Mobile Application for Pranayama Practice using Clustering

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***Abstract*—In yoga practice, pranayama (breathing practice) is considered as very important. In the practice of pranayama, a practitioner has to carefully make a mental note of the count of number of rounds of pranayama and also most importantly, the duration to which a person is inhaling/exhaling. Maintaining a specific ratio in the inhalation: exhalation cycle is of great importance and critical as well. For a beginner, the process of counting is so demanding that the awareness of the breathing process is difficult to maintain, and it reduces the quality of practice of pranayama. The proposed system is to create an application that fixes our capacity of inhalation and exhalation. Then the application should give both visual and auditory signals during pranayama. By doing this project we increase the quality of pranayama. Thereby increasing the efficiency of breathing which in turn reduces depression and anxiety.**

Keywords—Pranayama, Inhalation, Exhalation, Application

I. INTRODUCTION

Pranayama is a one of yoga practice which depends on breathing patterns like Inhalation, exhalation and retention. In yoga breathing is of top priority. However, while practicing yoga one needs to keep maintaining a particular frequency of breathing i.e. how much time inhalation and exhalation should take place? Similarly, Retention and exhalation. In the practice of pranayama, a practitioner has to carefully make a mental note of the count of the number of rounds of pranayama and also most importantly, the duration to which a person is inhaling/ exhaling. Maintaining a specific ratio in the inhalation: exhalation cycle is of great importance and critical as well. For a beginner, the process of counting is so demanding that the awareness of the breathing process is difficult to maintain, and it reduces the quality of practice of pranayama. By the continued practice of Pranayama, the lungs will get proper Oxygen supply. This will lead to quality and quantity of the blood circulation in the whole body. With the good quantity of blood circulation, tissues and cells will be nourished. Good practice of pranayama improves metabolism. Regular breathing practice helps for relaxation, stress management and Increase of concentration. One of the goals of yoga is to reduce some of the negative effects of stress. Regular "Bhramari" pranayama practice is effective for maintaining balance of Harmon in the body [3].

The duration of inhalation and exhalation depends entirely on the capacity of the practitioner. One should Start with whatever they are comfortable with – say five seconds inhalation, four seconds of retention and five seconds exhalation. Later it can be increased up to more than twenty seconds. Schools based yoga intervention may improve several factors that are relevant to academic performance of a student such as emotional imbalance, By the continued practice of Pranayama, the lungs will get proper Oxygen supply. This will lead to quality and quantity of the blood circulation in the whole body. With the good quantity of blood circulation, tissues and cells will be nourished. Good practice of pranayama improves metabolism. Regular breathing practice helps for relaxation, stress management and Increase of concentration. One of the goals of yoga is to reduce some of the negative effects of stress. Regular "Bhramari" pranayama practice is effective for maintaining balance of Harmon in the body [3].

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The existing apps are capable of guiding inhalation, retention and exhalation with the simple beep sound with a fixed frequency. Frequency of breathing cannot be fixed since it depends on the factor of someone's age and health related issues. Some other apps use special kinds of gadgets and sensors for this purpose. Our app is capable of analyzing the breathing pattern. Thus, more dynamic in nature and uses only the phone which makes it more user friendly. We identify and count inhalation and exhalation using the mobile phone microphone, as while inhaling and exhaling deeply there tend to be a particular sound. We can take that sound as an input and also give the participant a feedback on how they have performed on each round of their pranayama. App records the breathing sound, and runs a classification algorithm and determines a few features such as the frequency, Inhalation time, Exhalation time ext. and use them to give enriched user feedback about the quality of breathing.

II. RELATED WORK

Hashoul et al [1], aspiratory respiratory sicknesses from breathed out breath. Through sensors recognizing unpredictable natural mixes (VOCs) illnesses present in breathed out breath. Sensors that have been created and utilized for the recognition and diminishes high hazard from blood, breath, body liquid of the respiratory issue. a portion of the sensors and ailments are, sensor exhibits for illness recognition in breathed out breath utilizing cross receptive and synthetic sensor , and asthma is the most widely recognized infection, identified by breath investigation approach dependent on location and observing of breathed out nitric oxide fraction(FeNO), and lung malignancy is distinguished by surface acoustic wave sensor and colorimetric sensor, and tuberculosis is conclusion of TB, utilizing Phillips et al and Nakhleh et al is QMB sensor to evaluate the breathed out breathing and utilizing carbon dark sensor.

