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Millie Pant · Tarun K. Sharma · Om Prakash Verma · Rajesh Singla · Afzal Sikander *Editors*

Soft Computing: Theories and Applications

Proceedings of SoCTA 2018

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Preface

It is a matter of pride to introduce the third international conference in the series of "Soft Computing: Theories and Applications (SoCTA)," which is technically sponsored by MIR Labs, USA, and partially funded by TEQIP-III and CSIR New Delhi, India, in association with Springer and Inderscience and joint effort of researchers from IIT Roorkee and other prestigious research and academic institutes including DRDO, New Delhi, and Amity University, Rajasthan. The objective of this international conference was to provide opportunities for the researchers, academicians, industry persons, and students to interact and exchange ideas and experience and gain expertise in the current trends and strategies for core and allied fields of Soft Computing.

This conference took place in the historic city of Jalandhar at the campus of research-driven Institute of National Importance, Dr. B. R. Ambedkar National Institute of Technology, Jalandhar, organized by Department of Instrumentation and Control Engineering. The conference stimulated discussions on various emerging trends, innovation, practices, and applications in the field of Soft Computing.

This book that we wish to bring forth with great pleasure is an encapsulation of 132 research papers, presented during the three-day international conference. We hope that the initiative will be found informative and interesting to those who are keen to learn on technologies that address the challenges of the exponentially growing information in the core and allied fields of Soft Computing. We are thankful to the authors of the research papers for their valuable contribution to the conference and for bringing forth significant research and literature across the field of Soft Computing. The editors also express their sincere gratitude to SoCTA 2018 Patron Prof. L. K. Awasthi, Director, Dr. B. R. Ambedkar National Institute of Technology Jalandhar; Plenary Speakers Prof. Ajith Abraham, Director, MIR Labs, USA; Keynote Speakers: Prof. Swagtam Das, ISI Kolkata, and Dr. Hossain Zolfagharinia, Ryerson University, Canada; Programme Committee Members; International Advisory Committee; Reviewers and Local Organizing Committee; and Sponsors without whose support the support and quality of the conference could not be maintained.

We would like to express our sincere gratitude to Prof. Yogesh Singh, Vice-Chancellor, Delhi Technical University, for gracing the occasion as the Chief Guest for the Inaugural Session and delivering a plenary talk. We would like to express our sincere gratitude to Prof. Shailendra Kumar Jain, Director, Sant Longowal Institute of Engineering and Technology, Longowal (SLIET), as Guest of Honor for the Inaugural Session. We would like to extend our heartfelt gratitude to Dr. Hossain Zolfagharinia, Ryerson University, Canada, for gracing the occasion as the Chief Guest for the Valedictory Session.

We express our special thanks to Prof. Ajith Abraham, Director, MIR Labs, USA, for being a General Chair and finding time to come to NIT Jalandhar amid his very busy schedule. We are also grateful to Prof. Millie Pant and Dr. Gaurav Manik, IIT Roorkee, for their benign cooperation and support. A special mention of thanks is due to our student volunteers for the spirit and enthusiasm they had shown throughout the event. We express special thanks to Mr. Aninda Bose, Senior Editor, Interdisciplinary and Applied Sciences, Springer, New Delhi, and Springer team for the valuable support in the publication of the proceedings. With great fervor, we wish to bring together researchers and practitioners in the field of Soft Computing year after year to explore new avenues in the field.

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He has over 10 years of teaching and research experience in the diverse fields of Control Engineering. His areas of interest include control theory and applications, circuit design, model order reduction, optimization, and robotics. He is actively involved in various research and consultancy projects. He has published more than 25 research papers in reputed national and international journals and conferences.

A Low Cost Charcoal Film Based Moisture Sensor: Fabrication and Computing

Subham Mishra, Sourabh Verma, Somendra Prasad, Sushanta S. Bordoloi, Rupam Goswami, Kanjalochan Jena, Vikas Kumar Jha and K. Parvathi

Abstract This paper reports the fabrication and system design of a low cost charcoal based moisture sensor of dimension 1 cm × 1 cm × 260 µm. Seven different samples were prepared and calibrated for 25 µL of water. The sensitivities are reported for the different samples. It has been discovered that the final node voltage (post-exposure to moisture) depends on the initial node voltage linearly when the experimental data points are fitted. A ratio in the range 1.16–1.27 is obtained while calibrating for the presence of 25 µL of moisture.

