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Editorial

Emerging Electronics Technologies and Solutions for Eco-Friendly Cities

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Introduction

The development of electronic solutions and their application to smart cities are an inevitability. On the other hand, the growing population is forcing us find new, more effective solutions. According to the preliminary model forecasts, population growth is expected to stop at the end of this century (source: Pew Research Centre (https://www.pewresearch.org/fact-tank/2019/06/17/worlds-population-is-projected-to-nearly-stop-growing-by-the-end-of-the-century/ (accessed on 9 October 2020))). The increasing demand for power, water supply and waste management, pedestrian safety, the efficient use of electric vehicles, traffic jams and long commutes, the identification of road users and travel path predictions, and rising air and noise pollution levels are the most pressing issues in today's cities. The place we live in has a huge impact on our lives. Advanced planning is a feature of green development which reduces our dependence on vehicles that produce greenhouse gas emissions. The development of eco-friendly cities includes the development and application of new efficient solutions and technologies for transport management, emission control and pollution control, energy efficiency and the usage of renewable energy, and resource efficiency, etc. These solutions would ensure a better quality of life for the growing population.

This Special Issue in *Electronics* reports on some of the recent research efforts on this important topic. The eleven papers in this issue cover various aspects of emerging electronics technologies and solutions for eco-friendly cities.

The authors of [1] propose a method for predicting the bucket fill factor of a loader based on the three-dimensional information of the material surface. Firstly, a co-simulation model of loader shovelling material was established by using the multi-body dynamics software RecurDyn and the discrete element method software (DEMS) EDEM, and the co-simulation was conducted under different excavation trajectories. Then, before the shovel excavation, three-dimensional material surface information was obtained from DEMS, and the surface function of the material contour was fitted based on the corresponding shovel excavation trajectory information. Meanwhile, they obtained the volume of the material excavated by the loader by employing the numerical integration method, and it was divided by the rated bucket volume to obtain the estimated bucket fill factor. Finally, the actual volume of the material after the shovel excavation was divided by the rated bucket volume to obtain the accurate bucket fill factor. Thus, the prediction model of the bucket fill factor was built. The experimental results show that the proposed method is feasible, with a maximum error of 4.3%, a root mean square error of 0.025, and an average absolute error of 0.021.

In [2], simple mathematical model of a seismocardiogram (SCG) was developed, and three algorithms were created to explain the processes and behaviours of the model in detail. Using this algorithm, the processing program can be written in several programming languages, not only in MATLAB. This seismocardiogram model can be used to obtain the

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optimal parameters (fifth-order delay before adaptive filter, 892 filter order) for adaptive filters that can perform real cardio-mechanical vibration signal processing in order to estimate the AO peaks. As a result, the heart rate was calculated. However, filter orders 200 and 50 were evaluated again, and so the process was faster for both of the filters; the duration periods decreased from 1.20 to 1.09 and from 1.19 to 1.11 s, respectively. In each case, the signal processing and the necessary calculations were performed using MATLAB programs.

In [3], the authors analysed the excavator system's energy flow under a typical working condition load. In operation conditions, the output energy of the engine only accounts for 50.21% of the engine's fuel energy, and the actuation and the swing system account for 9.33% and 4% of it, respectively. In transportation conditions, the output energy of the engine only accounts for 49.80% of the engine's fuel energy, and the torque converter efficiency loss and excavator driving energy account for 15.09% and 17.98% of it, respectively. The research results show that the energy flow analysis method based on a typical working condition load can accurately obtain each excavator component's energy margin, which provides a basis for designing energy-saving schemes and control strategies.

The authors of [4] present a performance analysis of the overall ergodic outage probability of the optimal RS scheme for a low-power energy harvesting (LPEH) wireless sensor network (WSN). Since the simulations correlate with the theory, each relay was equipped with a battery that consisted of an on/off (1/0) decision scheme, according to the Markov property. In this context, an optimal loop interference relay selection was proposed and investigated. Moreover, the log-normal distribution method is crucial for characterizing the LPEH WSN's constraints. The system's performance was evaluated analytically and numerically in terms of the overall ergodic outage probability (OP) with the Monte Carlo simulation. The system had the lowest overall ergodic OP, thus, it performed the best, with an energy harvesting switch time of 0.175. Following the increase in the signal-to-noise ratio (SNR), the system without a direct link performed the worst. Furthermore, the system performed better as more relays were deployed. Finally, more than 80% of the data can be obtained under the household condition, without the need for additional bandwidth and power supply.

