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# Smart Health Web Application for Identifying Scoliosis and Finding Solution with Confident Manner

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ABSTRACT

Scoliosis is a medical condition in human spine. It is varied and can be classified into several categories as congenital, neuromuscular, syndrome-related, idiopathic, and spinal curvature. Mainly it categorized by cobb angle in the spine. This research conducted under several parts. Those are image processing, data analysis, data analysis and recommendation and social interaction. By conducting this research, we found that people need to be informed about this medical condition. As a solution we decide to provide a well detailed and accuracy web application for users. We provide a valuable chance to our users to get more services from one web application easily. User can identify about medical condition or status by providing a image of spine to web application. And scoliosis category type by providing Cobb angle or symptoms. User able to find the details of all the scoliosis types easily from a one page. User has facility to find a consultant throughout this web application. Another main factor we found in this research is people scared to get treatments for this medical condition. As a solution for that our web application provides a community feature to user to find people who has faced the same condition or people who are succeed from the treatments. Finding pharmacies feature has included under this community feature.

***Index Terms*—Scoliosis, Cobb angle, Analysis, Recommendation**

## I. INTRODUCTION

Scoliosis is not defined as illness. It is a medical condition in human spine. Normally it is risky 1 percent of deaths in some countries. Currently fully recovered patients' amount is reporting very less. There are many reasons for this situation. People do not have a clear idea about this medical condition. They are not having correct information about medical condition of own spine. Even they have the symptoms they ignore it because of they do not have any idea about it. In some cases, people do not move to treatments may be because of they cannot find best consultants, do not have any idea about their condition, do not have any idea about the risk in future and mainly they are scared to move to treatments because of misunderstanding about treatments and because of traditional beliefs. Before going for treatments patients must have an idea about their scoliosis severity. Degree of the scoliosis patient's spine is called "Cobb angle". The cobb angle is different from patient to patient. The patient can get an idea about his/her scoliosis severity by knowing the cobb angle of his/she spine. There are 4 types of scoliosis according to the severity. Using the spine x-ray image, Cobb angle can be measured. If the patient knows the cobb angle of his spine, then he knows the severity of his/her scoliosis. According to scoliosis severity, the patient can go for appropriate treatment.

Plain X-rays can show the severity of the spine curvature and confirm the diagnosis of scoliosis. Because more X-rays will be taken over the years to see whether the curve is becoming worse, repeated radiation exposure could become an issue. To reduce the risk, system may suggest a scoliosis type according to the spine angle. There can be several treatments according to the scoliosis types as well.

Treatments for scoliosis differ depending on how severe the curve is. Children with extremely mild curves typically don't require any therapy at all, although they may require periodic exams to determine whether the curve is getting worse as they age.

This research provides best solution for this current situation. This research was conducted under several sections including image processing, data analysis, data analysis and recommendation and social interaction. Patient who visits to this web application can upload an image of spine and identify about their spine medical condition. Whether they have scoliosis or not. In second section user can identify the category of scoliosis by entering the degree percentage angle which called as cobb angle. And user can identify category types by providing symptoms which they have. Otherwise, user can view list of scoliosis types which is able to find details about the scoliosis type.

Users are able to find the best consultants who treat scoliosis and display precautions to users and treatments for scoliosis types. Finally, users have a social interaction of community feature that can share ideas with other patients or new users. Providing community feature the patients can share ideas with others then it will help to minimize patients' fear and make the patients 'confident. Patients who are under treatments and who successfully recovered can be communicate through this feature. Patients' can gain best options they had even about best consultant details, pharmacies and laboratory services related to the patient living district. It facilitates users to find pharmacies around the area.

In Sri Lanka filled with e Channeling service is a new trend to provide community feature with consultation in the medical field. In the Europe PMC People can share articles of scoliosis via email, Facebook, LinkedIn, and twitter. people can communicate with the consultants only via e channeling after doing the payment via the website. The target of our system is built confident of the patients not only communicating with consultants but also, people can share ideas with recovered people, patients, and others without doing any payment via the website. And patients can share articles, voice recording, audio, and video calling. Users can share any of them (articles, voice recording, audio, and video calling) via email, Facebook, LinkedIn, and twitter. Also, through the functionality of the Chabot contained in this website, the laboratory and pharmacy related to scoliosis related to the districts are indicated. By which the patient can connect with the concerned pharmacy / laboratory.

