SYMPTOMS BASED INTELLIGENT SYSTEM FOR LIVER DISORDER PREDICTION- A CASE STUDY OF PAKISTAN



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# Approval for Examination

Scholar’s Name: **BURHAN UL HAQQ ZAHIR** Registration No.**65454** Program of **MS (CS)** Thesis Title: **Symptoms Based Intelligent System for Liver Disorder Prediction- A Case Study of Pakistan**. It is to certify that the above scholar's thesis has been completed to my satisfaction and, to my belief, its standard is appropriate for submission for examination. I have also conducted plagiarism test of this thesis using HEC prescribed software and found similarity index 11% that is within the permissible limit set by the HEC for the MS degree thesis. I have also found the thesis in a format recognized by the BU for the MS thesis.

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**Author’s Declaration**

I, **Burhan Ul Haqq Zahir** hereby state that my MS (CS) thesis titled “**Symptoms Based Intelligent System for Liver Disorder Prediction- A Case Study of Pakistan**” is my own work and has not been submitted previously by me for taking any degree from this university (BAHRIA UNIVERSITY ISLAMABAD (LAHORE CAMPUS)) or anywhere else in the country/world. At any time if my statement is found to be incorrect even after my graduation, the University has the right to withdraw/cancel my PhD degree.

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# Plagiarism Undertaking

I, solemnly declare that research work presented in the thesis titled “**Symptoms Based Intelligent System for Liver Disorder Prediction- A Case Study of Pakistan”** is solely my research work with no significant contribution from any other person. Small contribution / help wherever taken has been duly acknowledged and that complete thesis has been written by me.

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Name of the Scholar: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

To my beloved father and teachers who helped me to be able to do MS and my wife who encouraged and support me to continue my study.

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# ABSTRACT

Liver disorder is a very serious disease and leads to different kinds of other diseases i.e. Hepatitis A, B, C, Fatty Liver Disease etc. It becomes life threating if not cured because it can cause liver cancer. Studies have shown that it can be cured if diagnosed at early stage but the problem is that, symptoms does not appear at early stage even patient don’t feel any kind of abnormality in its body. On the other hand, if this disease reaches at its peak it becomes very difficult to cure because sometimes it causes the different type of other disease like liver cancer. Currently most of the research is being done on the image based diagnosing processes which use the images-based dataset. Image-based dataset for liver disorder prediction is collected from X-ray and ultrasound etc. Patient have to wait and pay for those tests. That is way this is time taking as well as costly process. This research will use symptoms-based dataset of patients. This research will help less experienced doctors to predict the liver disorder by offering the AI/ML-based model to predict the liver disorder.

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# CHAPTER 1

# INTRODUCTION

## 1.1 Background to the Research

Liver is one of the main organ of human body. It is responsible to maintain different kind of acids and to remove the poisons from our body. A healthy liver guarantees normal living of a human as disordered liver can lead to liver cancer; a survey [1] shows that liver cancer is the second most dangerous cancer disease that causes deaths in the world. It is very important that liver disorder should be diagnosed at early stage.

Information Technology in the field of medicine proving its effectiveness. Even development of RAMS (Robot Assistant Microsurgery System) has been tested and results are satisfied for the role of assistant microsurgeries with more accuracy and efficient way which is developed by University of Nankai [2]. When we talk about Intelligent System it means we want to design a system that can predict or diagnose the disease with minimum error [3].

Currently different machine learning algorithms are being used for disease diagnostic e.g. Decision Tree, Naive Bayes, Support Vector Machine (SVM), Random Forest, Artificial Neural Network (ANN) etc. [4]. Machine Learning (ML) is subdomain of Artificial Intelligence. In AI we train computer in a special way that computer can take decisions itself without human intervention. Machine Learning has proved its importance in the field of disease prediction that gives reliable prediction and performance.

No doubt every organ of human body has its own importance but liver due to ins functionally is one of the most important organs. Liver is the largest organ of our body. It weights nearly 1.5 Kg in an adult [5]. Moreover, liver is responsible to maintain balance and manage different types of acids that are necessary for the functioning the body. Liver helps human body to store energy as well as digest food and removes the poisons form human body [6]. Patient suffering with liver dysfunction may also face the problem in these functions that are very critical i.e. anabolism, security from gut-derived toxins and detoxify cation.

Liver disorder should be considered very serious as liver plays main role to the normal life of human. In traditional way of diagnosing the abnormality of liver tissue radiologists decide it on behalf of their experience and knowledge. Sometimes this method leads to wrong interpretation as some studies shown that the accuracy rate is about 72% [7].

