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(57) Abstract :
People are suffering from a variety of sleep disorders as a result of the increased speed of social activities, quick changes in lifestyles, and increased strain in professional sectors. Many sleep-related disorders are observed to be indicators of Neurological Disorders in later age, which have an impact on quality of life in everyday activities. Analysis and Classification of Sleep Scoring are critical steps in diagnosing these illnesses. For clinicians, monitoring the participants' complete sleep lengths and analyzing sleep staging in traditional and manual lab environments is a very time-consuming task. We considered the Novel Automated Machine Learning Algorithms Based System for Sleep Staging for reliable diagnosis of various Sleep Disorders. Characteristics Analysis is utilized for the automated analysis of sleep epochs gathered from subjects while they were sleeping. The present invention disclosed herein is a Novel Automatic Sleep Staging Features Analysis System using Machine Learning comprising of: Human Brain (101), EEG Signal Acquisition (102), Channel Data Segmentation (103), Preprocessing (104), Feature Extraction (105), Automatic Feature Selection (106), Classification (107), and Sleep Stages (108); used to analyze the sleep staging features by machine learning algorithms. The present invention uses Extreme Learning Machine with Particle Swarm Optimization (ELM-PSO) for automatic features selection and classification. The present invention is tested by Sleep Disordered and Healthy Subjects for sample size of each subject same, was 750 epochs and the length of each epoch is the 30s.

No. of Pages : 19 No. of Claims : 7

FORM 2

THE PATENTS ACT, 1970

(39 of 1970) &

THE PATENTS RULES, 2003

COMPLETE SPECIFICATION

(See section 10, rule 13)

1. TITLE OF THE INVENTION:

A NOVEL AUTOMATIC SLEEP STAGING FEATURES ANALYSIS SYSTEM USING MACHINE LEARNING

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3. PREAMBLE TO THE DESCRIPTION:

COMPLETE SPECIFICATION

The following specification particularly describes the invention and the manner in which it is to be performed.

A NOVEL AUTOMATIC SLEEP STAGING FEATURES ANALYSIS SYSTEM USING MACHINE LEARNING

FIELD OF INVENTION

The present invention relates to the technical field of Computer Science Engineering.

Particularly, the present invention is related to a Novel Automatic Sleep Staging Features Analysis System using Machine Learning of the broader field of Machine Learning in Computer Science Engineering.

More particularly, the present invention is related to a Novel Automatic Sleep Staging Features Analysis System using Machine Learning used to analyze the sleep staging features by machine learning algorithm. The Sleep Stages behavior of Affected Sleep Problem and Healthy are tested by the invention disclosed herein.

BACKGROUND & PRIOR ART

The most useful where the analysis and study of human brain behaviour can be very important in different health sector applications such as diagnosis for mental and Neuro-disorder diseases and abnormalities is a Novel Automatic Sleep Staging Features Analysis System using Machine Learning disclosed here. EEG signal recordings were used to study the activities of the human brain. The main purpose of EEG is to help physicians make accurate diagnoses of various disorders based on recorded behaviour of individuals, and to help sleep experts differentiate sleep irregularities and forecast epileptic seizures, among other things. Sleep-related problems, for example, are huge global concerns today because good sleep can determine the major balance between our physical and mental health, it directly affects human quality of life, and its repercussions mirror many other diseases in our bodies. As a result, sleep research can provide light on a variety of health risks and difficulties, including memory loss, diabetes, and cardiovascular disease. It is now more important to analyse potential signs of sleep difficulties, and a sleep staging score is required for practically all diseases.

