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A Review on Smart Chair Sitting Posture Recognition System

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ABSTRACT: Sitting posture recognition can be used to evaluate the awareness of a person carrying out a task, such as working, and can aid in avoiding other health risks. To prevent the damage from dangerous sitting postures, an area sitting posture recognition system is desired with low power consumption and low computing overhead. The system ought to conjointly give sensible user experience with accuracy and privacy. This paper reports a unique posture recognition system on office chair which will categorise seven completely different health-related sitting postures. The system uses force sensors, Analog to Digital Converter (ADC) board and a Machine Learning formula of a two-layer Artificial Neural Network (ANN) enforced on Arduino Atmega 2560 r3. The system achieves 97.78% accuracy with a floating-point evaluation and 97.43% accuracy with the 9-bit fixed-point implementation. The ADC management logic and therefore the ANN are constructed with a most propagation delay of 8.714ns. The dynamic power consumption is 7.35mW once the sampling rate is 5 Sample/second with the clock frequency of 5MHz.

KEYWORD: Smart Chair, Sitting Posture Recognition, Force Sensors, Artificial Neural Network, Real-time Machine Learning.

I. INTRODUCTION

Sitting with an unhealthy sitting posture for a long time seriously harms human health and may even lead to lumbar disease, cervical disease and may cause musculoskeletal disorders such as back pain with deteriorating lung function, low back pain or injury, pains in muscle and connective tissues of tendons, increasing spine load, changing cervical spine position, neck pain, pressure ulcers and shoulder pain. The current sitting posture recognition systems planned in the literature will be classified by the sensing element sorts. Pressure sensors are used for the recognition of sitting posture recognition. This aggravates the process complexity and hardware re-source overhead, which is sometimes related to a shortened battery life. The classifier is running on the computer that can't be merely incorporated into the chair. A hard-ware friendly sitting detection resolution was according in which applies 4x4 force-sensitive resistor (FSR) sensors and the process formula is enforced on a microcontroller (MCU). However, it solely detects whether or not somebody is sitting on the chair it, however, cannot classify different sitting postures to address the same issues, a unique sensible chair solution in terms of sensing and process for sitting posture recognition is planned. The most contribution of this work is to introduce force sensors with a machine learning formula to build a low-complexity hardware system for sitting posture recognition.

II. LITERATURE REVIEW

N.B. Gaikwad(2019) proposed an **Efficient FPGA implementation of multilayer perceptron for real-time human activity classification**. The smartphone-based human action recognition (HAR) systems don't seem to be capable to deliver high-end performance for difficult applications. Here tend to propose an avid hardware-based HAR system for sensible military wearables, that uses a multilayer perceptron (MLP) formula to perform activity classification. To realize the versatile and economical hardware style, the inherent MLP design with parallel computation is enforced on FPGA. The system performance has been evaluated victimisation the UCI human activity dataset with 7767 feature



samples of twenty subjects. The 3 mixtures of a dataset are trained, validated, and tested on 10 different MLP models with distinct topologies. The MLP style with the 7-6-5 topology is finalized from the classification accuracy and cross-entropy performance. The 5 versions of the ultimate MLP style (7-6-5) with totally different knowledge exactness are enforced on FPGA. The analysis shows that the MLP designed with 16-bit fixed-point knowledge exactness is the most effective MLP implementation in the context of classification accuracy, resource utilization, and power consumption. The projected MLP design needs solely 270ns for classification and consumes 120mW of power. The popularity accuracy and hardware results performance achieved are higher than several of the recently according to works.