Smolinska et al [2], describes that the principle point is to discover examples of VOCs identified with unusual breath conditions and depict the present cutting-edge utilizing AI multivariate examination techniques. breathomics information acquired from gas-chromatography mass spectrometry (GC-MS) is a logical strategy to gauge follow gases in complex blends, for example, breathed out air and result of this information is preprocessing and get framework information of VOCs. Utilizing GC-MS grid to discover solid sickness indicators utilizing multivariate measurable examination dependent on a little arrangement of chose VOCs removed during variable choice. Steps to follow are, crude GC-ms information into denoising and benchmark amendment and arrangement and get the pinnacle esteem are picking and consolidating the pinnacle and gathered this incentive as lattice. Examination utilizing multivariate measurable strategies, for example, unaided investigation and straight factual method.

Maheshkumar Kuppusamy et al [3], Describes Pranayama as a part of yoga practice is incredibly gainful to people for having great physical and psychological wellness. Objective of this exploration paper is to achieve knowledge on the adequacy of Bhramari pranayama. Pranayama is one practice that is viable to physiology of humanity from multiple points of view. Whole lung is ventilated as opposed to the shallow breathing which invigorates the base of the lung. Bhramari experts breathe in and breathe out gradually while breathing out produce murmuring seems as though honey bees. Bhramari practice is powerful for keeping up parity of Harmon. This is additionally effective at looking after tension. Pranayama proceeds with training diminishes the dead space ventilation and diminishes crafted by relaxing. Whole lung is ventilated as opposed to the shallow breathing which revives the base of the lung. Improves the cosmic framework towards parasympathetic strength.

Usha Manjunath et al [4], describes that the students of 13-18 years involved for 6 months period; students were made to do regular Pranayama daily. Schools based yoga intervention may improve several factors that
are relevant to academic performance such as emotional imbalance attention control and cognitive efficiency. All data obtained were expressed as mean, standard deviation the difference in observation before and after pranayama were studied using student paired test. Pranayama and other logic practice show highly significant improvements in the IQ and social adaptation parameter in mentally related children.

Yosuke Kawai et al [5], The quantitative accuracy and throughput performance for the newly developed hardware-based simultaneous ion counting and waveform averaging (AVG) in a time-of-flight (TOF) mass spectrometer was studied. The peak detection (PKD) algorithm was used for ion counting instead of voltage threshold detection method that is widely used in ion counting techniques. The silicon isotope abundance ratios were determined by the ion counting with ± 4 % uncertainties relative to the known isotope ratios. The measurements were carried out at relatively higher count rate condition (40 % which means that 0.4 ions arrived at the detector for each TOF trigger), but no systematic errors observed, which indicates the PKD algorithm was able to resolve two or more ions detected simultaneously compared to a simple voltage threshold detection algorithm. An excellent linear response was observed between PKD- based ion counts and the peak area determined by AVG waveform for 2 orders of magnitude. By using peak area based on AVG waveform for higher abundance ions and ion counting
based on PKD for lower abundance ions, the silicon isotope abundance ratios were determined with the same analytical precision at one-tenth of the analysis time required for the ion counting alone.

Hiromitsu Nishizaki et al [6], This study introduced the signal classification tasks using the deep learning framework. We showed that the recurrent based neural network was very effective in understanding and classifying the signal. In particular, the bi-directional LSTM can realize a robust classification. Although we dealt with the snack sound classification and the tennis swing classification, the RNN-based model can be widely applied to the time sequential data from various IoT devices. In the future work, we will develop an environment-understanding
system for in-home or forest environments with IoT devices and the deep learning framework.

Azam, Muhammad Awais et al [7], The study contains breath samples captured using smartphone under natural setting, the data set contains 255 breath cycles. The support Vector Machine (SVM) was applied on randomly partitioned samples while breathing kind of vibration is produced which can be used to identify different lung disease through breath sound pattern analysis smartphone was used to record airflow while placing it at the distance of 25 to 30cm from patient mouth. De-noising is performed to remove background noises. Wavelet denoising technique is used to filter noise from breath.

