Elangovan K

+91-9597263642 / +91-7994117650
elangoece3691@gmail.com

Research Interests

Digital instrumentation, Direct-digital conversion techniques, Design of analog interface circuits, Error analysis, and Compensation functions

Academic Qualifications

Doctor of Philosophy (Ph.D.) - Pursuing **January 2018 – Present**

Department of Avionics,
Indian Institute of Space Science and Technology (IIST).
Thesis Title: Efficient Digitizing Interface Circuits for Various Resistive Sensor Configurations with Considerations on Wide-span and Remote Measurements
Research Supervisor: Dr. Anoop C. S.

Master of Engineering (M. E.) **September 2014 – April 2016**

Electrical Engineering,
College of Engineering - Guindy Campus.
Specialization: Control and Instrumentation Engineering
Project Title: Automatic Guided Vehicle Control
Project Supervisor: Dr. B. Umamaheswari
CGPA: 7.79

Bachelor of Engineering (B. E.) **September 2008 – April 2012**

Electronics and Communication Engineering (ECE),
University College of Engineering, Panruti.
CGPA: 8.06

Important Course Works Undertaken during M. E. and Ph.D.

Interface circuits, Linear control systems, Analog VLSI circuits. Control system design, Soft computing techniques, Transducers and measurements, and Nonlinear control

Professional Experience

Assistant Professor (Adhoc basis) **August 2017 – January 2018**

Department of Electronics and Communication Engineering,
College of Engineering, Karunagappally,
(Managed by IHRD, Established by Govt. of Kerala)
Kerala – 690523.
Worked as an assistant professor, where I taught Electronic Devices and Circuits to the B. Tech. - Computer Science and Engineering students and Digital Filters to the M. Tech. Signal Processing students. In addition, I have handled Digital Signal Processing Lab to the B. Tech. students and Signal Processing Lab to the M. Tech. students. The above subjects cover the fundamentals of electronic devices and their applications.

Brief Details of Research Works

Resistive sensors are widely used in various industries such as aerospace, automobile, biomedical fields, etc. These resistive sensors are present in different configurations (single element, differential element, and bridge type). In addition, the properties (such as nominal resistance, transfer relation, sensitivity, and installed-location) of the resistive sensor can also vary. In my research work, efficient digitizing interface circuits for various types of resistive sensors are designed and evaluated. The digitizing interfacing schemes have merits over the analog schemes such as high accuracy, less power consumption, and high resolution. In addition, the digitizing schemes do not require an extensive analog-to-digital converter, which reduces the overall cost as well as the errors. In the first part, a modified dual-slope-based resistance to digital interface, utilizing constant current excitation, is designed and analyzed. This scheme has many meritorious features (e. g., preset current facility, requirement of a single reference voltage, and ability to interface with various types of resistive sensors) than the existing similar types of works. Next, an alternate relaxation-oscillator-based interface has been developed for resistive sensors. This circuit avoids the usage of the reference voltage and reduces the components-count, thereby reducing the cost as well as the power consumption. However, the above-discussed circuits require high conversion time and errors for wide-span measurements. Considering this fact, a new relaxation-oscillator-based interface circuit that can provide good performance for wide-span resistive sensors is designed and implemented. The novel technique of this scheme intelligently employs a programmable gain element, depending on the value of sensor resistance, in its architecture to achieve the desired performance.

In some industrial applications, the remotely-located sensors need to be connected to the electronics unit, using long connecting wires. The wire resistance can cause a significant amount of output error in the aforementioned schemes. To avoid this error, digitizing circuits, using novel wire-resistance compensation techniques, are proposed using relaxation-oscillator and enhanced dual-slope principles. The proffered schemes are experimentally verified and concluded that the output of these digitizers is independent of the connecting wire resistances. Next, the complexity of the interface circuit is reduced with the help of an improved microcontroller-interface approach. This involves the interfacing of magneto-resistive sensors to the microcontroller with the help of one active element (Op-amp). The method works on the principle of charging and discharging of a capacitor along desired resistance paths. This provides the features of independence from pin resistance of the microcontroller and mismatch of bridge resistances. However, this work possesses dependence on the precision of the threshold voltages of the microcontroller and mismatch in diode cut-in voltage, in the case of remote resistance measurements. Therefore, an interface with a similar charge-discharge principle but with a few more additional circuit components has been developed and analyzed. This improved digitizer gives very good stability in the threshold voltages, along with all the other merits of the microcontroller approach.

