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Message from the Technical Program Chairs

Welcome to the proceedings of the INDICON 2021. It is the flagship international conference of the IEEE India Council organized by IEEE Kolkata Section and hosted at Indian Institute of Technology, Guwahati during 19th -21st December, 2021.

In INDICON 2021, we have received 690 paper submissions from twenty countries. The EDAS Conference Management system was used for paper submission and review. The topical diversity of the submissions was noteworthy. The 44 Tack Chairs in 12 different tracks and 566 members of the Technical Program Committee along with a team of external reviewers worked hard during the review process under a strict timeline. While most of the paper had 4 to 5 reviews, there was at least 3 reviews for each paper. At the end of the review process 261 papers were selected for inclusion in the proceedings and presentation in the conference. The final technical program presents a slice of cutting edge R&D in 12 specified tracks.

I sincerely thank all the authors for their interest in INDICON 2021 and all Program Committee members and external reviewers for their commitment in spite of the tight schedule and a high review load. I would also like to thank all the Track Chairs, Session Chairs, Keynote and Invited Speakers and members of the Organizing Committee and all who help continuously for successfully organizing the INDICON 2021. We hope that you will find the INDICON 2021 proceedings to be technically rewarding.

Wishing all of you and your family members a healthy and prosperous new year.

Ujjwal Maulik
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An improved multi-IRS aided MISO system using multivariate analysis	Gyana Ranjan Mati; Susmita Das; Tapesh Swami
Enhancement of Precision on Cloud Data using Multi-Layered Bloom Filter	D V N. Siva Kumar; Saptarsi Saha
Spectrum Auction Mechanism Based on Concurrent Bidding for Channel Allocation in Ad Hoc CRNs	Monisha Devi; Nityananda Sarma; Sanjib K. Deka
Distributed DBA Scheme for Fog Node Equipped LR-EPON Based FiWi Network	Ateet Gupta; Vinod Chandra; Subhajit Mukherjee; Aneek Adhya
Bilateral Access Control with Traceability and Revocability in Secure Cloud-Fog Computing Framework	Vishnu Kalgi; Priyanka Parimi; Rashmi Ranjan Rout
Fuzzy Logic based Task Scheduling Algorithm in Vehicular Fog Computing Framework	Krishnanand Rai; Satish Vemireddy; Rashmi Ranjan Rout
Adaptive Replacement Cache with Quality of Service for Delay Sensitive Applications in Named Data Networking	Prajjwal Singh; Nityananda Sarma
Level Crossing Rate and Average Fade Duration of RIS-Assisted RF Communication System	Amina Girdher; Ankur Bansal; Ankit Dubey

Track: Computational biology and biomedical informatics

Multi-Class Classification on Chest X-Ray Images Using Convolution Neural Network	Bipal Khanal; Astha Singh; Sourav Paul; Ranjita Das
Improvement in ECG R-peak detection compared to conventional methods using LSTM	Soubarna Chowdhury; Chaity Sarkar; Aparajita Sengupta
Classification of Seizure Types Based on Statistical Variants and Machine Learning	Anand Shankar; Samarendra Dandapat; Shovan Barma
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Osteosarcoma Classification using Multilevel Feature Fusion and Ensembles	Bhuma Chandra Mohan
RecU-Net++: Improved Utilization of Receptive Fields in U-Net++ for Skin Lesion Segmentation	Rukhshanda Hussain; Hritam Basak

IMPROVEMENT IN ECG R-PEAK DETECTION COMPARED TO CONVENTIONAL METHODS USING LSTM

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Abstract: In this work, a modern R peak detection technique from Electrocardiograms (ECGs) based on the Long Short-Term Memory (LSTM) network is developed and compared with two existing R peak detection techniques: one using Pan Tompkins algorithm and the other based on Discrete Wavelet Transforms. The features of these three techniques are discussed and their performances have been compared with the help of certain performance indices.

The LSTM based detection technique appears to be more robust than the two existing algorithms and it is seen that this technique triumphs over other algorithms, having a significant edge in the case of noisy ECG signals.

Keywords: Pan Tompkins algorithm, Long Short Term Memory (LSTM) network, Machine Learning, Discrete Wavelet Transform, Wrapper function, Sensitivity, Positive predictability, Accuracy.

I. INTRODUCTION

Detecting R peaks or QRS-complexes from Electrocardiograms (ECGs) is of prime importance as it is the basis for heart rate determination and diagnosis of various heart abnormalities such as atrial premature contraction, tachycardia, bradycardia, etc.

An ECG signal can contain various types of noises, a few of them being the baseline wander, powerline interference, electromagnetic (EMG) noise and muscle artefacts. In the present study, these observations have been considered to be the effect of noise present in the ECG signals. These noises can cause various irregularities in the ECG signal such as:

- Shifting the ECG signal from its base line
- Causing a considerable amount of high amplitude negative peaks
- Causing amplification of ECG signals in the region between the actual R peaks, resulting in erroneous R peak detection.
- Causing some high frequency pseudo-peaks between two actual R peaks

Various methods have been proposed over the years for R-peak detection. Thungton et. al, in [1], mentions two important stages, i.e., pre-processing and thresholding involved in ECG R-peak detection and shows that wavelet transform is an efficient method for removing noise in pre-processing stage. Goodfellow et al., in [2], suggest that the DWT algorithm can be used to eliminate the noise and other stray frequencies, thus leaving behind and amplifying only the QRS region frequencies, helping to detect the R-peaks. Jiapu Pan and Willis J. Tompkins in their revolutionary paper [3] proposed the Pan Tompkins algorithm of R peak detection which involves bandpass filtering, digital analysis of slope, amplitude and thresholding. All these previous works mention the conventional noise filtering steps, before the actual detection of R-peaks while Juho Laitala et al. in their paper [4] suggested a method of detecting R-peaks without actually filtering out the noise, which is an improvement over the conventional ECG R-peak detection techniques. Thresholding methods [2,3,4,5,6] have gained the maximum popularity for R peak detection.

Among the various R-peak detection algorithms developed in the past years, Pan-Tompkins algorithm [3,5] is the most well-known and has served as the basis for development of other algorithms. The algorithm using Discrete Wavelet Transform (DWT) is relatively new and is also a popular algorithm for R-peak detection. Both of these algorithms can be broken down into two main steps:

- Signal processing to enhance the actual ECG signal and to eliminate any noise mixed with the actual ECG signal. This may include steps like applying filters [2,3], squaring of amplitude [3,5] etc.
- Amplitude threshold based peak decision making [2,3,5].

However, the existing algorithms are not robust enough to noises and artifacts. Pan-Tompkins and DWT algorithms work well when the ECG signal quality is not poor. As more and more disturbances enter into the ECG waveforms, the efficiency of filtering these disturbances (noise) by these algorithms is reduced, which might result in erroneous detection of R-peaks.

The present work is motivated by the low efficiency of existing algorithms in case of such irregular ECGs. This calls for more robust ECG R-peak detection algorithms. In this paper, a modern LSTM based R peak detection algorithm has been examined, which is robust against the effects of noises listed above. To the best of the knowledge of the authors, no work is reported which clearly compares various methods for R peak detection.

The paper is organized as follows: Section II contains the Preliminaries on ECG and LSTM. Section III describes the various algorithms of R-peak detection. Section IV contains the datasets and softwares used for implementation of this work. Section V mentions the various parameters used for comparing the LSTM and conventional algorithms, Section

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