T. Fischer et al [8], Snore Inhalation, Snore Exhalation, Breathe Inhalation, Breath Exhalation is Performed using classification. The classification consists of five binary robust boost classifiers. Another method is to apply one versus rest strategy and Artificial Neural Network (ANN) for voting on the output. As a number of smartphones is rising world-wide, A need of simple, same time reliable Technology for the detection of breath sounds. This can help to save money for health system in-terms of an Early Warning System (EWS). Training of the ANN is performed

with balanced dataset and scaled conjugate gradient Back propagation. Audio files of each smartphone differ in sound quality, snoring characteristics and distance from the source. Classifying these highly imbalanced, class noise data set into five is a classifying task. To reduce computational time and improve accuracy adoptive noise suppression and filtering is applied. Since computation power smartphone is rising, implementation of the proposed improvements in combination with more data for training and testing, sleep-disorder breathe detection for in-home environment becomes more accurate

III. IMPLEMENTATION DETALIS

A. PROBLEM DEFINITION

In yoga practice, pranayama (breathing practice) is considered very important. In the practice of pranayama, a practitioner has to carefully make a mental note of the count of the number of rounds of pranayama and also most importantly, the duration to which a person is inhaling/ retaining/ exhaling. Maintaining a specific ratio in the inhalation: exhalation cycle is of great importance and critical as well. For a beginner, the process of counting is so demanding that the awareness of the breathing process is difficult to maintain, and it reduces the quality of practice of pranayama. The overall main objective of the project is to create an application that is capable of counting the inhalation and exhalation. This app also ensures that feedback is given to users observing the inhalation and exhalation patterns.

B. ARCHITECTURE DESIGN

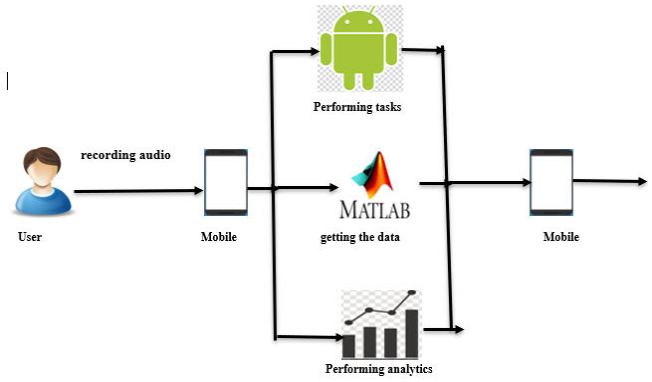

Fig.1. Architecture Design

This project is completely based on the respiratory system maintenance while practicing pranayama where inhalation and exhalation plays an important role. Initially an android application is created where the users will be trained or we can say that a tutorial will be provided for the beginners and an audio will be recorded with the help of the mobile microphone and the recorded audio will be converted automatically to the wave. The wave then will be taken as an input for the dataset creation. Based on the wave forms obtained, the peak and rms value will be produced. The peak values will be further classified into min, max and average peak values due to the large set of values obtained. Based on these values in the dataset analysis is been performed. Analysis is performed on more than three algorithms and compared among themselves and then the best one outputs the values. The output would be healthy breathing or not.

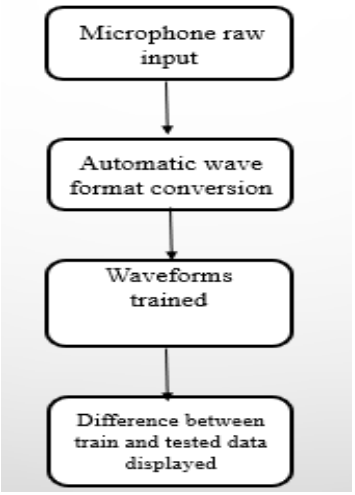

Fig. 2. Flow Diagram

As in simple terms we can explain the flow as a mobile phone captures the audio from the user and then a conversion takes place which results in the wave file generated. The generated wave file is then taken for analysis and implemented with different algorithms. The difference in the accuracy is computed among the algorithms and the best algorithm is decided based on the accuracy it presents. The analyzed output is presented to the end user

C. HARDWARE REQUIREMENS

Mobile: a phone with access to a cell radio framework so it tends to be utilized over a wide region, without a physical association with a system.
Microphone: In mobile phones, during a call, when you talk, your voice goes into the mic. A mic changes over voice into electrical sign. It is additionally called receiver and mouthpiece. It will consistently be at the bottom, inside a PDA.