Keywords Moisture sensor · Charcoal · Film · Sensitivity · Humidity

1 Introduction

Sensor technology has recently gathered wide interests due to its applicability to different domains ranging from soil analyses, humidity detectors to biomedical utilities and experiments. Different sensors have been proposed over time for multiple applications with wide range of sensitivities and accuracies depending upon the requirements. Chemical reactions, photoluminescence and impedance based sensors are a few of the methods being used for sensing. Of them, sensing moisture has been given the most important due to their universal applications. Thin film sensors using novel materials, the most widely used being ZnO, graphene oxide and carbon films, have been proposed and studied, and their sensitivities have been attributed to

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the material properties, morphological properties of the films and associated characteristics [1–6]. Use of quantum dots and alumina have also been presented and demonstrated for sensing humidity [7–9]. Researchers have commented on the different methods of deposition of moisture or humidity sensors [1, 10]. Apart from soil analyses, the moisture sensor has found an important application in dermatology (skin moisture) [11]. Ceramic material based sensors are another class of material engineered devices of which most are based on resistive-type sensing [12].

This paper presents a moisture sensor based on charcoal thin films. Wood charcoal in its raw form is inexpensive, easily available and possesses properties to sense moisture. Utilization of this sensing property of charcoal can be exploited to build cost-effective and robust sensors for moisture detection. The objectives of this paper are to report the fabrication of a moisture sensor using raw untreated charcoal, calibration of the detection of moisture on the sensor and definition of threshold parameters with respect to the sensor.

The second section of this paper describes the fabrication method for the deposition of charcoal thin films. The third section mentions the experimental set-up and the methods of measurement employed. The fourth section discusses the method of calibration and discusses the results. The fifth section concludes the paper.

2 Fabrication

Wood charcoal briquettes were collected from the hearth of a kitchen. The objective was to evaluate the sensing capacity of raw and untreated charcoal in order to keep the entire system economical. The charcoal briquettes were crushed to fine powder in a mechanical grinder. Thereafter, 0.496 g of charcoal powder was mixed thoroughly with 2.13 g of commercial acrylic paste as a binding material. Masks of 1 cm × 1 cm were developed using insulating tapes of thickness 130 μm on a paper substrate laid out on a cardboard. Aluminium contacts were laid out on both ends to have a two-terminal design. The mixture was deposited using Doctor's blade method. The deposited film was allowed to dry in an enclosed container at room temperature for 30 min. The dimension of the deposited film was 1 cm × 1 cm × 260 μm. The steps of fabrication are shown in Fig. 1.

3 Experimental Set-Up and Methodology

This section describes the experimental circuit for the sensors and the methodology adopted for economical detection.

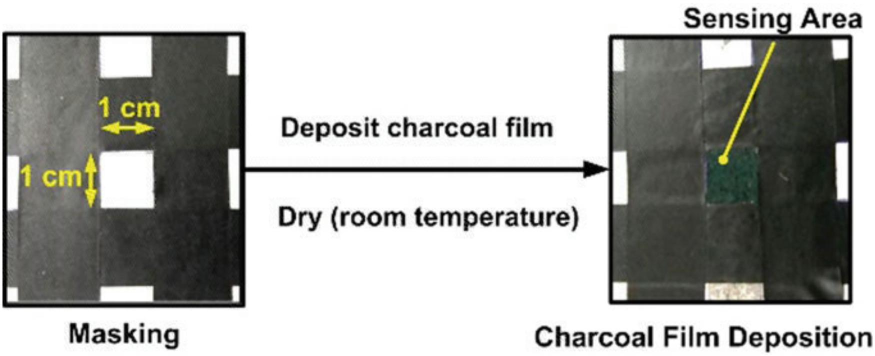

Fig. 1 Steps of fabricating a charcoal thin film

3.1 Experimental Set-Up

The experimental circuit used for the calibration of the moisture sensors is shown in Fig. 2. The circuit consists of two charcoal film deposited samples in connected in series configuration, one available for sensing (referred to as 'sensing sample' in the entire content of the paper) and the other as a resistance (referred to as 'resistive sample' in the entire content of the paper) which is kept fixed for the entire experiment. The entire series is connected to a DC supply of 5 V across it, with one contact of the sensing sample connected to 5 V, and one contact of the resistive sample connected to ground. The voltage is read at the node A in Fig. 2.

