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AUTOMATIC DETECTION AND RECOGNITION FRAMEWORK FOR THE VISUALLY IMPAIRED

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Abstract Inherited retinal diseases cause severe visual deficits in children. They are classified in outer and inner retina diseases, and often cause blindness in childhood. The diagnosis for this type of illness is challenging, given the wide range of clinical and genetic causes (with over 200 causative genes). It is routinely based on a complex pattern of clinical tests, including invasive ones, not always appropriate for infants or young children. A different approach is thus needed, that exploits Chromatic Pupillometry, a technique increasingly used to assess outer and inner retina functions. This paper presents a novel Clinical Decision Support System (CDSS), based on Machine Learning using Chromatic Pupillometry in order to support diagnosis of Inherited retinal diseases in pediatric subjects. An approach that combines hardware and software is proposed: a dedicated medical equipment (pupillometer) is used with a purposely designed custom machine learning decision support system. Two distinct Support Vector Machines (SVMs), one for each eye, classify the features extracted from the pupillometric data. The designed CDSS has been used for diagnosis of Retinitis Pigmentosa in pediatric subjects. The results, obtained by combining the two SVMs in an ensemble model, show satisfactory performance of the system, that achieved 0.846 accuracy, 0.937 sensitivity and 0.786 specificity. This is the first study that applies machine learning to pupillometric data in order to diagnose a genetic disease in pediatric age.

INDEX TERMS Artificial intelligence, clinical decision support systems, machine learning, pupillometry, python, rare diseases, retinitis pigmentosa, retinopathy, support vector machine

1. INTRODUCTION

Inherited Retinal Diseases (IRDs) represent a significant cause of severe visual deficits in children [1]. They frequently are cause of blindness in childhood in Established Market Economies (1/3000 individuals). IRDs can be divided into diseases of the outer retina, namely photoreceptor degenerations (e.g., Leber Congenital Amaurosis, Retinitis Pigmentosa, Stargardt disease, Cone Dystrophy, Acromatopsia, Choroideremia, etc.), and diseases of the inner retina, mainly retinal ganglion cell degeneration (e.g. congenital glaucoma, dominant optic atrophy, Leber hereditary optic neuropathy). Both conditions are characterized by extremely high genetic heterogeneity with over 200 causative genes identified to The associate editor coordinating the review of this manuscript and approving it for publication was Asad Waqar Malik . date, which represent a remarkable obstacle to a rapid and effective diagnosis (https://sph.uth.edu/retnet/disease.htm), also considering that the same gene could

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cause different and heterogeneous clinical phenotypes.

2. LITERATURE OVERVIEW

A study of the state of the art was developed at the beginning of the activity. The search for previous articles in the literature was done on Scopus, IEEE Xplore and PubMED, using the following keywords: ‘‘clinical decision support system’’, ‘‘eye diseases’’, ‘‘rare eye diseases’’, ‘‘CDSS’’, ‘‘DSS’’, ‘‘pupillometry’’, ‘‘retinitis pigmentosa’’ and ‘‘machine learning’’. No articles including all the above keywords were found. None of the found articles use both pupillometry and ML techniques. Most of the found articles refer to ‘‘clinicaldecision support system’’, ‘‘machine learning’’ and ‘‘eye diseases’’. The number of studies decreases when it deals with systems for ‘‘rare diseases’’, ‘‘retinitis pigmentosa’’ and ‘‘pupillometry’’. Among all the found articles, the seven resumed below were chosen based on regency and variety, so as to have different views of general approaches when ML interfaces with eye diseases. Brancati et al. [22] apply ML supervised techniques for detecting pigment signs on fundus images acquired with a digital retinal camera to study patients affected by RP. Gao et al. [23] apply the ML random forest algorithm on optical coherence tomography (OCT) images to support the diagnosis of choroideremia by detecting intact choriocapillaris. Four more articles apply similar supervised ML algorithms to common eye diseases such as age-related macular degenerations [24], [25] diabetic retinopathy [26] and glaucoma [27]. Gargeya et al. [28] bring a different approach to support the diagnosis of diabetic retinopathy using deep learning.