D. SOFTWARE REQUIREMENTS

Android Studio: Android Studio was announced on May 16, 2013 at the Google I/O gathering. It was in early access audit stage starting from variation 0.1 in May 2013, by then entered beta stage starting from adjustment 0.8 which was released in June 2014. The chief stable structure was released in December 2014, starting from adjustment 1.0.
Anaconda navigator: Anaconda Navigator is a work area graphical UI (GUI) remembered for Anaconda conveyance that permits you to dispatch applications and effectively

oversee conda bundles, conditions, and channels without utilizing order line orders.

Matlab: MATLAB is an unrivaled language for particular handling. It organizes estimation, discernment, and programming in an easy to-use condition where issues and game plans are imparted in conspicuous numerical documentation. Conventional utilizations include: Math and figuring.

Django Server: Django is the python based free and open source web outline work that follows the model layout see engineering stage. we utilize this casing work to run python code remotely on the outside server.

IV. DATA PREPROCESSING AND FEATURE SELECTION

A. Dataset

1	0.017721	0.015747	0.042018	0.17102	2
2	0.007995	0.00647	0.015545	0.057281	2
3	0.019753	0.017334	0.05122	0.16797	2
4	0.009631	0.008484	0.021485	0.10077	2
5	0.011596	0.010406	0.027895	0.10278	2
6	0.016541	0.013397	0.031944	0.15192	2
7	0.020482	0.018127	0.04746	0.15039	2
8	0.016581	0.015015	0.040848	0.17468	2
9	0.028433	0.024475	0.061604	0.35657	1
10	0.013252	0.010864	0.025644	0.088806	2
11	0.013862	0.011597	0.028694	0.12436	2
12	0.033229	0.028381	0.069243	0.29251	1
13	0.02198	0.01944	0.050148	0.19363	2
14	0.003942	0.00351	0.009316	0.02829	2
15	0.001095	0.000824	0.001568	0.010956	2
16	0.001372	0.00116	0.002532	0.059387	2
17	0.002321	0.00177	0.003747	0.01593	2
18	0.000429	0.000336	0.000639	0.003601	2
19	0.001093	0.000824	0.001611	0.009705	2
20	0.001042	0.000763	0.001514	0.007752	2
21	0.002325	0.00174	0.003469	0.019287	2
22	0.002325	0.00174	0.003469	0.019287	2
23	0.002274	0.002014	0.004249	0.16913	2

TrainInhale

Fig.3.Inhalation dataset

	A	B	C	D	E
1	0.001184	0.000977	0.001968	0.013672	1
2	0.001035	0.000763	0.001533	0.008606	1
3	0.056192	0.053589	0.17523	0.50879	2
4	0.000716	0.000549	0.001091	0.006165	1
5	0.002026	0.001556	0.0033	0.016998	1
6	0.001753	0.001282	0.002621	0.016235	1
7	0.001086	0.000824	0.001635	0.007813	1
8	0.002198	0.00177	0.003885	0.021942	1
9	0.12389	0.098236	0.22157	0.5509	2
10	0.011602	0.009766	0.026157	0.10852	1
11	0.029111	0.0271	0.089772	0.40009	2
12	0.023856	0.02243	0.072632	0.34369	2
13	0.000716	0.000549	0.001091	0.006165	1
14	0.006807	0.006348	0.021249	0.093353	1
15	0.068404	0.063171	0.17796	0.58765	2
16	0.012239	0.011322	0.034547	0.13266	1
17	0.047561	0.041351	0.095145	0.38892	2
18	0.008693	0.008087	0.019219	0.24521	1
19	0.11895	0.091705	0.20354	0.62045	2
20	0.012076	0.010498	0.020711	0.12616	1
21	0.009924	0.00824	0.020031	0.1077	1
22	0.011735	0.009674	0.023644	0.10291	1
23	0.022876	0.019409	0.04891	0.23154	1

TrainExhale

Fig.4.Exhalation Dataset

	A	B	C	D	E
1	0.017721	0.015747	0.042018	0.17102	2
2	0.007995	0.00647	0.015545	0.057281	2
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18	0.000429	0.000336	0.000639	0.003601	2
19	0.001093	0.000824	0.001611	0.009705	2
20	0.001042	0.000763	0.001514	0.007752	2
21	0.002325	0.00174	0.003469	0.019287	2
22	0.002325	0.00174	0.003469	0.019287	2
23	0.002274	0.002014	0.004249	0.16913	2