The main purpose of the community feature is the members of a community are similar in several ways. As they live within a definite locality, they lead a common life and share some common ends. Among the members similarity in language, culture, customs, and traditions and in many other things is observed. A social interaction is a social exchange between two or more individuals. These interactions form the basis for social structure and therefore are a key object of basic social inquiry and analysis. Social interaction can be studied between groups of two (dyads), three (triads) or larger social groups [2]. For the Smart Health Web Application contains community features of the social interaction. so, the users (recovered, not recovered and other people) can get other ideas or the experience vii through that which help to build confidence about their next step. it will help to minimize their fear or make them confident.

In 2008 research was carried out in Adolescent idiopathic scoliosis collected the data from the Department of Orthopedic Surgery and Rehabilitation, University of Iowa, Iowa City,

Iowa, IA, USA. Department of Orthopedics and Traumatology, Chinese University of Hong Kong, Hong Kong SAR, China. Department of Orthopaedics, Sahlgrenska University Hospital, Goteborg University, Gothenburg, Sweden to achieve their goal. They have used RefWorks as the database manager that alcreatingreate own personal database by importing references from text files or online databases and other various sources. In 2010 research was carried out US National Library of Medicine National Institutes of Health (PMC) used HTML, CSS as their technologies to achieve their goal. In 2008 research was carried out in BMJ Publishing collected the data from Cancer Prevention Research Centre, School of Population Health, Level 3, Public Health Building, The University of Queensland, Herston, Queensland 4006, Australia to achieve the goal of the community feature of the social interaction in the medical side.

## II. LITERATURE REVIEW

In a related research [1], they have used the watershed method to segment the spine image from x-ray image of scoliosis patient. They have to do that segmentation process manually. This segmentation method is not good accurate method for segmentation.

In this related research [2], their system is not fully automated system. They have to find upper end plate and lower end plate of the vertebrae. There is some human intervention in the process of this research. So, this is not a fully automated process of cobb angle measuring. As stated in the introduction, the primary objective of this research consists of all for scoliosis. Those who want to get a clear idea about Get an idea of scoliosis and the patient's risk level, consultant recommendation. And reduce their fear to face these situations through this web application. Choosing the best combination of factors as the cause of scoliosis. The application was able to find the most suitable ones by analyzing literature surveys and previous findings. Factors needed for forecasting. Its specialty is that it can capture all those factors Real time data.

Also, they have highlighted several important points the research conductors have considered in heart disease prediction.

## III. METHODOLOGY

The proposed system consists of four major areas,

- Calculating spine curvature for given X-ray image
- Finding the scoliosis type according to the spine curvature
- Recommendations for doctors according to the scoliosis type and prediction of precaution
- Prediction of nearest pharmacies and chat community

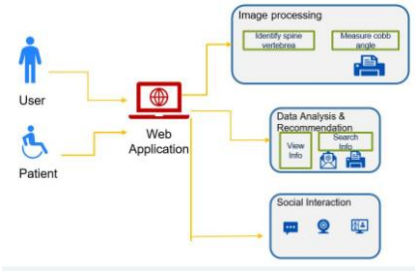


Fig.1. Overall system diagram

To get the accuracy data and information we met consultants and got idea about scoliosis. We could be able to collect data set from kaggle site and from consultants to make service accurate. All the datasets were checked by a consultant to confirmation of accuracy. Dataset were preprocessed and trained by using machine learning algorithms.

A sub objective of this research is to create a solution to measure the cobb angle of the spine using x-ray image. The processes of this sub objective are get input image, identify the spine, segment the spine, and measure cobb angle of the spine. The steps defined above shown by the Fig. 2.

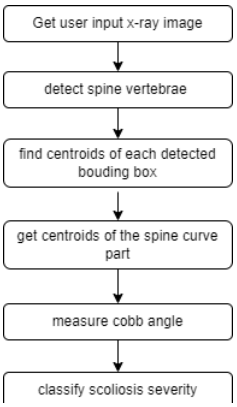


Fig.2. Steps of the cobb angle measuring process

A. Get input image The first step is to read the input spine x-ray image of the scoliosis patient.

B. Identify spine After get the input x-ray image next step is to identify spine in the x-ray image. Mask r-cnn is a popular instance segmentation algorithm that perform pixel level segmentation on detected objects. There is only one object type in this instance segmentation. That one object is spine. Train a machine learning model using mask r-CNN algorithm. Spine in the input x-ray image is detected by that trained machine learning model. In mask r-CNN algorithm, it generates a segmentation mask for each object. As scoliosis patient's x-ray image has only one object there is only one segmentation mask.