X.Tang(2018) proposed a **Real-Time QRS Detection System With PR/RT Interval and ST Segment Measurements for Wearable ECG Sensors Using Parallel Delta Modulators**. Objective of this paper is to presents a period EKG(ECG) observance system for wearable devices. The system is predicated on the projected parallel delta modulator design with native maximum purpose and native minimum purpose algorithms to sight QRS and PT waves. Therefore, of victimization the projected system and algorithm, period PR and RT intervals, and ST section measurements are often achieved in long-run wearable graph recording. The algorithmic rule is tested with the MIT-BIH heart disease information for QRS complicated detection and with the QT information for the P and T wave detections. The simulation result shows that the algorithm achieves on top of ninety nine, 91%, and ninety-eight accuracy within the QRS complex, P wave, and T wave detections, severally. Experimental results square measure conferred from the system image, within which the parallel delta modulator circuits square measure unreal in IBM 0.13 μm standard CMOS technology and therefore the algorithms square measure enforced in a Xilinx Spartan-6 field-programmable gate array (FPGA). The parallel delta modulators consume 720 compass points at a one-kilo cycle rate with a ± 0.6 V power offer. The projected system has the potential to be applied in the future long-run wearable graph recording devices.

P.Patel & B.B.B. Patel(2017) proposed a **Human body posture recognition – A survey**. Human posture recognition is gaining increasing attention within the field of computer vision because of its promising applications within the areas of non-public health care, environmental awareness, human-computer-interaction and surveillance systems. With the event of image process and a computer vision techniques, it's doable to analyze human behavior automatically by of the recognition the posture of frame, which has become the one among most important analysis topic in each computer-based on intelligent video closed-circuit television and pattern recognition space. Paper surveys the utilization of frame posture mechanism for interaction with the computers, describing numerous techniques for playacting correct recognition. During this paper different section of frame, posture discuss. Also, embrace the various techniques for every phase of the system.

M.Cornacchia(2017) proposed a **Survey on human activity recognition Using wearable sensors**. Providing correct and opportune data on people's activities and behaviors is one among the foremost vital tasks in pervasive computing. Infinite applications are often unreal, as an example, in medical, security, recreation, and military science situations. Despite human action recognition (HAR) being a vigorous field for over a decade, there are still key aspects that, if self-addressed, would represent a big flip within the manner folks move with mobile devices. This paper surveys the state of the art in HAR supported wearable sensors. A general design is 1st given beside an outline of the most elements of any HAR system. Here tend to conjointly propose a two-level taxonomy in accordance to the educational approach (either supervised or semi-supervised) and therefore the interval (either offline or online). Then, the principal problems and challenges are mentioned, further of the main solutions to every one among them. Twenty-eight systems are qualitatively evaluated in terms of recognition performance, energy consumption, conspicuousness, and suppleness, among others. Finally, tend to gift some open issues and ideas that, because of their high connexion, ought to be self-addressed in future analysis.

N.Y. Hammerla(2016) proposed a **Deep Convolutional And Recurrent Models For Human Activity Recognition Using Wearable's**. Human activity recognition (HAR) in ubiquitous computing is kicking off to adopt of deep learning to substitute for well-established analysis techniques that settle for hand-crafted feature extraction and classification techniques. From these isolated applications of custom deep architectures, it's, however, powerful to comprehend an overview of their suitability for problems ranging from the recognition of clever gestures to the segmentation and



identification of physical activities like running or ascending stairs. Throughout this paper, tend to strictly explore deep, convolutional, and continual approaches across three representative data sets that contain movement knowledge captured with wearable sensors. Here tend to explain the thanks to training continual approaches throughout this setting, introduce a novel regularization approach, and illustrate however they trounce the progressive on an outside benchmark dataset. Across thousands of recognition experiments with indiscriminately sampled model configurations, tend to research the suitability of each model for varied tasks in HAR, explore the impact of hyperparameters exploitation on the analysis of variance framework, and provide pointers for the professional World Health Organization wishes to use deep learning in their disadvantage setting.