There are different reasons that causes liver diseases like viruses, poisons, drugs or over usage of alcohol or it can be an inherited disease. Due to the mentioned reasons, there may be various types of disorders of liver i.e. Hepatitis A, B, C, Autoimmune Hepatitis Nonalcoholic Fatty Liver Disease, Cirrhosis, Hemochromatosis, Biliary Atresia and Liver Biopsy etc. [8]. infect Liver cancer is also becoming the alarming health problem for the world. At early stages symptoms of liver disease are abdominal pain, nausea, fatigue, loss in appetite etc. but these symptoms are not only the reason of liver disorder but jaundice, coma, sleepiness and swelling of the abdomen or in legs can also leads to the liver disorder [9][6].

Many major problems of health i.e. mortality is related to liver disease which is spreading in developing countries like Pakistan. Heterogeneous Liver and FLD (Fatty Liver Disease) are considered very serious as they lead to much more disorders of liver like cirrhosis and cancer. If these issues are diagnosed in the start, they can be recovered easily but the real problem is that it is not easy to detect in early stage [10]. As patient don’t feel any change in its body. There are some symptoms of this disease like pain in abdominal or yellowing the skin etc. When these symptoms appear, it becomes too late and liver can damage any other part of the body. As discussed, that liver disorder can cause liver cancer, according to the World Health Organization liver cancer is the second leading reason of death in the world [1].

Currently, most of the research in the field of liver disease is done on image-based diagnoses i.e. ultrasound images through machine learning classifier such as a Support Vector Machine, Random Forest or hierarchical classification by using statistical features because ultrasound is cost effective and easily available [10]. Recent researches witnessed that to diagnose/predict the liver disorder different approaches are available i.e. visualizing through Image processing and symptoms-based classification etc.

## 1.2 Significance of the Research

Liver disease is a silent killer disease as its symptoms do not show in early stages even patient of liver disorder does not feel that he is suffering with this problem. Live disease wakes up instantly when it becomes very critical and at this stage it becomes very difficult to cure. Liver disorder can cause liver cancer, according to the World Health Organization liver cancer is the second leading cancer that causes deaths in the world [1]. In the US 2nd digestive disease that results patient’s death and 5th in the UK [11]. In this research a better model will be identified that can help the doctors to predict the liver disorder by using supervised machine learning techniques.

# CHAPTER 2

# LITERATURE REVIEW

In [11], a web-based framework is presented to diagnose liver disorder using combined machine learning models. It presents a faster solution that can help to predict the liver disorder in the patients. Dataset of 583 patients was used from which 416 were the liver patients and rest of 167 having no liver disease. This dataset was collected from Andrha Pardesh India having division of 441 male and 142 female patients. Attributes of the dataset are Age, Gender, TB (Total Bilirubin), DB (Direct Bilirubin), Alkphos (Alkaline Phosphatase), Sgpt (Alamine Aminotransferase), Sgot (Aspartate Aminotransferase), TP (Total Proteins), ALB (Albumin), A/G Ratio (Albumin and Globulin Ratio) and Selector field. Selector is Labelled by experts, used to divide the data (Is patient of not). Weighted K-Nearest Neighbor, Decision Trees and Artificial Neural Networks algorithms were used and it was observed that combine result of these three algorithms was better than individual. Average accuracy of all was 93% where’s KNN and DT results are 84% and 88% percent respectively.

In [12] to find out the behavior of medical symptoms a huge research has been conducted. The potential weights of the factors of the disease are the basic interest of the researcher. For the diagnosis of the illness symptoms the CBR-PSO (cost-based rough particle swarm optimization) approach of the clustering was used. To find out the best weights of each variable GA (genetic algorithm) is applied. The accuracy in the liver disorder was 78.18% by applying the CBRPSO approach. To help the doctors in the process of diagnosis this model can be used for further classification technique. Using PSO (particle swarm optimization) or K-means alone cannot generate the results as the results were generated by using the CBRPSO algorithm.

The [13] researchers finds teenage females and aged males are more prone towards the liver cancer. To differentiate the non-liver persons from the liver patients Albumin and Globulin ratio can be very effective. Regardless of gender Bilirubin plays very important role. The age factor can also be very helpful as the aged persons more likely to drink and smoke which causes liver cancer. The key factors can be determined as Alkphos and age which are directly connected with the alcoholism with the age. Based on logistic regression we also find out that eliminating variable from the model does not affect the results. With the help of predictive analysis which are used for imputing the missing data for the missing values in the dataset we can generate better results. MICE technique is used for predicting the data rather than omitting the data due to this MICE technique the better results are generated.