C. Segmentation

The issue is it does not give an accuracy result. The next step is to segment the detected spine image separately. First convert the mask image into a binary image. Masked object pixels' values convert to 0 and background pixels' values convert to 1. Then masked object becomes black and background becomes white. After that remove the white colour segment from the original image. Then it remains the segmented the spine image. D. Measure cobb angle

In the measuring process, first, identify each vertebra of the spine using the mask r-CNN algorithm. Identify and get the minimum bounding rectangle using segmented vertebrae contour. The upper and lower border of the rectangle takes as the upper and lower border of the vertebrae. Draw a line on the top border of most tilted upper vertebrae and find the slope(mi). Draw a line on the bottom border of most tilted lower vertebrae and find the slope(MJ). Then using the below equation calculate the cobb angle.

$$\varphi = \max\left\{\left|\tan^{-1}\left(\frac{m_i - m_j}{1 + m_i \times m_j}\right)\right|\right\},$$

$$(i, j) \in \{(a,b) \mid a \in \mathbb{N}, b \in \mathbb{N}, b - a \geq 2 \text{ and } b \leq N\},$$

Fig.3. Equation for cobb angle calculation

After measuring the cobb angle, the system shows the scoliosis severity according to the cobb angle. Figure 4 shows the scoliosis severities.

| Degree of Cobb Angle (°) | Classification |
|---|---|
| <10° | Normal |
| 10° < x < 25° | Mild |
| 25° < x < 45° | Moderate |
| >45° | Severe |

Fig. 4. Scoliosis types according to the cobb angle

In the data analysis section methodology is as follows:

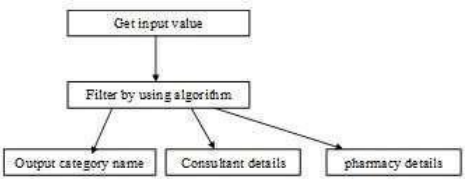


Fig. 5. Process of the data analysissection

When user inputs the district via the chatbot the correspondent data are taken from the dataset to recommend the laboratory and pharmacies related the patients' areas. Patients make the confident by sharing ideas with others by messaging via web application.

when a user inputs the scoliosis type via the web interface, the correspondent data are taken from the dataset to recommend the suitability of the health condition for the given type

Fig. 6. Model Summary

The suitability of each review is calculated logically by comparing the values obtained. Below is the logic used to calculate the suitability of each review separately.

An RNN regression model was used to predict suitable consultants related to the patients' reviews. The accuracy of this model is 94 percent. Below is the chart of model accuracy.

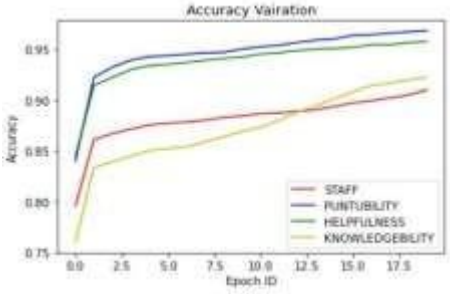


Fig.7. Accuracy variation

The proposed community feature of social interaction that has the capability of,

- Voice and video calling
- Sharing images and videos
- Text and voice messages

As the previous mentioned community feature of the social interaction will help to minimize the patients' fear and make them confident. Users who are under treatments and who successfully recovered can be communicate through this feature. Patients can share ideas, best options patients had ever about best consultant details. In this feature user can type messages or user can use voice messages and share articles via social Facebook, Email etc.

User can get best options and ideas of the hospitals, various treatments, and doctors. The Chabot shows the pharmacy and lab related to users' area. The software development life cycle which would be considered will be the agile methodology. And Scrum will be the methodology that will be followed under the agile methodology. Scrum is a lightweight agile project management framework with broad applicability for managing and controlling iterative and incremental projects of all types. Since scrum has the capability of inspecting and adapting to the change in requirements thus the solution the authors will implement is based on the hypothesis that was done by the literature survey and the survey implemented, constant changes. The data will be taken from Jayewardenepura Hospital ward no 10(Orthopedic) and Lady Ridgeway Hospital. By the relevant pharmacy and lab that have treatment and medicine for scoliosis.

| | inputs | tags |
|---|---|---|
| 0 | Kalutara | District_1 |
| 1 | Ampara | District_2 |
| 2 | Anuradhapura | District_3 |
| 3 | Badulla | District_4 |
| 4 | Batticaloe | District_5 |
| 5 | Colombo | District_6 |
| 6 | Galle | District_7 |
| 7 | Gampaha | District_8 |
| 8 | Hambantota | District_9 |
| 9 | Jaffna | District_10 |
| 10 | Kandy | District_11 |
| 11 | Kegalle | District_12 |
| 12 | Kilinochchi | District_13 |
| 13 | Kurunegala | District_14 |

