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# Oral Disease Detection using Neural Network

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***Abstract*—Oral diseases such as periodontal, oral cancer and tooth trauma are common non-communicable diseases that affect during the lifetime causing pain, uneasiness and even death. Periodontal is the eleventh most prevalent disease globally and the incidence of oral cancer is estimated around 20 cases per 1,000 people. It's normally caused by poor brushing, hormonal changes and flossing habits that allow plaque, a sticky film of bacteria. The mouth is regarded as a mirror of the complete wellness of the body and till now there is no personal device existing currently to monitor the oral health. An accurate prediction is essential for correct diagnosis and treatment of oral diseases. Dental diseases are mostly diagnosed at the later stage after severe pain occurs in the mouth. By predicting it at early stage, oral diseases which slowly make the roots of the teeth to get weaker can be prevented. This work aims at creating an economical, multimodal, personal oral sensing device that automatically senses and categorizes the data which will assist the clinician in early diagnosis and effective treatment. Our proposed smart electronic device automatically captures valuable parameters like pH, temperature, CO2 and other gases to overcome the challenges in the diagnosis of the oral problem. The captured data is fed to Convolutional Neural Network for classification of oral diseases.**

***Keywords: Oral disease, Periodontal, Oral cancer Tooth trauma and CNN.***

## I. Introduction

The Global Burden Study 2019 estimated that 3.58 billion people are affected with dental caries and severe periodontal (gum) disease, which is mentioned as the eleventh most prevalent disease globally. The most prevalent condition affecting 35% of population is due to untreated caries in permanent teeth. Severe periodontitis, untreated caries in deciduous teeth, severe tooth loss are the sixth, tenth and thirty sixth most widespread conditions. These three conditions in turn affect 11%, 9% and 2% of the global population. Oral cancer is one of the most common cancer in the world reported by FDI World Dental Federation. As per the National Oral Health Survey of India (2002-2003), the occurrence of periodontal diseases in the age groups 12, 15, 35-44 and 65-74 years is 57.0%, 67.7%, 89.6% and 79.9% correspondingly. Nineteen percentage of people are toothless in the age range of 65-74 years. Usually, the patient will visit the dentist after unbearable tooth pain and it is more difficult to provide treatment at the final stage. The head and neck cancer originates in any of the tissues in the mouth or any cancerous tissue growth located in the oral cavity. About 75% of oral cancers are mainly due to bad habits like usage of tobacco and alcohol consumption. The risk factors for oral cancer are unhygienic, discomfort caused by ill-fitting dentures and other rough surfaces on the teeth, mal nutrition, and some continued infections caused by fungi, bacteria or viruses.

It is inferred from the studies that periodontal disease may increase the risk of oral cancer. This paper describes affordable and portable personal device that monitors oral diseases, such as oral cancer, periodontal (gum disease), tooth erosion and gingivitis. It automatically detects and classifies the data using the convolutional neural networks.

## II. Related Work

Several studies have been carried out on the diagnosis of oral diseases and some of them are described in this section. F. M. Eggert et al. (1990) proposed a system for measuring pH to predict Gingival and periodontal disease and is near neutral at most sites in most individuals. Periodontal disorder ranges from healthy to periodontitis but the clinical evidence of gingivitis at a site near pocket depth are related with crevicular. From the results, it is observed that loss of $CO_2$ into the atmosphere from the biological fluid results in shifting of alkaline pH by 1 unit. Fatihah Mohdl et al. (2013) prepared a dataset for research which includes information about social habit, clinical symptoms, and histological variables. Data pre-processing is useful in future for developing decision support systems. A set of oral cancer dataset is created to use in knowledge-based decision support system. A periodontal disease identification using Convolutional Neural Networks (CNN) is proposed by Joo et al. (2019). Deep Learning has been an evolving tool in the field of machine learning for characterising the dataset. This paper discusses data processing and CNN structure. The data processing is used for fast and stable learning of data. Yao Liu et al. (2017) proposed a quantitative model for estimation of oral cancer risk in patients affected by oral leukoplakia. Oral Squamous Cell Carcinoma (OSCC) is the most common type of oral cancer. The authors devised an index (OCRI2) for assessing the cancer risk using the Peaks-Random Forest model. Prajapati et al. (2017) suggested a method




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using CNN and Transfer Learning for classification of dental diseases. For classification, Categorized dataset Radio Visiography (RVG) consisting of 251 X-ray images of three dissimilar classes is used. In this paper, the authors used a small labelled dental dataset to test the performance of CNN. In addition, transfer learning is used to improve the accuracy. The results are given for three dissimilar architectures of CNN. Overall accuracy attained is very promising. Masaki Yamaguchi (2010) discussed that Salivary Sensors in Point-of-Care Testing (POCT). The author has mentioned that saliva can be collected non-invasively and it is used not only for the diagnosis of oral diseases but also for the effective diagnosis of general diseases. By using this non-invasive method the rapid, low-cost and high-sensitivity analytical procedure were used for saliva sampling that improves tremendously in recent years, the suggested applications of such techniques are still constricted to identify oral diseases, viral infections and human stress tests.