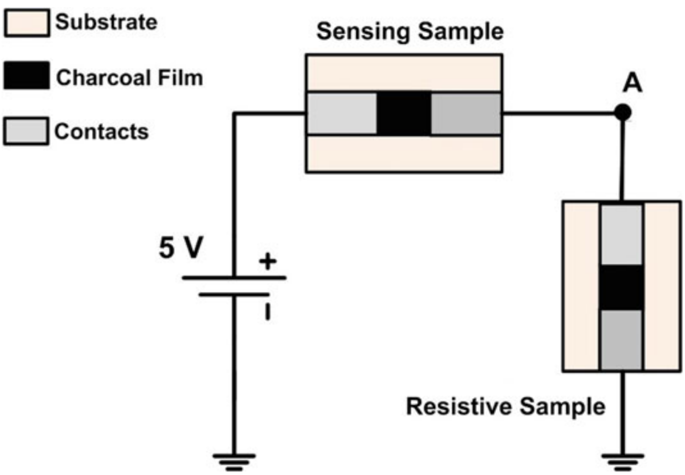

Fig. 2 Experimental circuit for the calibration of moisture sensor

3.2 Methodology

We define a sensitivity parameter which is the ratio of the voltage at node A in Fig. 2 before exposing the sensing sample to moisture to the value after it is exposed to moisture expressed through Eq. (1). The system is tested for 25 μL of water for seven samples prepared through the fabrication steps mentioned in Sect. 2.

$$\text{Sensitivity} = \left.\frac{V_{A,\text{moisture}}}{V_{A,\text{initial}}}\right|_{\text{room temperature}} \tag{1}$$

The potential divider circuit of Fig. 2 helps to sense the change in the resistance of the sample. As the sensing sample senses moisture, its resistance drops, resulting in a change in the voltage drop across it. In order to maintain the potential balance, an equivalent voltage drop must appear across the resistive sample. The node A gives the voltage across the resistive sample. This arrangement of obtaining the voltage at node A is reliable because the resistive sample remains fixed throughout the experiment. We have used a microcontroller (ATMEGA 328P) circuit to bias the circuit and read the voltages at node A.

4 Results and Discussion

The results of the experiment performed on seven samples are listed in Table 1. The initial and final voltages are plotted for each sample in Fig. 3. It is observed that the plot of final voltage follows a similar trend as that of the plot of initial voltage. This ensures predictability of the final value based on the initial value of the sample. This predictability is expressed in Fig. 4 where the final voltage has a linear dependence on the initial voltage, achieved through linear fitting of the experimental data. The linear fit which can be expressed as:

Table 1 Details of sensitivities of sensing samples

Sample no.	Initial voltage ($V_{A,\text{initial}}$)	Final voltage ($V_{A,\text{moisture}}$)	Sensitivity
1	2.84	3.32	1.17
2	2.86	3.4	1.19
3	2.32	2.9	1.25
4	2.41	3.05	1.27
5	3.13	3.64	1.16
6	2.63	3.25	1.24
7	2.86	3.33	1.16

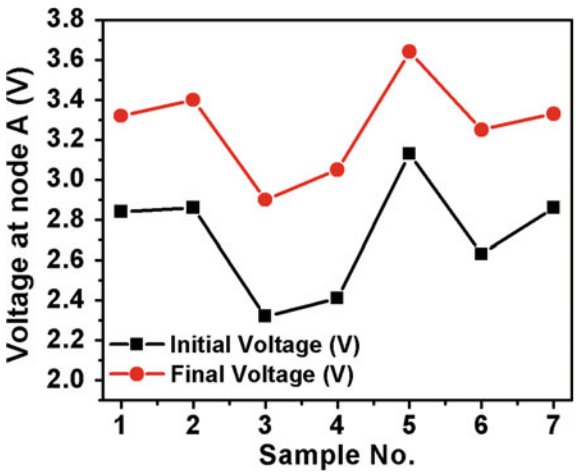

Fig. 3 Initial and final voltage values measured at node A of Fig. 2 for the seven sensing samples

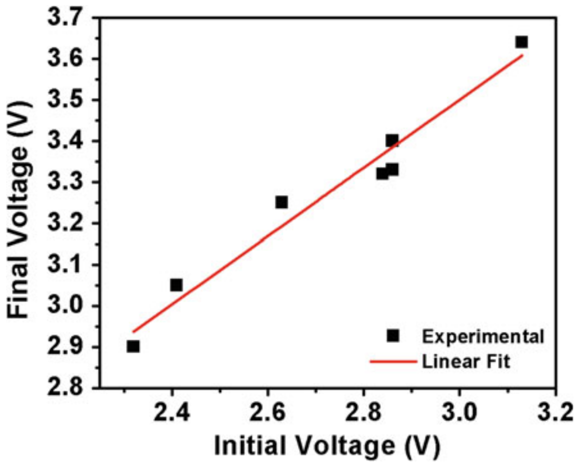

Fig. 4 Plot of final voltage versus initial voltage, showing a linear fit of the experimental data points

$$\text{Final Voltage} = A + (B \times \text{Initial Voltage}) \tag{2}$$

has fitting constants $A = 1.01673$ and $B = 0.82797$.