Fig.8. Data Frame

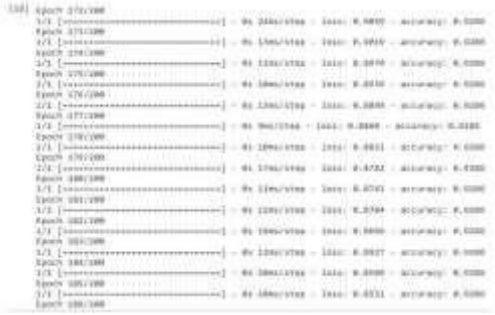

Fig.9. Checking accuracy

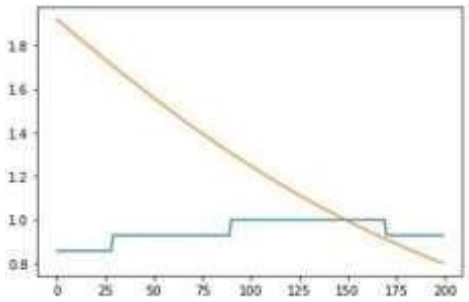


Fig.10. Output of the value

The system is tested and validated for the identification process. There, functional testing, usability testing, compatibility testing, performance testing, unit testing, and integration testing are used. The information in the dataset was used to verify the accuracy of the results obtained.

## IV. RESULTS AND DISCUSSION

A human cannot make a prediction by carefully analyzing all of those features. This is not a realistic option. As a result, forecasting data necessitates the use of a data model. That is why we regard it as a challenge and attempt to solve it. In this situation, we employed a random forest machine learning technique to produce a forecast. An examination of these datasets uncovers patterns indicating a large sampling bias. Despite the fact that our model has a high accuracy of 91.05 percent, it is very likely that it is overfitted to this data. If the goal is to forecast “Scoliosis” in people, feel such high accuracy is crucial.

### *Image processing*

In the spine curvature measuring section, it includes measuring the Cobb angle and checking scoliosis conditional using x-the ray image. first, get the x-ray image input. If the input image is not a spine x-ray image or if too much unclear an image that can identify the spine is, it gives an error message. Mask r-CNN is a convolutional neural network. It is easy to train a model using the mask r-CNN algorithm. There are 175 images in the dataset used to train the model. Used 155 images to train the model and used 20 images to validate the part. There may be a lack of scoliosis patient x-ray images. So the used dataset is small. So, to get a good accuracy result train the model for 20 epochs. Fig 11 shows the detected spine image with a segmentation mask.

Fig.11. Detected spine image with segmentation mask

When testing the trained model, it gives a good accurate result. To maintain efficiency and accuracy, used 90 percent is the minimum confidence level. That is mean if the confidence level is less than 90 percent ignore the detection result. As the accuracy metrics get average mean precision(amp), recall, and overlap metrics. Overlap is the area of intersection between ground truth and prediction. Overlap ranges between 0 and 1. Almost all images in the validation dataset have more than 0.85 overlap values. So, it can be considered a trained model that has good accuracy. Fig 12 shows the accuracy results of the spine detection model.

| Image id | Overlap |
|---|---|
| 1 | 0.9081133 |
| 2 | 0.9034722 |
| 3 | 0.9036132 |
| 4 | 0.8764183 |
| 5 | 0.915528 |
| 6 | 0.8621439 |
| 7 | 0.90238094 |
| 8 | 0.90110064 |
| 9 | 0.9166667 |
| 10 | 0.90609205 |
| 11 | 0.9073105 |
| 12 | 0.8820525 |
| 13 | 0.91283864 |
| 14 | 0.90812004 |
| 15 | 0.8901219 |

Fig.12. Accuracy of spine detection

After detecting the spine, separate the spine image. Fig 13 shows the result of the segmentation of the x-ray image.

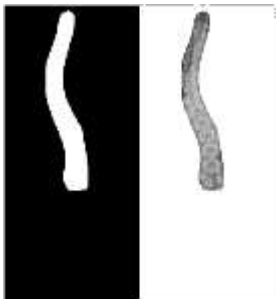

Fig.13. Threshold image with segmented spine image

Finally, according to this research paper [3], scoliosis can be classified into 4 types which depend on the cobb angle. These are normal, mild, moderate and severe.

It is hard to detect the spine vertebrae from x-ray images as the first step. Because the x-ray image is a grey color image and there is a small amount of data in the dataset. So, first, detect the spine and separate the spine image. Then it is easy to identify vertebrae using separated spine images.

