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Introductory notes for the Acta IMEKO second issue in 2024

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Dear Readers,

The second issue of Acta IMEKO is online. It includes the first edition of the special issue on metrology for archaeology and cultural heritage managed by Prof. Fabio Leccese. This Special Issue collects the extended version of some of the contributions presented at the 2023 IMEKO International Conference on Metrology for Archaeology and Cultural Heritage, held in Rome (Italy) from the 19th to the 21st of October 2023. It includes also further papers of the thematic issue on measurement for veterinary and animal science managed by Prof. Leopoldo Angrisani, Prof. Gianluca Neglia and myself [1]-[5]. As usual some papers not belonging to a thematic or special issue are published in the general track and as EiC it is my pleasure to give you an overview of them.

The study in [1] highlights the management of the hive superorganism. Precision beekeeping is today a growing sector, used as apiary management strategy, based on the constant monitoring of families, minimization of consumption of resources and maximizing of productivity. Thanks to the scales and a probe placed inside each hive, Authors obtained data relating to winter 2021 and spring 2022, where they had flowerings 30 days in advance of the seasonality. The fluctuation of temperatures entailed the early start of laying of the queen with fresh brood to feed and heat, even when temperatures dropped drastically, having to draw on pollen and honey stocks massively. The role of the beekeeper becomes crucial, to avoid compromising the annual production and to help the survival of the colony. To know the situation inside the hive without opening it and administering an adequate nutrient supply at the right time is not always easy, and the death of beehives due to hunger is typical of the spring period. Climate changes are increasingly affecting the survival of bees and remote monitoring of beehives is becoming increasingly important to ensure their survival and productivity.

ClassyFarm is a new IT system of the Italian Ministry of Health for the risk categorization of livestock farms in relation to four areas: animal welfare, biosecurity, antimicrobial usage and antimicrobial resistance. Within ClassyFarm, on-farm welfare measurement is carried out using protocols based on both resource-based indicators and animal-based indicators. The aim of the study in [2] was to develop a welfare measurement protocol for the apiary. Sixteen Italian beekeeping experts were involved into a focus group to discuss a list of resource-based and animal-based indicators, previously selected by the authors by means of a review of the scientific literature, in order to identify effective and significant welfare indicators to be collected in the field. Despite the difficulties encountered related to the nature of honey bees and the lack of scientific knowledge about their welfare, 12 resource-based and 7 animal-based indicators were identified as potentially able to screen the welfare of honey bee colonies in the apiary. This study represents the first step towards the future extension of the ClassyFarm system to the apiary.

Free usable space in broiler farms has a substantial impact on the welfare and health of the chickens. In [3] Author use a computer vision algorithm to estimate free usable space in this kind of farms. This method uses a real-time camera that collects images from the farms and an image processing algorithm based on a U-Net architecture, which estimates the free usable space available. The results of the method are compared with manual labels, and it is shown that the method is accurate and efficient in estimating the free usable space.

The presence of microplastics in the forage and feedstuffs of domestic animals represents an imminent threat to the entire food chain that may reach humans since the particles could be transferred into the intestinal barriers and contaminate blood and animal products. Until now, there is no simple, rapid, sustainable, and reliable method to detect microplastics in animal feed. The objective of the study presented in [4] was to investigate the ability of near-infrared spectroscopy (NIRS) to detect microplastics in ruminant feeds. Two types of instruments were tested using four feeds (corn silage, mixed hay, rye grass silage, soybean meal) and a total mixed ration. Two types of crumbled

contaminants, low-density polyethylene and polystyrene, were accurately mixed at ratios of 0, 1, 3, and 5 mg g^{-1}. The pool of the five matrices examined by the benchmark instrument (714-3333 nm) yielded an accuracy of approximately 0.8 mg g^{-1} and a detection limit of about 1 mg g^{-1}, however, the errors could be halved in separate calibrations. A short wavelength range (714-1070 nm) or a smart NIRS instrument proved an acceptable discrimination of the concentrations. Following these preliminary results, any validation on other samples with different and powerful NIRS tools is encouraged.