5 Conclusion

This paper proposes a moisture sensor using raw untreated wood charcoal and discusses the preliminary results for different samples fabricated with same dimensions. It has been discovered that for same volume of 25 μL of water on all the samples, the results are excellent with respect to the predictability of sensitivity. The range of sensitivities derived is 1.16–1.27 for the different samples. As a part of future work, the objectives are to reduce the range of sensitivity by experimenting with different post-treatments of the sample. The samples must be tested for obtaining the appropriate fitting of the curves for the higher volume of moisture exposed to them. The sensor may be applied to solutions as well.

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Analysis of SMAW Parameters Using Self Organizing Maps and Probability Density Distributions

Vikas Kumar, Manoj Kumar Parida and S. K. Albert

Abstract Shielded Metal Arc Welding (SMAW) is one of the most important welding process used in the industry for joining ferrous and nonferrous metals. In an arc welding process random variations in current and voltage takes place. Reliable acquisition of these variations during actual welding process and its subsequent analysis can be very useful to various parameters of the arc welding process. Now a day, the welding power sources have a provision of advance arc control to suitably adjust the welding parameters with minimum time delay and to set the right welding parameters during actual process. Hence, to study the exact behaviour of these modern power sources used for welding it is essential to acquire all the possible minute variations taking place while welding is in progress. In the present study, the effect of varying input current and welding power sources on SMAW process is studied. To evaluate the effect of current variations in a SMAW process data were acquired at different current values (from 70 to 120 A). Similarly, to study the behaviour of welding power sources data acquisition was done for six different welding power sources. In both the cases data were acquired at a sampling rate of 100,000 samples/s for duration of 20 s using a general purpose DSO while welding is in progress. These welds were prepared using same type of welding electrode by the same welder employing the identical parameters. The data thus obtained was filtered using the Fast Fourier Transform (FFT) low pass filter and subjected to statistical and neural network analyses. From the Probability Density Distributions (PDDs) and Self Organized Maps (SOM) generated using the data acquired, it is possible to differentiate various weld geometry. Further using these analyses, it is also possible to evaluate the performances of the different welding power sources. Grading of the power sources based on SOM technique matched well with grading arrived at based on the appearance

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of the weld bead. Results clearly indicate that the procedure presented here can be effectively used to assess the various parameters of welding power sources.

Keywords Statistical and artificial neural network analysis · Shielded metal arc welding · Arc power sources · Process

1 Introduction

Shielded Metal Arc Welding (SMAW) process is one of the most widely used welding process in the industry due to its inherent merits. Various modes of metal transfer and random arc behavior in an arc welding process leads to random variations in the welding data (voltage and current). Hence, monitoring this process is difficult, but if we can acquire these random variations at the same rate as they occur then a careful analysis of the same can provide us a very useful insight on the actual welding process which in turn can be used to evaluate various welding parameters. Similar studies on analyzing various welding parameters has already been reported in the literatures. Statistical tools like PDD (Probability Density Distribution) [1–8], signal processing, Artificial Neural Networks (ANN) have been used by many researchers for this purpose. Chen et al. [2] has shown the PDD technique can be used to study arc stability of different welding consumables. Similarly, in [3] welding electrodes and the filler wires were evaluated by the authors in Flux Cored Arc Welding (FCAW) process using current PDDs. Voltage and current data acquired form Gas Metal Arc Welding (GMAW) process was analyzed by the authors in [4] using VC++ and MATLAB programming. Recently, variations in the welding voltage and current were acquired by the authors using a commercially available, general purpose DSO for studying various aspects of Shielded Metal Arc Welding Process [5–8]. Li et al. has derived the range of parameters from the welding data to discriminate various faults in a welding process [9]. In another study, welding voltage and current was acquired to examine the effect of alloy enrichment in the weld metal deposit [10].

In the present study welding data (voltage and current) were acquired using a DSO while welding is in progress. Subsequently, performance of welding power sources was evaluated by analyzing the data thus acquired. This analysis was carried out using both statistical and Artificial Intelligence (AI) techniques. Results of this analysis and practical implications of the results thus obtained are delineated in this paper.