In the scoliosis types/categories section we were able to find eleven main types of Scoliosis. As Adult scoliosis, Idiopathic Scoliosis, Neuromuscular scoliosis, Kyphosis, Juvenile scoliosis, Lordosis, Adolescent scoliosis, Dextrose scoliosis, Functional scoliosis, infantile scoliosis, Levoscoliosis, compensatory. One major finding in this section is Idiopathic Scoliosis is a popular scoliosis type. And found that girls are having scoliosis more than boys.

In the consultant recommendation section user is able to find a consultant who treats scoliosis and provides some information on precautions for patients. Users can find to qualified doctors by filtering by comments and reviewing what they already achieved.

In the community section patients with scoliosis have a fear of scoliosis, which can lead to morbidity and mortality. The research problem is how to alleviate the fears in the minds of patients with scoliosis and how they can be treated. The machine chatbot allows the patients to find out the pharmacies and laboratory services for scoliosis disease related to the district where the patients live. And patients can get details from the recovery patients using the chatbot. The patient can then communicate individually or in groups with the recovered patients with the doctors or with the relevant pharmacy or laboratory service. The main objective is social interaction. Providing community features the patient can share their experience then it will help to

minimize their fear and make them confident. Users who are under treatment and who successfully recovered can be communicated through this feature. They can share ideas, the best options they had even about best consultant details. The patients can obtain the pharmacies and laboratory services related to the patients living district.

After testing and comparing algorithms found as follows:

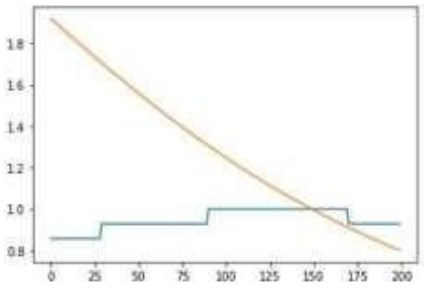


Fig.14. Accuracy of algorithms

A human cannot make a prediction by analyzing all those characteristics finely. This is Not a realistic option. Consequently, it is necessary to use a data model to predict the data. That's why we consider it a challenge and try to solve it. In this situation, A LSTM machine-learning method was used to produce a prediction. Examining these data sets reveals patterns that indicate large sample bias. Even though our model has a high accuracy of 85.8 percent, it is very likely That it is fixed over this data. The goal is to predict relevant labs and pharmacies in the relevant areas of the patients.

## V. CONCLUSION

In conclusion, in this system, scoliosis type, solutions, doctor recommendations, exercise and treatments schedules providing a web app called Smart Health, was presented, having as target audience Sri Lankan people. This can be used for other countries' people as well. Smart Health is intended to act as a single web app that has everything on a single platform that guides Sri Lankan users into making wise decisions regarding their health. This system will literally create a change in fear and make informative Sri Lankan people. Although in the literature survey, some recommender systems were mentioned and various applications are available already, even though there are similar applications researchers have found no similar web-based solution designed for Sri Lankans specifically.

The testing results of the components were very satisfactory with more than 70 percent of the accuracy considering following the doctors' suggestions, treatments, and pharmacies' Schedules and using an application like the one presented here. Researchers are planning to develop the suggested system with more features, and researchers will be focusing on recommending doctors or consultants to provide a more trustworthy service to the users. Scoliosis cases are increasing every day as reported from Around the world. But the worst thing is that most people have a vague understanding of the disease. Although scoliosis is associated with many medical conditions, most people do not know the disease properly. To find out the unexplained reasons for scoliosis, a complete medical history, physical examination, and radiographs should be performed must be performed. Monitoring of idiopathic scoliosis, orthopedic therapy, and surgery, depending on age, the severity of the curve, and risk of progression.

Scoliosis patients are advised to use various conservative treatment methods. The purpose of this study is to outline the most conservative therapy available for patients with scoliosis. Family history is one factor that may or may not have an impact on a growing child with scoliosis. Doctors believe that the disease may have hereditary influences is growing Scoliosis usually appears before or after puberty. Scoliosis can be associated with significant growth spurts that occur immediately before puberty. In the addition, scoliosis is more likely to affect tall women than other children their age. As a result, the term "SMART HEALTH APP" can be used to identify risk by Providing an opportunity for quick treatment through patient and emergency coordination. It will be a socially important system to help reduce this number of patients fearing for their lives due to the inability to get immediate access to Protection. In the future, we will conduct additional tests to improve the functionality of this Predictive classification for scoliosis using different feature selection algorithms and optimization techniques and improvement for this research project's Accuracy of data provided and accurate recommendations.

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