Sleep scoring is a process that uses Polysomnography recordings from patients to identify anomalies that occurred during sleep hours. Polysomnography is a multi-parameter test that aids in the analysis and interpretation of diverse and concurrent activities that occur in the body during sleep by capturing various electrophysiological signals. Various physiological signals from various regions of the body were recorded during therapy. Electroencephalogram (EEG) recordings of brain behaviour, Electromyogram (EMG) recordings of chin, left, and right limb activities, Electroocoulogram (EOG) signal recordings of eye movement behaviour, and Electrocardiogram recordings of heart rhythm. All of these recordings and analyses were measured by sleep professionals using R&K rules, which are standard sleep guides. According to R&K regulations, there are three stages of sleep: waking (W), non-rapid eye movement (NREM), and rapid eye movement (REM) (REM). NREM sleep stages are further subdivided into N1-N4 sub-sleep stages. N1 and N2 are considered light sleep, whereas N3 and N4 are considered deep sleep. Each epoch is 30 seconds long, according to R&K standards. In addition, another sleep standard known as AASM was developed with slight revisions to the prior R&K recommendations. According to the American Academy of Sleep Medicine, sleep is divided into five stages. The total number of sleep stages is the only difference between AASM and R&K rule. The N-REM stages 3 and 4 are integrated into one stage called N-REM stage 3 in AASM; another sleep stage was the same under R&K rules.

The EEG signals are the most commonly employed electrophysiological signals in the treatment and diagnosis of suspected sleep-related illnesses because they directly offer information on brain processes during sleep. Another significant benefit of EEG data is that they may be used to identify individual sleep stages using waveforms such as alpha, theta, beta, delta, and gamma. The electrodes, which primarily measure the changes in voltage differential between the different neurons, were used to record brain behaviour from the scalp. The electrode placement was done in accordance with international 10-20 EEG electrode placement criteria. The 10-20 idea relates to the electrode location on the scalp, which is either 10% or 20% right-left or front-back. Nowadays, EEG signal is used in the sleep laboratory for monitoring sleep quality in a real-time environment, and it can also be used as a portable method in the house so that one may easily evaluate sleep quality at home. The waking stage is a peaceful state in which a subject might prepare himself or herself for sleeping. After a while,

the body enters N-REM stage 1 and from there, a sleep cycle begins; it is a transition period between wake and sleep. Theta waves are regularly produced by the brain, and the usual duration of this state is 5 to 15 minutes. N-REM stage 2 is a deeper state of sleep, in comparison to stage 1, in which the heart rate and body temperature decrease. During this period of sleep, sleep spindles and k-complexes have been seen.

In N-REM stage 3, deep sleep begins, and the brain behaves slowly. In N-REM stage 4, delta waves are produced by the brain during this period of sleep. Finally, during the REM stage of sleep, little brain waves are visible, blood pressure may rapidly rise, breathing may become erratic, and rapid eye movements may occur. This process repeats itself throughout the night, from the NREM to the REM stages, with each cycle lasting about 90 minutes. In most cases, one healthy sleep covers 3-5 sleep cycles for a subject. In general, EEG signal records are highly complex in nature, and the parameters of these signals fluctuate constantly in terms of amplitude, phase, and frequency. We must analyse the prolonged durations of the signal to extract relevant data from raw EEG signals. Another challenge noted in EEG recording is that it is often impossible to examine recorded hours of sleep data with 5-10s time windows. From many sleep research, it has been discovered that the multi-channel EEG technique has some drawbacks when it comes to evaluating irregularities caused by disruptions in the subject's health. As a result, most sleep researchers classified sleep stages using a single-channel EEG**.** Traditionally, technicians have manually analysed and interpreted sleep stages, which has a number of drawbacks, including the inability to manage a large number of sleep EEG records, the fact that it is a time-consuming and expensive procedure, and the fact that it is a human-dependent process. As a result, it has been necessary to create an automated sleep stage categorization system in order to improve classification accuracy.

There are some technologies developed many novel Automatic Sleep Staging Features Analysis System using Machine Learning allocating used to analyze the sleep staging features by machine learning algorithm. But the way of analyzing the sleep staging features is different than the invention disclosed herein. Some of the work listed in the prior art is as follows:

US10492720 - *System and method for determining sleep stage,* presents “Methods and apparatus monitor health by detection of sleep stage. For example, a sleep stage monitor may access sensor data signals related to bodily movement and respiration movements.