3. REQUIREMENT ANALYSIS

The project involved analyzing the design of few applications so as to make the application more users friendly. To do so, it was really important to keep the navigations from one screen to the other well ordered and at the same time reducing the amount of typing the user needs to do. In order to make the application more accessible, the browser version had to be chosen so that it is compatible with most of the Browsers.

REQUIREMENT SPECIFICATION

Functional Requirements

- Graphical User interface with the User.

Software Requirements

For developing the application the following are the Software Requirements:

1. Python
2. Django
3. MySql
4. MySqlclient
5. WampServer 2.4

Operating Systems supported

1. Windows 7
2. Windows XP
3. Windows 8

Technologies and Languages used to Develop

1. Python

Debugger and Emulator

- Any Browser (Particularly Chrome)

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Hardware Requirements

For developing the application the following are the Hardware Requirements:

- Processor: Pentium IV or higher
- RAM: 256 MB
- Space on Hard Disk: minimum 512MB

4. FEASIBILITY STUDY

The feasibility of the project is analyzed in this phase and business proposal is put forth with a very general plan for the project and some cost estimates. During system analysis the feasibility study of the proposed system is to be carried out. This is to ensure that the proposed system is not a burden to the company. For feasibility analysis, some understanding of the major requirements for the system is essential.

Three key considerations involved in the feasibility analysis are

- ECONOMICAL FEASIBILITY
- TECHNICAL FEASIBILITY
- SOCIAL FEASIBILITY

5. ECONOMICAL FEASIBILITY

This study is carried out to check the economic impact that the system will have on the organization. The amount of fund that the company can pour into the research and development of the system is limited. The expenditures must be justified. Thus the developed system as well within the budget and this was achieved because most of the technologies used are freely available. Only the customized products had to be purchased.

5.1 TECHNICAL FEASIBILITY:

This study is carried out to check the technical feasibility, that is, the technical requirements of the system. Any system developed must not have a high demand on the available technical resources. This will lead to high demands on the available technical resources. This will lead to high demands being placed on the client. The developed system must have a modest requirement, as only minimal or null changes are required for implementing this system.

5.2SOCIAL FEASIBILITY:

The aspect of study is to check the level of acceptance of the system by the user. This includes the process of training the user to use the system efficiently. The user must not feel threatened by the system, instead must accept it as a necessity. The level of acceptance by the users solely depends on the methods that are employed to educate the user about the system and to make him familiar with it. His level of confidence must be raised so that he is also able to make some constructive criticism, which is welcomed, as he is the final user of the system.

In this project as extension I am adding Extreme Machine Learning Algorithm which is an advance neural network based algorithm and the advantage of this algorithm is filtration of dataset to remove irrelevant columns/attributes and used only important attributes to build machine learning model and due to this filtration an efficient and accurate model will be generated and which can increase prediction accuracy. To run project follow projects screen shots and to run extension concept just you need to run all button and

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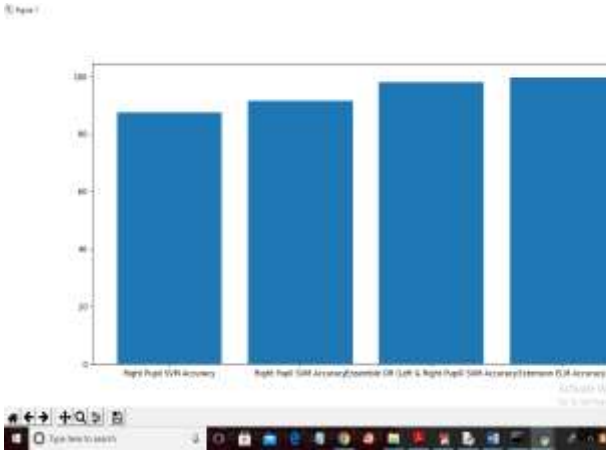
then click on 'Run Extension Extreme Learning Machine Algorithm' button to apply ELM algorithm on dataset and to get below prediction accuracy.