In [14] paper it is described that lipids in hepatocytes with abnormal retention causes many Liver disorders i.e. obesity, type ii diabetes and alcohol can be the reason of many other disease like NAFLD (Non-Alcoholic Fatty Liver Disease) hepatotoxicity in many forms of medical conditions. This is the reason that it is very important to get proper quantification of steatosis which will help to diagnose to actual disease. To achieve the best result, it is only possible by visual inspections of liver tissue sections by a competent doctor which is a time taking process as well as dependent on observer’s competency and variability. To overcome this problem and to reduce the risk factor an alternative solution is available that is called digital pathology. In digital pathology we use images of tissue sections in high-resolution, those images used as input in machine-based image processing. For this many methods were proposed for liver steatosis to give advantage to doctor/human as reviewing process but they did not perform as expected especially when steatosis is overlapped. It means that it is still a challenge to build a program that support analysis of steatosis. Now deep learning is considered as good alternative for biomedical image analyst. So, team adopt the Mask-RCNN based method using deep learning and even after some customization it is able to segment overlapped steatosis droplets. As sufficient labelled data of steatosis droplets was not available, team modified their method to create training data under the supervision of domain expert. The presentation of model showed that it is possible to increase the power of diagnosing the liver disorder and assessment of transplantation.

Research [15] shows that every year maximum deaths caused by cancer which is approximately 700,000 and almost 600,000 among them are caused by liver cancer which is 85.71% of total deaths. It is not an easy task to work with healthcare data mining even if it is structured or unstructured data format. This paper shows that the work was done by using MATLAP-2016 to develop models with SVM, Decision tree and Logistic Regression. For this research patients were asked to get his Liver Function Test (LFT) and a dataset of 574 patients was collected during the analysis best accuracy was found by Logistic Regression which gave 95.8% of accuracy.

In [16] researchers presented many types of liver diseases. It is important to identify the exact disorder of liver for the proper treatment. For this a dataset consisting of 441 rows from which 142 were female patients was collected having eleven attributes Age, Gender, DB, Alkphos, TB, Sgpt, TP, ALB, A/G Ratio, Sgot, Selector field/labels. Different machine learning algorithms were tested including Naive-Bayes, K-Nearest Neighbors (KNN), K-means, Random forest and C5.0 on this dataset for classification. It was observed that Random Forest, K-Means and KNN were the best algorithms in accuracy, precision and recall respectively.

Paper [17] shows liver disease effect liver tissues. This results alcoholic liver disorder and non-alcoholic liver disease. Currently ultrasound examination is widely being use to diagnose this problem. But it is a challenge to collect sufficient ultrasound images to train machine learning algorithm. Data set of 722 ultrasound-images was collected from a hospital that is affiliated with Harbin Medical University. Data set was used to train GoogLeNet and lightGBM classification network and ultrasound images also used to extract 380-dimensional texture features. These extracted features were based on MGLCM and WMCM. It was noticed that after improvement of classification accuracy by 5.4% it reaches total of 82.6%.

In [18] it is stated that liver disorder does not afford the negligence in diagnose and treatment. In case carelessness of the patient, it becomes very difficult to cure the disease. To improve the performance of diagnosing the liver disorder (ILPD) data set was used to train classification models i.e. Logistic Regression, K- Nearest neighbour and Support Vector Machines. Dataset consists of ten attributes i.e. DB, TB, ALB, SGOT, SGPT and TP etc. K-Nearest Neighbour and Logistic Regression were the best algorithms with this dataset.

Table 4.3: Study of State of Art Approach

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sr.** | **Ref** | **Dataset** | **Techniques** | **Results** |
| 1 | 2020 [11]  (Base Paper) | Indian Liver Patient Dataset (ILPD). The dataset consists of a total of 583 patient records | Weighted K-Nearest Neighbor, Decision Trees, Artificial Neural Networks | Accuracy: 93% |
| 2 | 2019 [12] | Screening medical database from UCI data set | CBRPSO | Average accuracy rate around 78.18% |
| 3 | 2010 [13] | Indian Liver Patient Dataset (ILPD). The dataset consists of a total of 583 patient records | Logistic Regression,  Mice technique | MICE technique generated the better results |
| 4 | 2019 [14] | data set contains 451 liver images | Mask-RCNN with modified Resnet41, Resnet50, and Resnet65 | AP: 75.87% Recall: 60.66%  F1-Score: 65.88%  Jaccard: 76.97% |
| 5 | 2018 [15] | Liver Function Test (LFT) dataset of 574 patients | SVM, Decision tree and Logistic Regression | Logistic Regression Accuracy: 95.8% |
| 6 | 2018 [16] | Attribute data of 441 patients containing 11 attributes | Naive-Bayes, K-Nearest Neighbors (KNN), K-means, Random forest and C5.0 | RFt, K-Means and KNN were the best algorithms in accuracy, precision and recall respectively |
| 7 | 2019 [17] | 722 ultrasound-images | GoogLeNet and lightGBM | Accuracy: 82.6%. increased by 5.4% |
| 8 | 2018 [18] | Indian Liver Patient Dataset (ILPD) | Logistic Regression, K- Nearest Neighbor and Support Vector Machines | K-Nearest Neighbor and Logistic Regression gave highest accuracy than others |