At least a portion of the detected signals may be analyzed to calculate respiration variability. The respiration variability may include variability of respiration rate or variability of respiration amplitude. A processor may then determine a sleep stage based on a combination bodily movement and respiration variability. The determination of sleep stages may distinguish between deep sleep and other stages of sleep, or may differentiate between deep sleep, light sleep and REM sleep. The bodily movement and respiration movement signals may be derived from one or more sensors, such as non-invasive sensor (e.g., a non-contact radio-frequency motion sensor or a pressure sensitive mattress)."

US20200093422 - *Sleep Stage Classification System,* states*"* A sleep stage classification system (330) is provided. A sleep stage analyzing is performed based on an output signal (100a) of a PPG sensor (100). An estimation unit (310) is adapted to estimate features associated to a respiratory effort of a user based on the output signal (100a) of the PPG sensor (100) and to output a respiratory effort feature signal. A respiratory effort determining unit (320) is adapted to determine to respiratory effort based on the respiratory effort feature signal from the estimation unit (310). A sleep stage classification unit (330) is adapted to classify a sleep stage of a user based on the determined respiratory effort from the respiratory effort determining unit (320) and to output a sleep stage classification signal (310)."

US9655559 - *Automated sleep staging using wearable sensors,* states "A method and system for automated sleep staging are disclosed. The method comprises determining at least one physiological signal during a predetermined time period, extracting at least one feature from the at least one physiological signal, and classifying the at least one feature using a machine learning classifier to output at least one sleep stage. The system includes a sensor to determine at least one physiological signal during a predetermined time period, a processor coupled to the sensor, and a memory device coupled to the processor, wherein the memory device includes an application that, when executed by the processor, causes the processor to extract at least one feature from the at least one physiological signal and to classify the at least one feature using a machine learning classifier unit to output at least one sleep stage."

Groupings of alternative elements or embodiments of the invention disclosed herein are not to be construed as limitations. Each group member can be referred to and claimed individually or in any combination with other members of the group or other elements

found herein. One or more members of a group can be included in, or deleted from, a group for reasons of convenience and/or patentability. When any such inclusion or deletion occurs, the specification is herein deemed to contain the group as modified thus fulfilling the written description of all related groups used in the appended claims.

The above information disclosed in this background section is only for enhancement of understanding of the background of the invention and therefore it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

SUMMARY OF INVENTION

The present invention, Referring to Figure 1, illustrates a Novel Automatic Sleep Staging Features Analysis System using Machine Learning comprising of: Human Brain (101), EEG Signal Acquisition (102), Channel Data Segmentation (103), Preprocessing (104), Feature Extraction (105), Automatic Feature Selection (106), Classification ELM-PSO (107), and Sleep Stages (108); used to analyze the sleep staging features by machine learning algorithms. A Novel Automatic Sleep Staging Features Analysis System using Machine Learning is invented here provides Automatic Sleep Staging Features Analysis by the Machine Learning Algorithms Based System for Sleep Disordered and Healthy Subjects for sample size of each subject same, was 750 epochs and the length of each epoch is the 30 seconds. Sleep Stages behavior of Affected Sleep Problem Subject-15, Subject-16, Subject-19, and Subject-23 with a 30 second epoch length is analyzed by the Machine Learning Algorithms Based System. Sleep Stages behavior of Healthy Subject-1, Subject-2, Subject-5, and Subject-8 with a 30 second epoch length is analyzed by the Machine Learning Algorithms Based System. Sleep Stages behavior of Affected Sleep Problem Subject and Healthy Subject are considered as two categories in the invention disclosed here in to Analyze Sleep Staging Features automatically by the Machine Learning Algorithms based System. The Sleep Stages behavior of Affected Sleep Problem and Healthy Subject contains five stages namely Wake (201), N-REM1 (Non-Rapid Eye Movement 1) (202), N-REM2 (Non-Rapid Eye Movement 2) (203), N-REM3 (Non-Rapid Eye Movement 3) (204), and REM (Rapid Eye Movement) (205). Each subject is having these five stages comes finally under three classes namely Wake (201), Non-Rapid Eye Movement, and Rapid Eye Movement. Totally twelve statistical features are