To improve the sound source identification performance in low-SNR cabin environments, the authors of [5] introduce cross-spectral matrix (CSM) reconstruction methods such as diagonal reconstruction (DRec), robust principal component analysis (RPCA), and probabilistic factor analysis (PFA), which have been widely studied in planar arrays, into spherical arrays-based functional delay and sum (FDAS). Three enhancement methods, namely EFDAS-DRec, EFDAS-RPCA, and EFDAS-PFA, were established. The main conclusions obtained through the simulations and experiments are as follows: (1) EFDAS can significantly improve the sound source identification performance of FDAS under low SNRs, which effectively suppress the sidelobe contamination, shrink the mainlobe contamination, and maintain the strong localization capability for weak sources. (2) Compared with FDAS at SNR = 0 dB and when the number of snapshots = 1000, the average MSLs of EFDAS-DRec, EFDAS-RPCA, and EFDAS-PFA were reduced by 6.4 dB, 21.6 dB, and 53.1 dB, respectively, and the mainlobes of the sound sources shrunk by 43.5%, 69.0%, and 80.0%, respectively. (3) The three EFDAS methods improved the quantification accuracy of FDAS when there was a large number of snapshots.

The authors of [6] applied cardiac biosignals, an excited accelerometer, and a gyroscope for the prevention of accidents on the road. This paper adopts the seismocardiogram hypothesis which involves using measurements from a seismocardiogram to identify the drivers' heart problems and safely stop the vehicle before they enter into a critical condition by informing the relevant departments in a nonclinical manner. The proposed system works without an electrocardiogram, and it detects heart rhythms more easily. The estimation of the heart rate (HR) is calculated through automatically detected aortic valve opening (AO) peaks. The system is composed of two micro-electromechanical systems (MEMSs) which evaluate the physiological parameters and eliminate the effects of external interference

on the entire system. A few digital filtering methods are discussed and benchmarked to increase the seismocardiogram efficiency. As a result, the fourth adaptive filter obtains the estimated HR = 65 beats per min (bmp) in a still noisy signal (SNR = −11.32 dB). In contrast with the low processing benefit (3.39 dB), 27 AO peaks were detected with a 917.56 ms peak interval mean over 1.11 s, and the calculated root mean square error (RMSE) was 0.1942 m/s^2 when the adaptive filter order was 50 and the adaptation step was equal to 0.933.

In [7], the paper investigates the rescheduling strategy and algorithm for DDBFSP, in which machine breakdown events are categorised as disruptions in manufacturing sites. Firstly, the mathematical model of DDBFSP, including the event simulation mechanism, was constructed. The makespan and stability as the objectives were considered. The goal of the paper was to achieve two objectives. An "event-driven" policy in response to the disruption was applied. A two-stage "predictive-reactive" rescheduling strategy was proposed. In the first stage, a static environment, a distributed blocking flowshop scheduling problem (DBFSP) without machine breakdown, was considered, and the global initial schedules were generated, while in the second stage, after the machine breakdown occurs, the initial schedule is locally optimized by a hybrid repair policy based on "right-shift repair + local reorder", and the discrete memetic algorithm (DMA) reordering algorithm based on differential evolution was proposed for the local reorder operation. To test the effectiveness of the DMA, comparisons with mainstream algorithms were conducted on different scales. The statistical results show that the ARPDs obtained from DMA were improved by 88%.

In [8], a method of coal thickness prediction using VMD and LSTM is presented. Firstly, empirical mode decomposition (EMD) and VMD methods were used to denoise simple signals, and the denoising effect of the VMD method was verified. Then, the wedge-shaped coal thickness model was constructed, and the seismic forward modelling and analysis were carried out. The results show that coal thickness predictions based on seismic attributes are feasible. On the basis of the VMD denoising of the original 3D seismic data, VMD-LSTM was used to predict the coal thickness. The data were compared with the prediction results of a traditional BP neural network. The coal thickness prediction method proposed in this paper has high accuracy and coincides with the coal seam information about existing boreholes. The minimum absolute error of the predicted coal thickness is 0.08 m, and the maximum absolute error is 0.48 m. This indicates that VMD-LSTM has high accuracy in predicting coal thickness.

In [9], the authors present a mobile sensor node for monitoring air and noise pollution, and the developed system was installed on an remote control drone, which could quickly monitor large areas. It relies on a Raspberry Pi Zero W board and a wide set of sensors (i.e., NO2, CO, NH3, CO2, VOCs, PM2.5, and PM10) to sample the environmental parameter at regular time intervals. A proper classification algorithm was developed to quantify the traffic level from the noise level acquired by the onboard microphone. Additionally, the drone is equipped with a camera, and it implements a visual recognition algorithm (Fast R-CNN) to detect waste fires and mark them using a GPS receiver. Furthermore, firmware for managing the sensing unit operation was developed, as well as the power supply section. In particular, the node's consumption was analysed in two use cases, and the battery capacity needed to power the designed device was determined. The on-field tests demonstrated the proper operation of the developed monitoring system. Finally, a cloud application was developed to remotely monitor the information acquired by the sensor-based drone and upload them to a remote database.