Rearing conditions can affect fish morphology, physiology, and welfare in several manners, for instance given the different hydrodynamic conditions or stocking densities. In [5] a preliminary study is presented aimed to evaluate non-invasive tools to understand if and how the farming system can influence external shape, skin pigmentation, and freshness evolution during refrigerated storage of European sea bass and gilthead sea bream. A total of 100 individuals (50 sea bass and 50 sea bream) were obtained from a fish farm (located in Piombino, Italy) equipped with floating cages and inland tanks. Fishes were photographed in lateral aspect to analyse shape, while skin colour was analysed with a colorimeter. Freshness and *Rigor Index* were observed during 7 days of refrigerated storage. Results showed that shape and colour analyses can be useful tools to discriminate fish farmed under different conditions, *i.e.*, marine sea cages and inland tanks. Moreover, farming conditions significantly affected *rigor* resolution and fish freshness, especially in European sea bass.

The paper in [6] deals with a new monitoring of the structural health of the Roman Bridge of S. Angelo. It is located along the road that connected Capua to Reggio Calabria (Via ab Regio ad Capuam), and it constitutes an important remain of Roman engineering works and is the best-preserved bridge along the road itself. The monitoring is carried out as part of a series of initiatives aimed at gaining in-depth knowledge and safeguarding a series of historic buildings in the same area. A new type of sensor, characterized by features not offered at the same time by those currently on the market, has been developed to aid structural and environmental monitoring. Previous surveys had been carried out with geomatic techniques; one of the products of these surveys is a 3D model of the bridge, used as input to carry out a Finite Element Modeling (FEM) analysis. The results of this FEM analysis will be compared with those obtained by the measurements carried out with the new sensor. The monitoring campaign, which has just begun, and the expected results are described and commented on. The main results obtained to date are the model of the bridge, a structural analysis and the settlements that have occurred over time as well as the creation of the new sensor.

Combining the information from the registered source images is the process involved in the image-fusion. In [7], two fusion rules are explored. The first one is based on the weightage-based rule. The second one is the Smoothness and weightage-based algorithm. Smoothness is used to reduce the noise from the source images. These two methods are independent of the selection of the transform. In this work, Discrete Wavelet Transform is considered to perform the experimentation. The recital comparison was made between multiresolution transforms using maximum selection method, weightage method, and smoothness along with weightage. The source images are generally multi-focused, satellite, panchromatic, and clinical medical images. The experimental results show that more smoothened (in addition with weightage) images (including edges and curves) provide high visual information. The advantage of this approach is proven using the performance metrics such as PSNR, NCC, MI, ESOP, and FSIM. The blocking artifacts are reduced by decomposing the transforms and the high frequency noise in the source image is smoothened by proposed approaches.

Recently, there has been an increase in concerns about the accessibility, security, and reliability of aviation engines. To prevent engine failures which can be quite serious, it is important to take effective measures. The objective of the paper presented in [8] is to create a deep learning simulation that can accurately predict an aircraft engine's viability and remaining usefulness using meta-heuristic techniques to improve its performance. These techniques discover the optimal hyper parameters and architecture for the deep learning model. This will help minimize downtime and maintenance costs for the aircraft fleet by handling complex data such as sensor readings and past maintenance records while also adapting to changing conditions over time. Since training deep learning models can be computationally intensive, meta-heuristic methods increase their robustness. The aim is to enhance performance by increasing the accuracy rate and reducing mean squared losses of multiple deep learning methods used for predicting aircraft engine maintenance by hybridizing them with metaheuristic algorithms.