TrainInhale

Fig.5.Unwanted data

V. PROPOSED MODEL

A. Kmeans Clustering

To create dataset using .mp3 audio files using MATLAB software first we converted it into .wav format then we computed RMS and Peak values. Once after computation has been done, we got around thousands of peak values that too in varying numbers for one .wav file and one RMS (Root Mean Square) value so we come up with an idea to take only minimum, average and maximum of peak values. Then we created .csv files in which consists of those RMS and Peak values so know our dataset is ready but we have only X variables or attributes and we don't have any resulting variable or we say Y. To find that we implemented unsupervised K-means Clustering where we formed two clusters with default labelling 1 and 2 in which the nearest row values are grouped which says whether inhalation is valid or invalid (same for exhalation also). So now we come up with an Y value and we included this resulting attribute (Y) value in respective X row in .csv file, now our complete dataset is ready. Then to test some new data and to find accuracy of our module again we did same work as above and tested the module and ended up with accuracy for all inhalation exhalation and unwanted dataset.

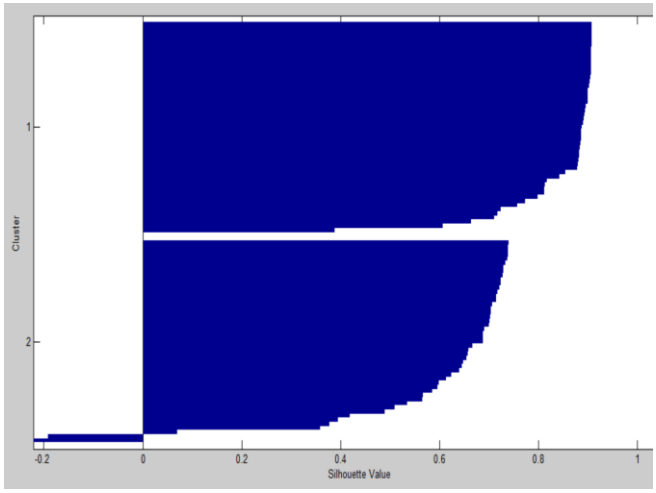

Fig.6.Two Clusters labelled 1 and 2 which have consists of group of nearest values of Inhealation dataset (same for both exhalation and unwanted dataset also).

B. Decision Tree

Decision tree algorithm is used to get all the possible solution based on given condition, there are two nodes, one is decision node and other one is leaf node to make the decision intern of tree form. Using this algorithm, we trained the module using train inhalation and exhalation

dataset and test the model with separate dataset and also testing with a unwanted data has been done and its accuracy is shown in the table 1.

C. Random Forest

Working of this algorithm is also same as decision tree but the difference in this algorithm is, it is a combination result of two or more Decision trees into one. This Random forest algorithm work on bagging principle, means it takes an average result of all decision trees and builds the complete module. Using this algorithm, we built a model for our dataset by training and tested it with other datasets for Inhalation, exhalation and unwanted set of data and its accuracy is shown in table 1.

D. SVM (Support Vector Machine)

To identify that which algorithm gives best accuracy for our dataset we implemented SVM where the hyperplane divides out data of inhale and exhale as valid or invalid. For this algorithm we gave our complete training inhalation dataset and exhalation dataset separately to train SVM module. Once after training as been done we gave testing set of data to observe how accurately our trained SVM module tests the data. And we obtained high accuracy in SVM only we can estimate this by observing the accuracy obtained for unwanted data, here compare to all other algorithms what we have implemented SVM is giving a very smaller number of accuracies for unwanted data and high accuracy for correct set of testing data.

One thing here is both K-means clustering and SVM has been implemented in MATLAB software Version 2013a so in this version of software we don't have inbuilt function to plot SVM classified data with hyperplane so we didn't able to do that but if we have higher MATLAB version then we can plot that easily.

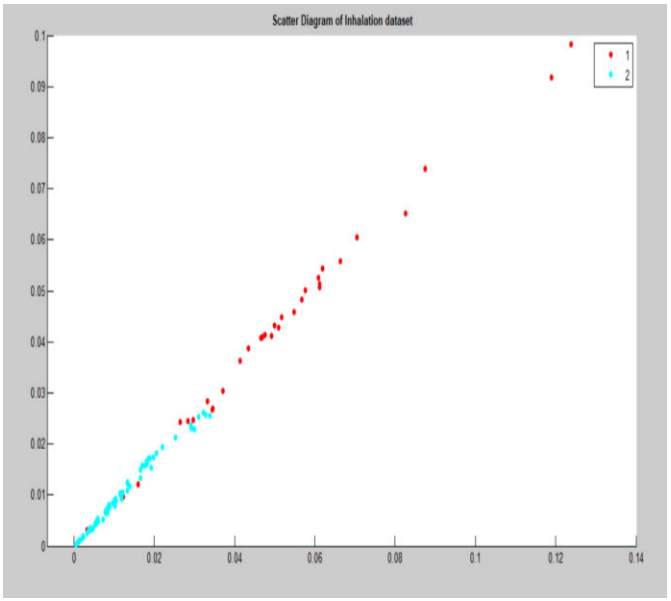

Fig.7.Scatter Plot of inhalation dataset(Same for both Exhalation and unwanted dataset also)