2 Experimental Setup

2.1 Data Acquisition and Welding Setup

Figure 1 shows the photograph of the arc welding machine setup with data acquisition system. For comparing the performance of the welding power sources, bead-on-plate welds were made on carbon steel plates using E7018 electrodes (3.15 mm dia.) and the different welding power sources. The instantaneous values of voltage and current data were acquired while bead on-plate welding on carbon steel is in progress.

For recording the welding process online, a DSO of 500 MHz band width with a maximum sampling rate of 4 Giga Samples/s is used. To acquire the large number of data points and to study the actual behavior of the welding process an Ethernet cable has been used for connecting DSO with external computer. The welding time was set to 20 s and 2,000,000 samples were acquired during this time. The data thus obtained were filtered and statistically evaluated by probability density distributions (PDDs) and neural network Self Organized Maps [11] algorithm.

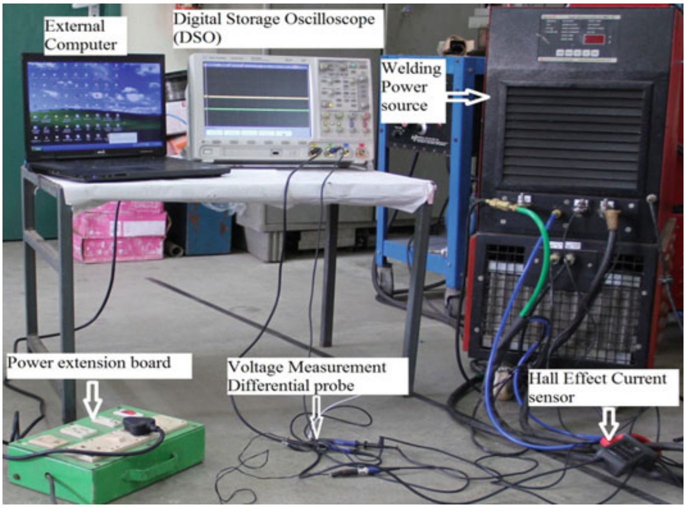

Fig. 1 Experimental setup

3 Results and Discussions

3.1 Evaluation of Welding Power Sources

Time domain analysis of voltage and current signals obtained for the rectifier power sources (Table 1), are shown in Fig. 2. It consists of a steady state condition with random dip in voltage with corresponding change in current. The sharp reduction observed in the voltage correspond to short circuit metal transfer, which takes place in basic coated electrodes of the type E 8018 used in the present study. From these oscillograms we can say that the two power sources employed to suppress the current surge that accompany short circuit metal transfer in welding are different and the time

Table 1 Various power sources used for comparison

Power supply	Electrode type	Voltage during welding (Volts)	Current during welding (Amps)	Mode of operation
Rectifiers (Machine 1)	E 8018	25	120	Constant current
Generator (Machine 2)	E 8018	25	100	Constant current
Inverter (Machine 3)	E 8018	25	100	Constant current
Inverter (Machine 4)	E 8018	25	100	Constant current
Inverter (Machine 5)	E 8018	25	100	Constant current and constant voltage

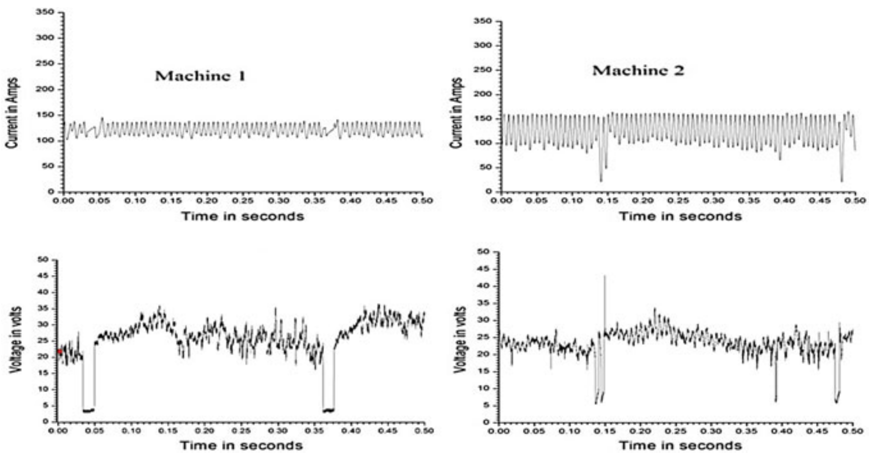

Fig. 2 Time domain analysis of weld data obtained from different rectifier power sources