# CHAPTER 3

# RESEARCH GAP

Currently, symptoms-based lived disorder prediction in research is not enough carried out. Instead, work is done on image base analysis using different ML algorithms. Symptoms-based liver disorder is helpful for both patient and doctor. This way of prediction does not require costly pre-tests etc. This research can contribute in diagnosing liver disorder using symptoms-based patient profile instead of ultrasound or X-Rays.

## Problem Statement

Most of the research were carried in the field of Medical history to predict Liver Disorder by using Image based dataset i.e. X-Rays, ultrasound etc. [14]. It is a time taking, costly, as well as it is predicted at the stage where liver has been damaged. Not enough literature is witnessed to predict Liver Disorder by using symptoms-based dataset. So, there is a need to carry research to detect Liver Disorder by using symptoms-based dataset by collecting dataset form local hospitals.

## Research Questions

The following research question will be addressed in this research work.

1. How to predict Liver Disorder by using symptoms-based dataset with better accuracy?

# CHAPTER 4

# AIMS AND OBJECTIVES

Based on literature review of Liver Disorder using symptoms-based dataset, very little work is done for detection and classification. So, to address this issue this research aims to design and develop model to achieve better accuracy on local dataset.

The aim of this research is to facilitate medical professionals to detect Liver Disorder with high expertise of consultants.

1. Collection of datasets from local hospital(s).
2. To predict Liver Disorder by using symptoms-based dataset with better accuracy.

# CHAPTER 5

# RESEARCH METHODOLOGY

There are different ways to carry research. There exist different techniques and methods to find out the answers to the research related questions. To find out more facts and figures and identify variables related to the research, for this research both qualitative and quantitative will use and then analyze the research problem. Its purpose is to find a solution to the research problems. Classification based Machine Learning algorithms are used to diagnose/predict the disease. The following methodology is used to predict Liver Disorder by using advance machine learning and deep learning. The methodology following to complete the research consist of 5 phases.

Phase 1

Phase 2

Figure 5.1 Methodology

Phase 3

Phase 4

Phase 5

5.1 Phase 1

In this phase thorough literature review will be conducted using this literature research will be further improved and statement of work will be documented.

## 5.2 Phase 2

In the 2nd phase data of liver disorder patients will be collected from different hospital.

## 5.3 Phase 3

To transfer raw data into workable format some of the preprocessing techniques will be used like Data Cleaning/Cleansing, Data Integration, Data Transformation etc.

## 5.4 Phase 4

Using different designing techniques, we will design the model with best accuracy either through parameters tuning or through modifying techniques.

## 5.5 Phase 5

In the final phase discuss the results and compare the results with previous proposed models with our proposed model.

**GANTT CHART**

**Activity Plan**

|  |  |  |
| --- | --- | --- |
| **Activity** | **Objective** | **Schedule** |
|  | Topic Selection | 1 week |
|  | Literature review | 5 weeks |
|  | Find Research Gap and problem identification | 3 weeks |
|  | Research Proposal | 4 weeks |
|  | Data Collection | 6 weeks |
|  | Data Preprocessing | 5 weeks |
|  | Analysis and Predicting | 6 weeks |
|  | Testing and validation | 6 weeks |
|  | Final documentation | 12 weeks |

## 

**Fall 2020**

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| Activities | Weeks | | | | | | | | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| Topic Selection |  |  |  |  |  |  |  |  | Mid Term Exams |  |  |  |  |  |  | Final Term Exams | |
| Literature review |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Find Research Gap and problem identification |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Research Proposal |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Proposal Defence |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Data Collection |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Preprocessing |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| Documentation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |

**Spring 2021**

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| Activities | Weeks | | | | | | | | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| Data Preprocessing |  |  |  |  |  |  |  | Mid Term Exams |  |  |  |  |  |  |  | Final Term Exams Preparation | |
| Analysis and Predicting |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Testing and validation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Documentation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

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