In [10], a beacon-based hybrid routing protocol was designed to adapt to the new forms of intelligent warfare, accelerate the application of unmanned vehicles in the military field, and solve problems such as high maintenance costs, path failures, and repeated routing pathfinding in large-scale unmanned vehicle network communications in new battlefields. This protocol used the periodic broadcast pulses initiated by the beacon nodes to provide synchronization and routing to the network and established a spanning tree,

which the nodes used to communicate with each other. An NS3 platform was used to build a dynamic simulation environment with service data to evaluate the network performance. The results showed that when it was used in a range of 5~35 communication links, the beacon-based routing protocol's PDR was approximately 10% higher than that of AODV routing protocol. At 5~50 communication links, the result was approximately 20% higher than the DSDV routing protocol.

The authors of [11] aimed to explore a more ecological and sustainable solution to the problems of cities around the world. Particularly, this paper presents a conceptual design of the main sterilization chamber for infectious waste. The Design Thinking (DT) method was used, since it has a user-centred approach which allows for the co-design and inclusion of the target population. This study demonstrates the possibility of obtaining feasible results based on the user's needs through the application of DT as a framework for engineering designs.

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References

1. Wang, S.; Yu, S.; Hou, L.; Wu, B.; Wu, Y. Prediction of Bucket Fill Factor of Loader Based on Three-Dimensional Information of Material Surface. *Electronics* **2022**, *11*, 2841. [CrossRef]
2. Uskovas, G.; Valinevicius, A.; Zilys, M.; Navikas, D.; Frivaldsky, M.; Prauzek, M.; Konecny, J.; Andriukaitis, D. A Novel Seismocardiogram Mathematical Model for Simplified Adjustment of Adaptive Filter. *Electronics* **2022**, *11*, 2444. [CrossRef]
3. Su, D.; Hou, L.; Wang, S.; Bu, X.; Xia, X. Energy Flow Analysis of Excavator System Based on Typical Working Condition Load. *Electronics* **2022**, *11*, 1987. [CrossRef]
4. Nguyen, H.-S.; Sevcik, L.; Van, H.-P. Performance Analysis on Low-Power Energy Harvesting Wireless Sensors Eco-Friendly Networks with a Novel Relay Selection Scheme. *Electronics* **2022**, *11*, 1978. [CrossRef]
5. Zhao, Y.; Chu, Z.; Li, L. Performance Enhancement of Functional Delay and Sum Beamforming for Spherical Microphone Arrays. *Electronics* **2022**, *11*, 1132. [CrossRef]
6. Uskovas, G.; Valinevicius, A.; Zilys, M.; Navikas, D.; Frivaldsky, M.; Prauzek, M.; Konecny, J.; Andriukaitis, D. Driver Cardiovascular Disease Detection Using Seismocardiogram. *Electronics* **2022**, *11*, 484. [CrossRef]
7. Zhang, X.; Han, Y.; Królczyk, G.; Rydel, M.; Stanislawski, R.; Li, Z. Rescheduling of Distributed Manufacturing System with Machine Breakdowns. *Electronics* **2022**, *11*, 249. [CrossRef]
8. Huang, Y.; Yan, L.; Cheng, Y.; Qi, X.; Li, Z. Coal Thickness Prediction Method Based on VMD and LSTM. *Electronics* **2022**, *11*, 232. [CrossRef]
9. De Fazio, R.; Dinoi, L.M.; De Vittorio, M.; Visconti, P. A Sensor-Based Drone for Pollutants Detection in Eco-Friendly Cities: Hardware Design and Data Analysis Application. *Electronics* **2022**, *11*, 52. [CrossRef]
10. Mu, W.; Li, G.; Ma, Y.; Wang, R.; Li, Y.; Li, Z. Beacon-Based Hybrid Routing Protocol for Large-Scale Unmanned Vehicle Ad Hoc Network. *Electronics* **2021**, *10*, 3129. [CrossRef]
11. Castiblanco Jimenez, I.A.; Mauro, S.; Napoli, D.; Marcolin, F.; Vezzetti, E.; Rojas Torres, M.C.; Specchia, S.; Moos, S. Design Thinking as a Framework for the Design of a Sustainable Waste Sterilization System: The Case of Piedmont Region, Italy. *Electronics* **2021**, *10*, 2665. [CrossRef]