindness. Exudates are yellow-white lesions with rather clear-cut borders and are lipid deposits seen at the posterior pole of the fundus. DR is painless and thus loss of vision may be a late sign, when treatment becomes ineffective. If it is diagnosed in an early and still asymptomatic phase, one of the successful treatments which avert visual loss due to macular edema is laser photocoagulation. For early diagnosis of DR and to ensure that timely treatment is taken,

regular screenings should be conducted by diabetic patients, where retinal image analysis plays an important role.

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