extracted, in different combinations of five, nine and twelve feature set combinations are also extracted to understand the performance of the disclosed system. From the Human Brain, EEG signals are acquired in two subjects called Sleep Stages behavior of affected subject and Healthy Sleep subject. These acquired signals may suffer from artifacts and noise and are removed by principal component analysis and Butterworth filter after C3-A2 Channel Data segmentation. The input EEG signals are segmented into 30 seconds (6000 sample points) in the invention disclosed here, a statistical approach to extract the twelve time-domain features to characterize the signal properties from each segment of the input records is considered. The ELM-PSO (107) is a Machine Learning Classification Algorithm that is used to classify the behaviour of afflicted and healthy sleep subjects. Extreme Learning Machine with PSO exhibits accuracy of 96.70 percent for Category-I subject, which is affected subject's Sleep Stages behaviour. Extreme Learning Machine with PSO scores 94.4 percent for Category-II subject, Healthy Sleep. For both Category-I subject and Category-II subject, Machine Learning Classification Algorithm such as Extreme Learning Machine with PSO performing better accuracy of well above 90% proves the ability of the present invention disclosed.

BRIEF DESCRIPTION OF SYSTEM

The accompanying drawings are integrated into and form part of this specification to enable a better understanding of the invention presented here. The drawing depicts exemplary embodiments of the present disclosure and, when read in conjunction with the description, helps to clarify the principles of the disclosure. The drawings are for illustration purposes only and are not intended to limit the scope of the present disclosure.

The present invention, Referring to Figure 1, illustrates a Novel Automatic Sleep Staging Features Analysis System using Machine Learning comprising of: Human Brain (101), EEG Signal Acquisition (102), Channel Data Segmentation (103), Preprocessing (104), Feature Extraction (105), Automatic Feature Selection (106), Classification ELM-PSO (107), and Sleep Stages (108); used to analyze the sleep staging features by machine learning algorithms, in accordance with main exemplary embodiment of the present disclosure.

In accordance with another exemplary embodiment of the present disclosure, Figure

2(a) depicts the Sleep Stages behaviour of Affected Sleep Problem Subject-15 with a 30 second epoch length.

In accordance with another exemplary embodiment of the present disclosure, Figure 2(b) depicts the Sleep Stages behaviour of Affected Sleep Problem Subject-16 with a 30 second epoch length.

In accordance with another exemplary embodiment of the present disclosure, Figure 2(c) depicts the Sleep Stages behaviour of Affected Sleep Problem Subject-19 with a 30 second epoch length.

In accordance with another exemplary embodiment of the present disclosure, Figure 2(d) depicts the Sleep Stages behaviour of Affected Sleep Problem Subject-23 with a 30 second epoch length.

In accordance with another exemplary embodiment of the present disclosure, Figure 3(a) depicts the Sleep Stages behavior of Healthy Subject-1 with a 30 second epoch length.

In accordance with another exemplary embodiment of the present disclosure, Figure 3(b) depicts the Sleep Stages behavior of Healthy Subject-2 with a 30 second epoch length.

In accordance with another exemplary embodiment of the present disclosure, Figure 3(c) depicts the Sleep Stages behavior of Healthy Subject-5 with a 30 second epoch length.

In accordance with another exemplary embodiment of the present disclosure, Figure 3(d) depicts the Sleep Stages behavior of Healthy Subject-8 with a 30 second epoch length.