Y.Chen & Y.Xue(2016) proposed a **Deep learning approach to human activity recognition based on Single Accelerometer**. In this paper, tend to propose associate degree acceleration-based human action recognition technique victimization in style deep design, Convolution Neural Network (CNN). Particularly, construct a CNN model and modify the convolution kernel to adapt to the characteristics of tri-axial acceleration signals. Also, for comparison, tend to use some widely used ways to accomplish the popularity task on identical datasets. The big dataset tend to consists of 31688 samples from eight typical activities. The experiment results show that the CNN works well, which may reach a mean accuracy of 93.8% with no feature extraction ways.

F. Attal(2015) proposed a **Physical human activity recognition using wearable sensors**. Human activity recognition contains a wide selection of applications like remote patient observance, rehabilitation and the aiding disable. Physical activity reduces the chance of many chronic diseases and is think about as a key factor for a healthy life. To enhance the state of worldwide tending, numerous devices have been enable that enables doctors to perform remote observance and increase users' motivation and awareness. Real-time activity recognition systems encourage users to adopt healthier life vogue by increasing personal awareness regarding physical activities and its positive consequences on health. In this paper ,a machine learning-based mostly technique is planned to boost the accuracy of activity recognition system victimization feature choice technique on associate degree acceptable set of statistically derived options. A public out there HAR dataset on physical activities has been employed in this work. A linear forward choice method is utilized for feature choice.

K. Batterretxea(2014) proposed a **Wearable human activity recognition system on a chip activity recognition system on a chip**. The availability of low-cost wearable motion and biometric sensors has favoured the analysis on wearable human action recognition (HAR) systems. However, a HAR system comprehends several complicated signal process stages that sometimes need some computationally exigent operations which may hardly be directly performed in associate embedded system. Trendy FPGA technologies and also the system-on-chip (SOC) the approach opens the door to the implementation of complicated single-chip signal process systems to supply small, wearable and autonomous embedded HAR systems. However, compared to a pure embedded package approach, the doubtless higher performance-to-power quantitative relation of FPGAs will solely be exploited in terribly exigent applications and by a careful style of the enforced system. During this work, tend to describe a primary step within the consecution of associate FPGA-based utterly autonomous single-chip HAR system which may be custom-made and optimized to the user with no want of external computing means that neither of human intervention. The system includes all stages during a HAR method, i.e., signal segmentation, the signal process for feature extraction, input area spatiality reduction (feature selection), and activity estimation by means that of a neural classifier. A physical activity recognition example is employed as a reference style to judge the performance of the system and to draw conclusions on the potential advantages of victimization FPGAs in future wearable HAR applications.

F. Banreki(2013) proposed a **Gas sensors characterization and multilayer perceptron (MLP) hardware implementation for gas identification using a field programmable gate array (FPGA)**. This paper develops a primitive gas recognition system for discriminating between industrial gas species. The system beneath the instigation consists of an array of eight micro-hotplate-based SnO₂ skinny film gas sensors with completely different property patterns. The output signals area unit is processed through an indication acquisition and analyzing system. These signals feed a decision-making classifier, that is obtained via a Field Programmable Gate Array (FPGA) with terribly High-Speed microcircuit Hardware Description Language. The classifier depends on a multilayer neural network



supported by a backpropagation algorithmic rule with one hidden layer of 4 neurons and eight neurons at the input and 5 neurons at the output. The neural network designed when implementation consists of twenty thousand gates. The achieved experimental results appear to point out the effectiveness of the projected classifier, which may discriminate between five industrial gases.