Later, the research focussed on the design and development of linearizing digitizers for thermistors. Latter is a nonlinear temperature sensor with good sensitivity and a wide operating range. The digitizer employs a simple linearization function that requires the knowledge of a few calibration data points of the sensor characteristics. The scheme shows very good linearity for a wide operating range. Further, sensors such as humidity sensor, lossy capacitive transducer, and metal oxide gas sensor are basically impedance sensors, whose electrical equivalent consists of a parallel combination of a resistor and capacitor (i. e., RC impedance sensor). Presently, the design and evaluation of the digitizing interface circuit which can measure the resistance and capacitance associated with the impedance sensor is being investigated.

Publications

International Journals (IEEE)

1. **Elangovan K**, B. Ashok Sontakke, and Anoop C. S., " Design, Analysis, and Hardware Verification of a Linearized Thermistor–Based Temperature Measurement System," in *IEEE Transactions on Instrumentation and Measurement*. (Accepted for publication) (Impact factor: 4.016)
2. **Elangovan K**, A. Antony, and Anoop C. S., "Simplified Digitizing Interface-Architectures for Three-Wire Connected Resistive Sensors: Design and Comprehensive Evaluation," in *IEEE Transactions on Instrumentation and Measurement*, vol. 71, pp. 1-9, 2022, Art no. 2000309, doi: 10.1109/TIM.2021.3136176. (Impact factor: 4.016)
3. **Elangovan K** and Anoop C. S., "An Efficient Universal Digitizer With Linear Transfer Characteristic for Resistive Sensor Bridges," in *IEEE Transactions on Instrumentation and Measurement*, vol. 70, pp. 1-4, 2021, Art no. 2004904, doi: 10.1109/TIM.2021.3089765. (Impact factor: 4.016).
4. **Elangovan K** and Anoop C. S., "Evaluation of New Digital Signal Conditioning Techniques for Resistive Sensors in Some Practically Relevant Scenarios," in *IEEE Transactions on Instrumentation and Measurement*, vol. 70, pp. 1-9, 2021, Art no. 2004709, doi: 10.1109/TIM.2021.3084316 (Impact factor: 4.016).
5. **Elangovan K**, S. Dutta, A. Antony, and Anoop C. S., "Performance Verification of a Digital Interface Suitable for a Broad Class of Resistive Sensors," in *IEEE Sensors Journal*, vol. 20, no. 23, pp. 13901-13909, 1 Dec.1, 2020, doi: 10.1109/JSEN.2020.2981279 (Impact factor: 3.301).
6. **Elangovan K** and Anoop C. S., "Simple and Efficient Relaxation-Oscillator-Based Digital Techniques for Resistive Sensors — Design and Performance Evaluation," in *IEEE Transactions on Instrumentation and Measurement*, vol. 69, no. 9, pp. 6070-6079, Sept. 2020, doi: 10.1109/TIM.2020.2972048 (Impact factor: 4.016).