Double click on 'run.bat' file to get below screen and then run all button and when u click on 'Run Extension Extreme Learning Machine Algorithm' button then you will get below extension results

In above screen on same dataset we got 99.57% accuracy and other algorithms got accuracy less than extension accuracy and now click on 'Ac



Graph with Metrics' button to get below screen

In above graph x-axis represents algorithm name and y-axis represents accuracy of those algorithms and from above graph we can conclude that Extension ELM accuracy is more than other algorithms

6 INPUT AND OUTPUT DESIGN

INPUT DESIGN

The input design is the link between the information system and the user. It comprises the developing specification and procedures for data preparation and those steps are necessary to put transaction data in to a usable form for processing can be achieved by inspecting the computer to read data from a written or printed document or it can occur by having people keying the data directly into the system. The design of input focuses on controlling the amount of input required, controlling the errors, avoiding delay, avoiding extra steps and keeping the process simple. The input is designed in such a way so that it provides security and ease of use with retaining the privacy. Input Design considered the following things:

- What data should be given as input?
- How the data should be arranged or coded?
- The dialog to guide the operating personnel in providing input.
- Methods for preparing input validations and steps to follow when error occur.

OBJECTIVES

1.Input Design is the process of converting a user-oriented description of

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the input into a computer-based system. This design is important to avoid errors in the data input process and show the correct direction to the management for getting correct information from the computerized system.

2. It is achieved by creating user-friendly screens for the data entry to handle large volume of data. The goal of designing input is to make data entry easier and to be free from errors. The data entry screen is designed in such a way that all the data manipulates can be performed. It also provides record viewing facilities.

3.When the data is entered it will check for its validity. Data can be entered with the help of screens. Appropriate messages are provided as when needed so that the user will not be in maize of instant. Thus the objective of input design is to create an input layout that is easy to follow

OUTPUT DESIGN

A quality output is one, which meets the requirements of the end user and presents the information clearly. In any system results of processing are communicated to the users and to other system through outputs. In output design it is determined how the information is to be displaced for immediate need and also the hard copy output. It is the most important and direct source information to the user. Efficient and intelligent output design improves the system's relationship to help user decision-making.

1. Designing computer output should proceed in an organized, well thought out manner; the right output must be developed while ensuring that each output element is designed so that people will find the system can use easily and effectively. When analysis design computer output, they should Identify the specific output that is needed to meet the requirements.

2.Select methods for presenting information.

3.Create document, report, or other formats that contain information produced by the system.

The output form of an information system should accomplish one or more of the following objectives.

- Convey information about past activities, current status or projections of the
- Future.
- Signal important events, opportunities, problems, or warnings.
- Trigger an action.

7. CONCLUSION

This paper describes a new approach for supporting clinical decision for diagnosis of retinitis pigmentosa starting from analysis of pupil response to chromatic light stimuli in pediatric patients. The system was developed to clean artefacts, extract features and help the diagnosis of RP using a ML approach based on an ensemble model of two fine-tuned SVMs. Performances were evaluated with a leave-one-out cross-validation, also used to identify the best combination of internal parameters of the SVM, separately for both the left and right eyes. The class assigned to each eye were combined in the end with an OR-like approach so as to maximize the overall sensitivity of the

CDSS; the ensemble system achieved 84.6% accuracy, 93.7% sensitivity and 78.6% specificity. The small amount of data available for this work, calls for further tests with a larger data pool for validating the performance of the system. Future scope includes testing the same approach with different devices. A problem that came out with great evidence, at the signal acquisition stage, is the frequent presence of movement artifacts. This is due to the particular shape of the device, together with the young age of the enrolled patients. Devices with different frame, including also systems based on smartphones, are going to be investigated. Moreover, considering the duration of the whole acquisition protocol, the procedure would benefit of some systems to capture the attention of the young patient

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