C.Qian(2013) proposed a **Low power configurable neural recording system for epileptic seizure detection**. This paper describes a low-power configurable neural sound system capable of capturing and digitizing each neural action-potential (AP) and fast-ripple (FR) signals. It demonstrates the practicality of convulsion detection through metal recording. This technique options a fixed-gain, variable-bandwidth (BW) front-end circuit and a sigma-delta ADC with climbable information measure and power consumption. The ADC employs a 2nd-order single-bit sigma-delta modulator (SDM) followed by a low-power devastation filter. Direct impulse-response implementation of a sinc three filter associated 8-cycle knowledge pipelining in an IIR filter area unit planned for the devastation filter style to boost the facility and space potency. In measurements, the side exhibits 39.6-dB DC gain, 0.8Hz to 5.2 rate of war, 5.86- μ Vrms input-referred noise, and 2.4- μ W power consumption in AP mode, whereas showing 38.5-dB DC gain, 250 to 486 cycle per second of war, 2.48- μ Vrms noise, and 4.5- μ w power consumption in FR mode. The noise efficiency factor (NEF) is 2.93 and 7.6 for the AP and FR modes, respectively. At 77-dB dynamic range (DR), the ADC encompasses a peak SNR and SNDR of 75.9dB and 67dB, severally, whereas overwhelming 2.75-mW power in AP mode. It achieves 78-dB DR, 76.2-dB peak SNR, 73.2-dB peak SNDR, and 588- μ W power consumption in FR mode. Both analogue and digital power supply voltages are 2.8 V. The chip is fabricated in a very normal 0.6- μ m CMOS method. The die size is 11.25 mm².

F. Rincn(2011) proposed **Development and evaluation of multilead wavelet-based ECG delineation algorithms for embedded wireless sensor nodes**. This work is dedicated to the analysis of multi-lead digital wave rework (DWT)-based EKG (ECG) wave delineation algorithms, that were optimized and ported to a poster wearable detector platform. A lot of specifically, we tend to investigate the utilization of root-mean-square (RMS)-based multi-lead followed by a single-lead online delineation rule, that relies on a progressive offline single-lead delineator. The recursive and software system optimizations necessary to change embedded cardiogram delineation, even so, the restricted process and storage resources of the target platform are delineated, and therefore the performance of the ensuing implementations are analyzed in terms of delineation accuracy, execution time, and memory usage. Curiously, RMS-based multi-lead delineation is shown to perform equivalently to the most effective single-lead delineation for the 2-lead QT info (QTDB), among a fraction of a sample length of the Common Standards for diagnostic technique (CSE) committee tolerances. Finally, a comprehensive analysis of the energy consumption entailed by the thought-about algorithms is projected, that permits relevant insights into the dominant energy-draining functionalities and that suggests appropriate style pointers for durable wearable cardiogram observation systems.

C.Lin(2010) proposed **P- and T-Wave delineation in ECG signals using a Bayesian approach and a partially collapsed Gibbs sampler**. Detection and delineation of P- and T-waves are vital problems within the analysis and interpretation of cardiogram (ECG) signals. This paper addresses this downside by mistreatment Bayesian reasoning to represent a prior relationship among graphical record wave elements. Supported by the recently introduced part folded Gibbs sampler principle, the wave delineation and estimation are conducted at the same time by employing a Bayesian rule combined with a Markov process town technique. This technique exploits the sturdy native dependency of graphical record signals. The planned strategy is evaluated on the annotated QT info and compared to different classical algorithms. A crucial feature of this paper is that it permits not just for the detection of P-wave and T- peaks and limits, however conjointly for the correct estimation of waveforms for every analysis window. This may be helpful for a few graphical record analyses that need wave morphology data.

III. CONCLUSION

This paper present a smart chair sitting posture recognition system using force sensors and Arduino Atmega 2560 r3 implemented artificial neural network. Force sensors are used for the recognition of sitting postures. Sensors are deployed on the top of the seat, the backrest, and the armrests on an office chair. We were focusing on creating a



practical smart system for sitting posture detection in the office. Our primary goal is to design a system, which could be easy to implement in any office space where the person does not have to use the same chair every day. The sensors are under the lining, so they are not visible to the user. This can result in spinal pain and related problems. Therefore, a means to remind people about their sitting habits and provide recommendations to counterbalance, such as physical exercise, is important. Posture recognition for seated postures have not received enough attention as most works focus on standing postures

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