DETAIL DESCRIPTION OF THE SYSTEM

The present invention herein is a Novel Automatic Sleep Staging Features Analysis System using Machine Learning is explored, a Novel Automatic Sleep Staging Features Analysis System using Machine Learning is provided in the following layout that explains the entire view of the implementation of the invention that is used to analyze the sleep staging features by machine learning algorithms. The innovation will become more well-known as a result of the following complete description, and objects other

than those described below will become evident. The appended drawings are used in this description. The invention will become more well-known as a result of the following detailed description, and objects other than those described above will become evident. This description pertains to the drawings that go with the invention.

The present invention, Referring to Figure 1, illustrates a Novel Automatic Sleep Staging Features Analysis System using Machine Learning comprising of: Human Brain (101), EEG Signal Acquisition (102), Channel Data Segmentation (103), Preprocessing (104), Feature Extraction (105), Automatic Feature Selection (106), Classification ELM-PSO (107), and Sleep Stages (108); used to analyze the sleep staging features by machine learning algorithms, in accordance with main exemplary embodiment of the present disclosure. The Human Brain (101) is a complex organ that regulates all human actions, including sleep, as evidenced by electroencephalogram recordings (EEG). The method of acquiring Electroencephalogram (EEG) data from the human brain is known as EEG Signal Acquisition (102). The dataset for the invention reported here are the EEG signals recorded here. EG signals are recorded and classified into different subjects for Category-I subject, which is Sleep Stages behaviour of affected subject, and Category-II subject, which is Healthy Sleep subject, as follows: Subject-15, Subject-16, Subject-19, and Subject-23 for Category-I subject, and Subject-1, Subject-2, Subject-5, and Subject-8 for Category-II subject. C3-A2 Channel Data Segmentation (103) is the Channel Data Segmentation utilized here. Table 1 and Table 2 show the C3-A2 Channel Data Segmentation of a dataset with two categories and five sleep stages. The EEG signals are divided into 30-second segments (6000 sample points). Preprocessing (104) is used to remove various forms of artefacts and noise from EEG signals acquired from participants during sleep hours. The general form of recorded signals is

$$R_s=E_s+N_s \qquad \text{Equation (1)}$$

Where E_s represents the original EEG signal and Ns represent the noise signal. The Extraction (105) use a statistical methodology to extract multiple time-domain features from each segment of the input records in order to characterize signal qualities. Mean, Variance, Maximum, Minimum, Range, Median, Mode, Standard deviation, Zero crossing, rate, Skewness, Kurtosis, and Third Quartile are the statistical properties. In the process of classification, the innovation given here uses three different trials based on three separate sets of feature vectors from all 12 features, with the results from two sets being evaluated with the best weightage. There are nine and five features,

respectively. The ReliefF feature selection method is used in the Automatic Feature Selection (106) to screen the important features that directly aid in the recognition of abnormal sleep patterns during sleep. One of the supervised features weighting selection algorithms is ReliefF. It analyses and analyses the efficiency of features that are most useful for distinguishing between distinct stages. The ability to deal with unknown and redundant data is a major benefit of this method. ReliefF is a feature selection algorithm that helps to systematically filter the sleep characteristics by screening the top five and nine features. The five-set features are shown to be the most effective in detecting sleep disturbances in both categories of subjects. ELM-PSO (107) is a Machine Learning Classification Algorithm that is used to classify the behaviour of afflicted and healthy sleep subjects. Extreme Learning Machine with PSO exhibits accuracy of 96.70 percent for Category-I subject, which is affected subject's Sleep Stages behaviour. Extreme Learning Machine with PSO scores 94.4 percent for Category-II subject, Healthy Sleep. For both Category-I subject and Category-II subject, Machine Learning Classification Algorithm such as Extreme Learning Machine with PSO performing better accuracy of well above 90% proves the ability of the present invention disclosed.

The experimental Data considered in the invention disclosed here is from two subjects as duplicated in the Table 1 and Table 2.