VI. PERFORMANCE EVALUATION

Models	Accuracy of Test Inhalation Data	Accuracy of Test Exhalation Data	Accuracy of Testing Unwanted data and Inhalation Data	Accuracy of Testing Unwanted data and Exhalation Data
KNN	74%	97%	46%	56%
SVM	98%	100%	48%	39%
Decision Tree	85%	72%	50%	50%
Random Forest	94.4%	66%	50%	50%

Table.1. Accuracy Chart

VII. RESULTS

Fig.8.Android App Version

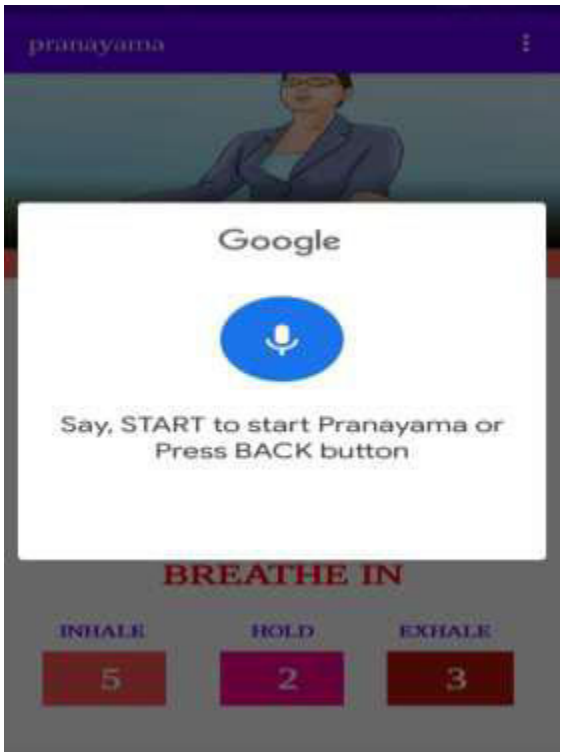

Fig.9.Google voice input pushup

Fi.g..11. Menu of the Application

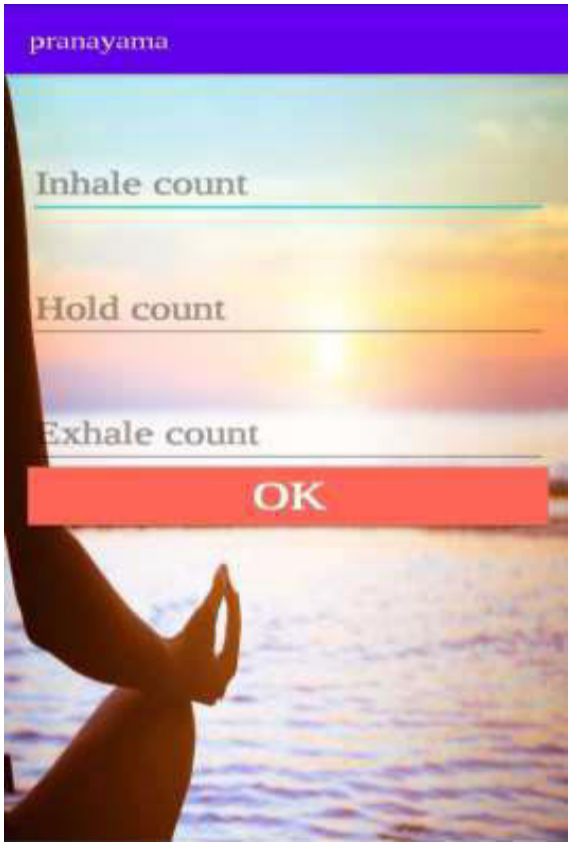

Fig.10.Set count of pranayama activity

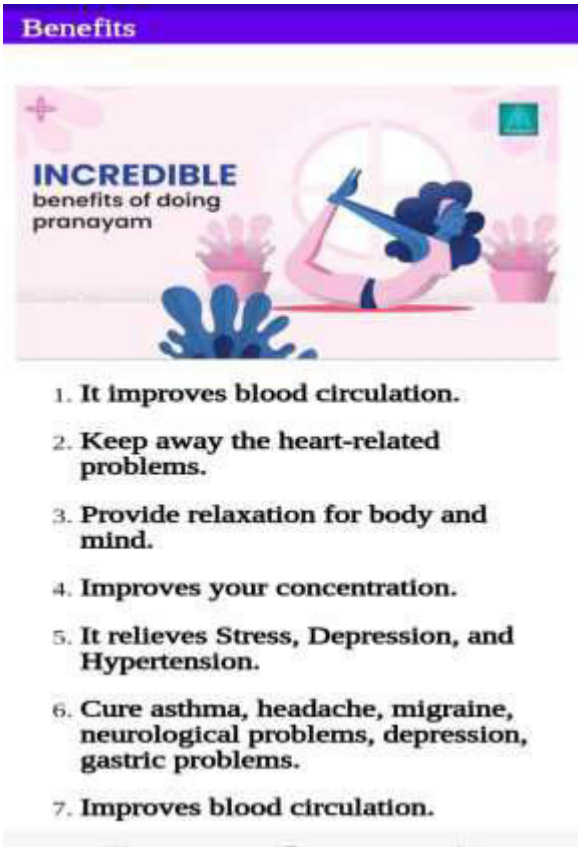

Fig.12.Benefits of the pranayama activity

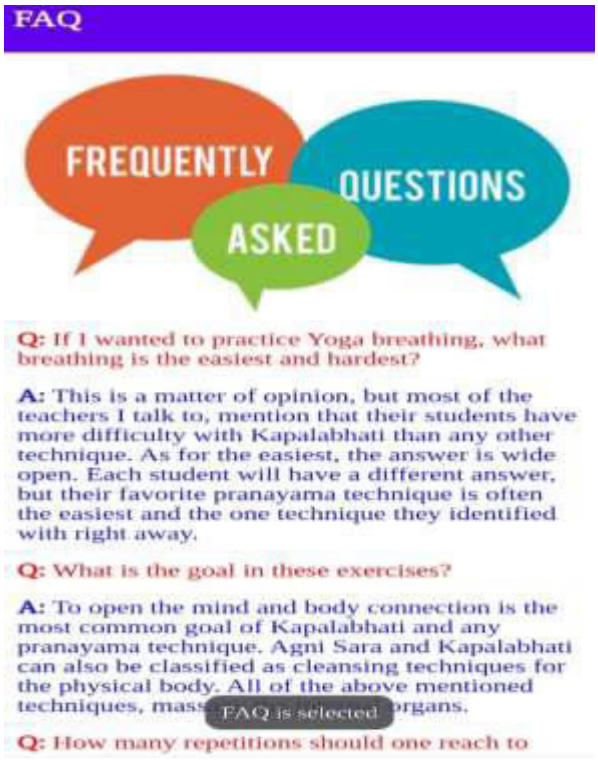

Fig.13.Frequently Asked questions