Peer-reviewed Reputed IEEE International Conference Papers

1. S. K. Ambedkar, **Elangovan K**, K. B. Nandapurkar, and Anoop C. S., "Linearizing Relaxation-Oscillator Based Front-End for Magneto-Resistive Angle Sensors," in *Proc*. *IEEE Sensors Applications Symposium (SAS)*, pp. 1-6, Aug. 2021.
2. **Elangovan K** and Anoop C. S**.**, “A Digital Readout Suitable for Resistive Sensors Affected with a Parasitic Capacitance Element,” in *Proc. IEEE International Instrumentation and Measurement Technology Conference*, Glasgow, Scotland, May 2021.
3. **Elangovan K** and Anoop C. S**.**, “A Simple Digitization Scheme for Resistive Sensors and its Adaptation for Remote Measurements,” in *Proc. IEEE International Instrumentation and Measurement Technology Conference*, Glasgow, Scotland, May 2021.
4. **Elangovan K** and Anoop C. S., "A Self-Calibration Circuit for the Resistance Measurement of Parallel R-C sensor," in *Proc*. *IEEE Second International Conference on Control, Measurement, and Instrumentation (CMI)*, pp. 201-205, Jan. 2021.
5. **Elangovan K** and Anoop C. S., "A Digital Front-End for Remotely Located Resistive Sensors," in *Proc*. *IEEE International Symposium on Smart Electronic Systems (iSES) (Formerly iNiS)*, pp. 7-12, Dec. 2020.
6. **Elangovan K** and Anoop C. S., "Relaxation Oscillator Based Digital Interface Circuit for Resistive Sensors," in *Proc*. *IEEE 17th India Council International Conference (INDICON)*, pp. 1-5, Dec. 2020.
7. **Elangovan K** and Anoop C. S., "A Digital Signal-Conditioner for Resistive Sensors and its Utility for Linearizing GMR-based Magnetometer," in *Proc*. *IEEE Sensors Applications Symposium (SAS)*, pp. 1-6, Mar. 2020.
8. **Elangovan K**, B. Ashok Sontakke, and Anoop C. S., "Evaluation of a Digital Converter for Linear and Nonlinear Temperature Sensors," in *Proc*. *IEEE Sensors Applications Symposium (SAS)*, pp. 1-6, Mar. 2020.
9. **Elangovan K**, S. Saha, and Anoop C. S., "A Simple Digital Interface Circuit for Giant Magneto-Resistance Sensors," in *Proc*. *IEEE Region 10 Conference (TENCON)*, pp. 2285-2288, Oct. 2019.
10. **Elangovan K** and Anoop C. S., "Analysis and Performance Verification of an Efficient Digital Converter for Resistive Sensors," in *Proc*. *15th IEEE India Council International Conference (INDICON)*, pp. 1-6, Dec. 2018.

Awards and Achievements

- Recipient of **Student Travel Award** for the paper titled "A Digital Signal-Conditioner for Resistive Sensors and its Utility for Linearizing GMR-based Magnetometer" at *Sensors Applications Symposium (SAS)*, held in Malaysia, May 2020.
- Qualified Gate 2014 examination with the percentile of **95.75** (ECE Branch)
- Qualified Gate 2017 examination with the percentile of **92.95** (ECE Branch)

Other Responsibilities

- Teaching assistant at Indian Institute of Space Science and Technology – Trivandrum for the Instrumentation and Measurement Laboratory (Undergraduate)
- Teaching assistant at College of Engineering, Guindy Campus for the Control and Instrumentation Laboratory (Undergraduate) and Control System Design Laboratory (Postgraduate).
- Reviewer of IEEE Transactions on Instrumentation and Measurement and IEEE Sensors Journal
- Session chair of IPRECON 2021 conference

Skills and Expertise

- Expertise in handling and operating high precision test and measurement equipment (Gaussmeter, High-resolution digital multimeter, Mixed-signal oscilloscope)
- Programming languages: Matlab, LabVIEW, and Embedded C
- Circuit design and PCB design software: LTspice and Kicad
- Graphing and analysis software: Origin

Extracurricular Activities

- Participated and won the first position in Cricket Tournament at Intramural Competition 2018-19, IIST, Trivandrum.
- Participated and won the man of the match award in Cricket Tournament 2018-2019, at IIST, Trivandrum.
- Served as team captain for the ECE Department, University College of Engineering, Panruti at Annual Sports Meet for the year 2011-12 (won the winners position in the Sports Meet, 2011-12).
- Actively participated in National Service Scheme during the year 2008-10.

References

Dr. Anoop C. S.
Associate Professor
Department of Avionics
Indian Institute of Space Science and Technology,
Trivandrum, Kerala, India.
Email: anoop.cs@iist.ac.in
Tel: +91-471-2568593

Dr. R. Sudharshan Kaarthik
Associate Professor
Department of Avionics
Indian Institute of Space Science and Technology,
Trivandrum, Kerala, India.
Email: sudharshan.kaarthik@iist.ac.in
Tel: +91-471-2568596

Dr. Kishor Bhaskarrao Nandapurkar
Assistant Professor
Department of Electrical Engineering
Indian Institute of Technology (ISM) Dhanbad,
Jharkhand, India.
Email: kishor@iitism.ac.in
Tel: +91-7869777275

Dr. V. Govindaraj
Assistant Professor
Department of mathematics
National Institute of Technology
Puducherry, Karaikal, India.
Email: govindaraj.v@nitpy.ac.in
Tel: +91-4368-265236