TABLE 1

Experimental Data Information: Sleep Disorder Affected Subject

Sleep Stages	**Number of Segments**
Wake	847
N1 Stage	446
N2 Stage	881
N3 Stage	434
REM	392

TABLE 2

Experimental Data Information: Healthy Controlled Subject

Sleep Stages	**Number of Segments**

Wake	648
N1 Stage	349
N2 Stage	942
N3 Stage	674
REM	387

The analysis is made manually to classify the sleep staging features in the inventions disclosed previously. Now the invention disclosed here is Novel Automated Machine Learning Algorithms Based System for Sleep Staging Features Analysis provides automatic analysis for the two categories of the Sleep Subjects. The invention described here incorporates data from two separate subgroups of the ISRUC-Sleep dataset: four participants from ISRUC-Sleep subgroup-I, in which the subjects were affected by various sleep difficulties, and four subjects from ISRUC-Sleep subgroup-III, in which the subjects were perfectly healthy. We collected 8 polysomnography (4 participants) in this study. Subjects with 1PSG +4. records (1 PSG Equals 8 PSGs) Tables 1 and 2 showed the distinct sleep stages epochs from sleep disturbed participants and healthy controls, respectively. Six EEG channels, two EOG channels, and three EMG channels were all recorded from participants over the course of a single night. The collected signal recordings were made using a 10-20 international standard electrode placement method and a sampling rate of 200 Hz. The main goal of this study was to analyze sleep irregularities that occurred during sleep using proper sleep stages classifications with the input of single-channel, C3-A2 EEG signals. The C3-A2 channel was chosen in most recent sleep studies, and several studies achieved higher classification accuracies using the C3-A2 channel input.

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CLAIMS

We claim:

1. A Novel Automatic Sleep Staging Features Analysis System using Machine Learning comprising of: Human Brain (101), EEG Signal Acquisition (102), Channel Data Segmentation (103), Preprocessing (104), Feature Extraction (105), Automatic Feature Selection (106), Classification (107), and Sleep Stages (108); used to analyze the sleep staging features by machine learning algorithms.

2. A Novel Automatic Sleep Staging Features Analysis System using Machine Learning as claimed in claim 1, wherein C3-A2 Channel Data Segmentation (103) is the Channel Data Segmentation utilized here, C3-A2 Channel Data Segmentation of a dataset with two categories and five sleep stages. The EEG signals are divided into 30-second segments (6000 sample points).

3. A Novel Automatic Sleep Staging Features Analysis System using Machine Learning as claimed in claim 1, wherein Preprocessing (104) is used to remove various forms of artefacts and noise from EEG signals acquired from participants during sleep hours.

4. A Novel Automatic Sleep Staging Features Analysis System using Machine Learning as claimed in claim 1, wherein the Extraction (105) uses a statistical methodology to extract multiple time-domain features from each segment of the input records in order to characterize signal qualities. Mean, Variance, Maximum, Minimum, Range, Median, Mode, Standard deviation, Zero crossing, rate, Skewness, Kurtosis, and Third Quartile are the statistical properties.

5. A Novel Automatic Sleep Staging Features Analysis System using Machine Learning as claimed in claim 1, wherein the ReliefF feature selection method is used in the Automatic Feature Selection (106) to screen the important features that directly aid in the recognition of abnormal sleep patterns during sleep.

6. A Novel Automatic Sleep Staging Features Analysis System using Machine Learning as claimed in claim 1, wherein ELM-PSO (107) is a Machine Learning Classification Algorithm that is used to classify the behaviour of afflicted and healthy sleep subjects. Extreme Learning Machine with PSO exhibits accuracy of

96.70 percent for Category-I subject, which is affected subject's Sleep Stages behaviour.

7. A Novel Automatic Sleep Staging Features Analysis System using Machine Learning as claimed in claim 1, wherein the Extreme Learning Machine with PSO scores 94.4 percent for Category-II subject, Healthy Sleep. For both Category-I subject and Category-II subject, Machine Learning Classification Algorithm such as Extreme Learning Machine with PSO performing better accuracy of well above 90% proves the ability of the present invention disclosed.