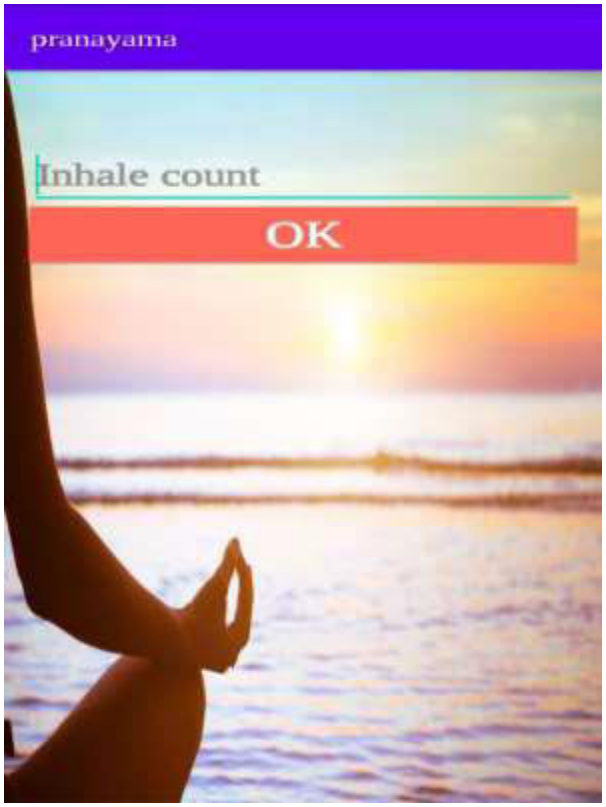

Fig.14.Inhale count

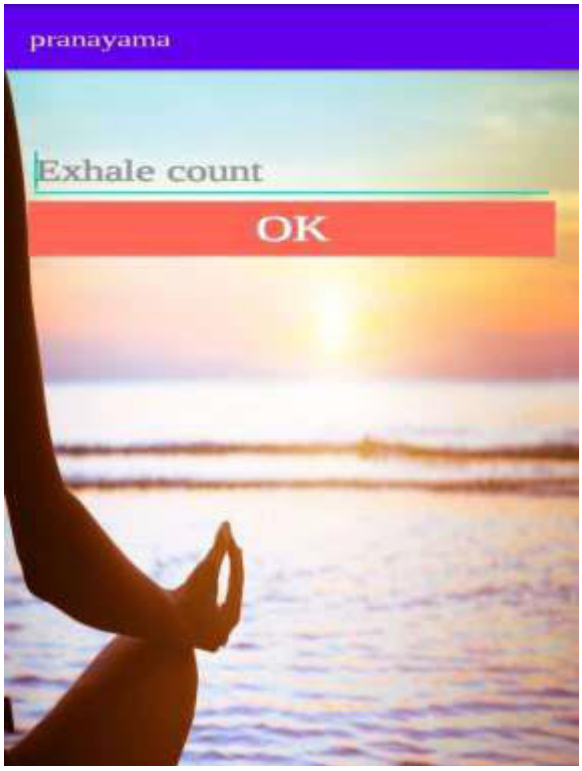

Fig.15.Exhale count

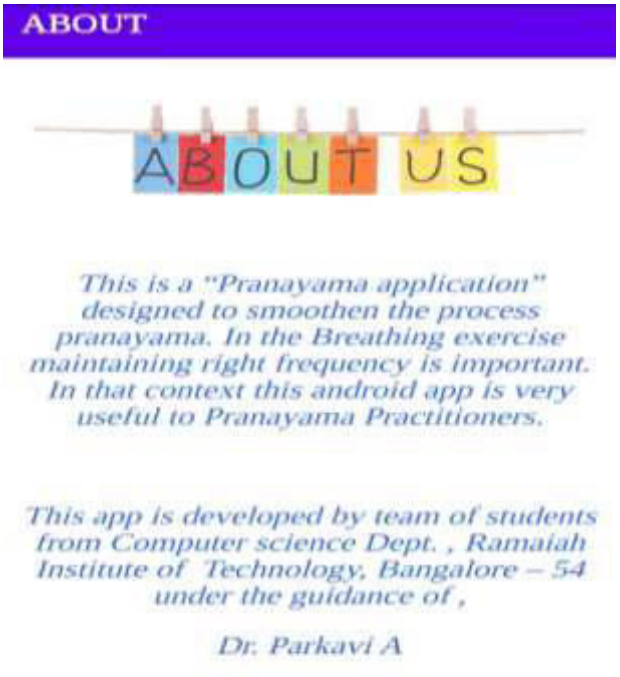

Fig.16.About us

VIII.CONCLUSION

Yoga is a group of mental spiritual and physical practice which originated from the ancient tradition. Thus, our app creates fixed duration of inhalation and exhalation timings. The application gives both visual and auditory signals during pranayama. With our app, we increase the quality of pranayama. This app also ensures that feedback is given to

users observing their inhalation and exhalation patterns. This application helps individuals in practicing there pranayama i.e. by providing the tutorials. It's very helpful for the beginners. The analysis done in this application helps individual to maintain the healthy inhalation and exhalation practice. Each and every application we have come across in our research only displays the inhalation and exhalation procedure but there is no proof of live audio recording, converting to wave and performing analysis which in turn provides a helpful information for the end users. As future work, we will have Breathing along with the Yoga monitoring system. Which should be able to observe the posture and give instruction or feedback to the end user. Combining the breathing and the asanas and providing like interaction to the end users would be the main intention.

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