G. Tsuruzoe and K. Tsuchiya (2016) developed a pH measurement sensor to be fixed on the Oral Measurement Device. The detection of oral disease with the help of blood test has several disadvantages and it is overcome with the help of pH sensor a physiological indicator. With the help of current technology, saliva is attracting attention since it can be collected noninvasively. So, measurement of intraoral is performed in the dentistry type pH sensor. A pH sensor is used for measuring intraoral cavity using different secretions and it is mounted on the mouthpiece device. Aberin and Goma (2018) presented a method for detecting periodontal disease using CNN. This method mainly concentrated on classifying the microscopic dental plaque images as healthy or unhealthy. The authors used the CNN with the Alex Net architecture to classify the images using Tensor flow. This model is able to produce an accuracy rate of 75.5%. Sajda, P. (2006) suggested an approach using machine learning for recognition and diagnosis of disease. Machine learning offers the researchers for the development and establishment of effective algorithms for analysis of multimodal biomedical data. ML is one of the promising tool in the field of computer aided diagnosis. Machine learning, a part of Artificial Intelligence (AI), focuses on algorithms capable of learning and adapting their structure based on a set of data collected from the dataset. The machine learning community is interested in disease detection because of easy storage of data and high speed communication networks.

Shashikantpatil (2019) designed a model for detecting the tooth cavities. Multilinear principal component analysis is applied as a feature extraction step. Adaptive Dragonfly algorithm (DA) algorithm and Neural Network (NN) classifier is used for classification. To assess the performance of the caries detection model, Accuracy, sensitivity, specificity, precision, False Positive Rate (FPR), False Negative Rate (FNR), Negative Predictive Value (NPV), False Discovery Rate (FDR), F1-Score and Matthews Correlation Coefficient (MCC) are used.

Arushi Tetarbe et al. (2017) proposed an oral cancer detection technique which used different algorithms of data mining to detect oral cancer. Health institutions employ data mining technique for classification of life threatening diseases, e.g. cancer, dengue and tuberculosis. In this approach WEKA (Waikato Environment for Knowledge Analysis) is applied with ten cross validation to calculate and collect output. WEKA comprises of a large number of data mining machine learning algorithms. The system first classifies the oral cancer from the dataset and then various data mining methods in WEKA are used for analysis. The major aim is to classify the dataset using this method and help to collect important and useful material from the data and choose an appropriate algorithm for accurate prognostic model from it.

## III. Methodology

The proposed method is explained in Fig. 1. The parameters like pH, temperature, $CO_2$, and alcohol concentration levels are collected using pH sensor, temperature sensor, $CO_2$ sensor and MQ6 sensor respectively.

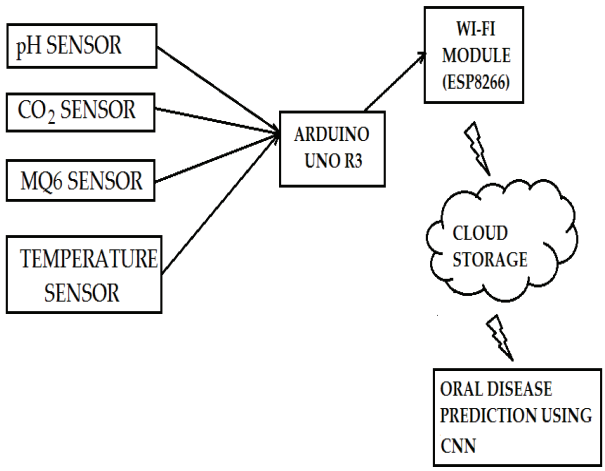


Fig. 1: Proposed Method

The pH value of normal mouth ranges between 6.85 - 6.96. For the diseased subject, the pH value is in the range of 9.11-10.2. The temperature sensor measures the temperature of the mouth. The average normal oral temperature is 31° C and for the person affected by oral disease, the temperature is greater than 31° C. The MQ6 detects the alcohol content of the mouth, it ranges between 360 - 650 ppm. The normal range is 480 - 530 ppm. The abnormal values lies between 360-480 and 530-650. The bacteria in the mouth use the $CO_2$ during the fermentation process and it varies for the healthy and unhealthy person. For the diseased person, it is in the range of 390-470 ppm. The data from the sensors fed to the Arduino UnoR3. The

sensor data from the Arduino is sent to cloud through Wi-Fi module.

Convolutional Neural Network is used for classification of the disease. Convolutional Neural Network is basically made up of neurons with weights and bias, that are inspired by the human brain. Architecture of CNN consists of an input layer, hidden layer and output layer. Convolution layers and batch normalization layers form the hidden layer. The output layer is usually fully connected layer followed by softmax and classification layer.

## IV. Results and Discussion

The acquired pH, temperature, $CO_2$, MQ6 values from the subjects are sent to cloud to form the dataset. Due to limited number of subjects with oral diseases in our locality, pre-existing dataset from Kaggle is also stored in the cloud to increase the dataset variability. Once the dataset is created, it is applied to CNN algorithm for training and testing process.

For training process 200 x 4 (pH, Temperature, MQ6, $CO_2$) data and for testing process 50 x 4 data were used. Based on the values in the dataset, CNN classifies as normal, periodontal and oral cancer. Equation (1) helps to assess the performance of CNN in terms of accuracy.

$$Accuracy = \frac{TP+TN}{TP+TN+FP+FN} \quad (1)$$

From the experimental results it is observed that CNN performed well with an accuracy of 91%.

## V. Conclusion

This work assists in detecting oral diseases. So, it is possible to reduce deaths caused by Oral cancer, by detecting it in early stage. The loss of periodontal attachment structures are mainly due to periodontitis. If left untreated, it eventually results in tooth loss and predicting it in initial stages helps in early treatment of the disease. The data acquired from the sensors can be stored in the cloud for further analysis. CNN classifier is used to classify the data with satisfactory results. This device will act as the strong diagnosing system and aids the dentist to provide effective treatment for oral diseases.

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