Food products are prone to microbial contamination able to affect their safety and quality attributes and their nutritional value. The interest in the potential use of bioactive compounds deriving from natural matrices, especially agro-industrial wastes, as alternatives to classical food preservatives has rapidly increased. In [9] a food grade olive mill wastewater polyphenolic extract and a commercial mix were characterised and their antioxidant and antimicrobial capacity were assessed. The antimicrobial activity was preliminary assessed *in vitro* by agar well diffusion, subsequently by microdilution method to define the minimum inhibitory and bactericidal concentration. The olive mill wastewater polyphenolic extract registered a higher antioxidant capacity and antimicrobial efficacy compared to commercial mix with wide potential application in food industry.

Sound quality analysis and sound design are well-known human-centered strategies to evaluate the subjective perception of noise and to design machines and environments with pleasant and comfortable acoustic signatures. The subjective acoustic perception is conventionally measured by means of sound quality metrics determined through a correlation process with jury test results. The exploitation of electroencephalogram (EEG) measurements during the jury test for the registration of the brain activity in response to the acoustic stimuli presented to the jurors can allow us to estimate the jurors' perception directly from their physiological response. The study in [10] presents results from the application of an EEG wearable device to investigate changes in the EEG frequency domain at different acoustic stimuli. Forty-three participants were recruited, and the EEG signals were recorded using the wearable sensor. The analysis of power spectral densities (PSDs) was performed by Authors to investigate features correlated to acoustic sensation induced by audio stimuli. Statistically significant differences were found between three audio stimuli. The results bring to the conclusion that wearable sensors could be used for EEG acquisition applied to acoustic perception evaluation.

Accurately simulating and operating photovoltaic (PV) modules is vital for thoroughly analyzing their performance under different conditions. The main focus of the paper in [11] is to address the inherent nonlinearity in solar PV systems. To achieve this, the particle swarm clustered optimization (PSCO) is applied to extract parameters of solar modules, allowing for a more

comprehensive understanding of their behaviour. PSCO aims to enhance the accuracy and effectiveness of PV module analysis. For that, PSCO utilizes clusters within the particle population, enabling localized communication and information sharing. By doing so, it effectively facilitates efficient exploration and exploitation of diverse regions, fostering a comprehensive understanding of the behaviour of PV modules under different conditions. Through this approach, PSCO maximizes the accuracy and effectiveness of parameter extraction, contributing to advancements in PV system analysis and performance evaluation. The effectiveness of PSCO is demonstrated in extracting parameters for the three-diode model (TDM) of the STP6-120/36 and Photowatt-PWP201 PV modules. PSCO surpasses state-of-the-art algorithms with significantly low root mean square error (RMSE) values showcasing its superior accuracy.

Microplastics have become a significant concern for the well-being of marine ecosystems. Small fragments of plastic debris are released into the environment from both the direct disposal of plastic products and the deterioration of larger items. Ingestion of microplastics by marine life can result in detrimental effects, including physical harm and the accumulation of toxic chemicals in their tissues. The aim of the research presented in [12] is to design a compact and cost-effective measurement system for effectively detecting and quantifying microplastics in marine environments. The proposed system uses a 2.4-inch liquid-crystal display (LCD) panel and a digital USB microscope, both of which are connected to a single-board computer, with a dedicated python-based graphical user interface (GUI). Specifically, the light transmitted through plastic and organic samples was measured in order to identify and classify them. Various types of materials, such as polypropylene, polyvinyl chloride, polycarbonate, polyethylene, and organic algae samples, were tested and the metrological performance of the system has been estimated. The transmittance of the samples analyzed was primarily influenced by their opacity and thickness. In general, thicker materials exhibited significantly lower transmittance values. This trend was particularly evident in organic components and opaque plastic samples, where transmittance was significantly low. In addition, the experimental results suggest that the colour of the material also affects transmittance, although as a secondary factor. The employed technique could be used to identify and distinguish samples based on material properties, thereby allowing the proposed system to be a valuable tool for further research on microplastics in marine environments.

It worth to highlight that also the papers in this issue would promote the fulfilment of the United Nations UnGoal (https://sdgs.un.org/goals) and the preservation or our cultural heritage.

I hope you will enjoy your reading.

Francesco Lamonaca
Editor in Chief

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