Dated this 11th day of June, 2021

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A NOVEL AUTOMATIC SLEEP STAGING FEATURES ANALYSIS SYSTEM USING MACHINE LEARNING

ABSTRACT

People are suffering from a variety of sleep disorders as a result of the increased speed of social activities, quick changes in lifestyles, and increased strain in professional sectors. Many sleep-related disorders are observed to be indicators of Neurological Disorders in later age, which have an impact on quality of life in everyday activities. Analysis and Classification of Sleep Scoring are critical steps in diagnosing these illnesses. For clinicians, monitoring the participants' complete sleep lengths and analyzing sleep staging in traditional and manual lab environments is a very time-consuming task. We considered the Novel Automated Machine Learning Algorithms Based System for Sleep Staging for reliable diagnosis of various Sleep Disorders. Characteristics Analysis is utilized for the automated analysis of sleep epochs gathered from subjects while they were sleeping. The present invention disclosed herein is a Novel Automatic Sleep Staging Features Analysis System using Machine Learning comprising of: Human Brain (101), EEG Signal Acquisition (102), Channel Data Segmentation (103), Preprocessing (104), Feature Extraction (105), Automatic Feature Selection (106), Classification (107), and Sleep Stages (108); used to analyze the sleep staging features by machine learning algorithms. The present invention uses Extreme Learning Machine with Particle Swarm Optimization (ELM-PSO) for automatic features selection and classification. The present invention is tested by Sleep Disordered and Healthy Subjects for sample size of each subject same, was 750 epochs and the length of each epoch is the 30s.

Dated this 11th day of June, 2021

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FORM 5

THE PATENT ACT, 1970

(39 OF 1970) &
The Patent Rules, 2003

DECLARATION AS TO INVENTORSHIP

[See sections 10(6) and Rule 13(6)]

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10	Dr.Gouse Baig Mohammad	Indian	Associate Professor, Department of CSE, Vardhaman College of Engineering, Hyderabad, Telangana, India. Pin Code:501218	India	Telangana

I/We Mr.Santhoshkumar M, Dr.Jarabala Ranga, Dr.L.Thomas Robinson, Dr.Anvesh Thatikinda, Dr.Gogula Santhosh Reddy, Mr.V N S L Narayana A, Dr.Sushma Jaiswal, Mr.Tarun Jaiswal, Dr.A.V.Sudhakara Reddy, Dr.Gouse Baig Mohammad., hereby declare that the true and first inventor(s) of the invention disclosed in the complete specification filed in pursuance of my/our application numbered…….dated is/are:

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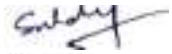
10	Dr.Gouse Baig Mohammad	Indian	Associate Professor, Department of CSE, Vardhaman College of Engineering, Hyderabad, Telangana, India. Pin Code:501218	India	Telangana

Dated this…11th day of June, 2021

Name of the Signatory	Signature:-
Mr.Santhoshkumar M	
Dr.Jarabala Ranga	
Dr.L.Thomas Robinson	
Dr.Anvesh Thatikinda	
Dr.Gogula Santhosh Reddy	
Mr.V N S L Narayana A	
Dr.Sushma Jaiswal	
Mr.Tarun Jaiswal	
Dr.A.V.Sudhakara Reddy	
Dr.Gouse Baig Mohammad	

3. DECLARATION TO BE GIVEN WHEN THE APPLICATION IN INDIA IS FILED BY THE APPLICANT (S) IN THE CONVENTION COUNTRY:-

~~We the applicant(s) in the convention country hereby declare that our right to apply for a patent in India is by way of assignment from the true and first inventor(s).~~

~~Dated this ……day of 2020~~

~~Signature:~~

~~Name of Signatory:~~

4. STATEMENT ~~(to be signed by the additional inventor(s) not mentioned in the application form)~~

~~I/we assent to invention referred to in the above declaration, being included in the complete specification filed in pursuance of the stated application.~~

~~Dated this ……day of 2020~~

~~Signature of the additional inventor (s)~~

~~Name :~~

To

The Controller of Patents

The Patent office at CHENNAI