Rubén D Fonnegra, Ph.D(c)

Curriculum Vitae

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Personal Info

Date of birth	24th June, 1993
Place of birth	Medellín, Colombia
Citizenship	Colombian
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Personal Profile

An enthusiastic, adaptive, fast-learning and very disciplined person. Electronical Engineer, Master in Automatización y Control Industrial and current Ph.D. candidate in Engineer with a broad and acute interest in the development of computational systems for the aid of cancer diagnosis. I particularly enjoy collaborating with scientists from different disciplines to develop new skills and abilities to solve new challenges.

Education

2010 – 2015 **B.S. Electronical Engineer**, *Electronic and Telecommunications department*, Facultad de ingenierías, Instituto Tecnológico Metropolitano.
Medellín, Colombia
Thesis: Anti-collision system for navigation inside an UAV using fuzzy controllers and range sensors
Advisor(s): M.Sc. Germán David Góez Sánchez
Program: https://www.itm.edu.co/aspirante-pregrado/programas-profesionales/ingenieria-electronica/

2016 – 2019 **M.Sc. Automation and Industrial Control**, *Graduate school*, Faculty of Engineer, Instituto Tecnológico Metropolitano.
Medellín, Colombia
Thesis: Automatic Emotion Recognition from Multimodal Information Fusion Using Deep Learning Approaches
Advisor(s): Gloria Mercedes Díaz Cabrera, Ph.D. ; Juan Carlos Caicedo Rueda, Ph.D.
Program: https://www.itm.edu.co/maestrias/maestria-en-automatizacion-y-control-industrial/

2020 – Currently **Ph.D(c) Engineer**, *Graduate school*, Faculty of Engineer, Instituto Tecnológico Metropolitano.
Medellín, Colombia
Thesis: Currently
Advisor(s): Gloria Mercedes Díaz Cabrera, Ph.D. ; Juan Carlos Caicedo Rueda, Ph.D.
Program: https://www.itm.edu.co/doctorado-en-ingenieria/

Languages

Spanish	Reading: Native	Speaking: Native	Listening: Native
French	Reading: Intermediate	Speaking: Intermediate	Listening: Intermediate
English	Reading: Good	Speaking: Good	Listening: Good
IELTS: B2			

Research interest

- Machine Learning and Pattern Recognition
- Theories in Artificial Intelligence
- Data analysis and processing
- Computer Vision and Image Processing

Research Activities and Affiliations

Feb 2015 – Mar 2016 **IEEE student branch - Medellín, Colombia**.
Institution: Instituto Tecnológico Metropolitano
Role: Member

Jan 2014 – Dec 2018 **Research group in Automática, Electrónica y Ciencias Computacionales**
Institution: Instituto Tecnológico Metropolitano
Role: Student member

Jan 2020 – Dec 2023 **Machine learning for cellular biology research group - Caicedo Lab**.
Entidad: Broad Institute of MIT and Harvard
Role: Graduate research member

Jan 2019 – Current - **Research group in Ambiental Innovation - GIIAM**
Institution: Institución Universitaria Pascual Bravo
Role: Associate Researcher

Working Experience

Jan 2014 – Jun 2018 **Instituto Tecnológico Metropolitano. Colombia. Academic laboratory worker**
Programmable Logic Controllers (PLC) Laboratory worker. Charge activities included preventive, predictive and corrective maintenance performing in industrial drivers, planning academic schedules, maintenance reports, students monitoring and permanent counseling to students and teachers concerning to programming devices (PLC, microcontrollers and FPGAs), controllers design, custom software and other programmed activities from facultad de ingenierías of Instituto Tecnológico Metropolitano.

Feb 2016 – Jun 2018 **Instituto Tecnológico Metropolitano. Colombia. Professor**
Professor in courses of microcontrollers programming, from Mechatronics and Electronic Engineering programs; which are focused in operation and develompment of electronic solutions using digital and analog peripheral devices, users interfaces design, embedded systems design and communication interaces in Microchip and Freescale devices.

Jul 2018 – Current - **Instituto Tecnológico Metropolitano. Colombia. Adjuct professor**
External professor of the in Fundamentals and Applications of Deep Learning, whose main objective is to provide complete training in the fundamentals and use of Deep Learning and Artificial Intelligence tools to propose commercial solutions or in industrial environments using algorithms, libraries and strategies commonly used in this discipline (Python and Tensorflow).

Au 2018 – Current

Institución Universitaria Pascual Bravo. Colombia. Associate professor

Full-time professor supporting the academic programs in Software Development Technology, Software Engineering, and the Master's in Computer Science. Currently involved in research projects in the areas of machine learning for biomedical image processing and synthesis. *Oriented Courses:*

- **Data Structures (Software Development Technology):** Basic concepts on the use of structures (arrays, matrices, stacks, queues, trees) in compiled and interpreted programming languages, with emphasis on proper management of computational resources (memory, access times, among others). - **Pattern Recognition (Software Engineering):** Implementation of algorithms and techniques for extracting meaningful information from datasets to solve tasks such as segmentation, object recognition, speech recognition, among others.
- **Machine Learning (Software Engineering):** Development and implementation of algorithms and models that learn patterns and make data-driven decisions to solve real-world problems.
- **Data Analytics (Specialization in Big Data):** Design and implementation of specialized systems to analyze, interpret, and model datasets in order to extract valuable information, patterns, and trends for decision-making or understanding phenomena. Includes the use of statistical tools and data mining techniques to extract knowledge from large-scale data.
- **High Performance Computing (HPC) (Master's in Computer Science):** Development of techniques and tools to solve complex problems by optimizing the use of computational resources. Covers advanced architectures (HPC clusters, GPUs, Google Cloud Computing - GCC, Amazon Web Services - AWS), parallel programming models (OpenMP, CUDA, Python), and tools for distributed systems (Docker, Podman, Kubernetes). Includes performance analysis, load balancing, and scalability, with emphasis on scientific and industrial applications. Students gain practical experience through projects focused on simulations, machine learning, and numerical problems in HPC environments.
- **Computational Intelligence (Master's in Computer Science):** Covers theoretical and practical foundations of computational intelligence techniques, from traditional models to deep neural networks. Focuses on the design, implementation, and evaluation of adaptive models capable of solving complex, nonlinear, and uncertain problems in scientific, industrial, and social domains. Through the integration of bio-inspired models and machine learning, students develop skills to apply these techniques in contexts such as optimization, data analysis, predictive modeling, and intelligent control systems.

Participation in research projects

Emotion Recognition from physiological signals using computational intelligence

This project aims to apply various computational strategies for emotional recognition by considering two key dimensions: emotional valence (positive/negative) and emotional intensity (high/low). In this context, different computational approaches are evaluated to develop systems capable of identifying emotional events based on these two dimensions independently, using a dataset that includes Galvanic Skin Response (GSR) signals. Furthermore, the results are analyzed to highlight differences between human–human and human–robot interactions, allowing for a comparative assessment of emotional responses in each context.

Institutions: Institución Universitaria Pascual Bravo

State: Concluded

Diagnosis and Prognosis of COVID-19 Using Multimodal Data and Artificial Intelligence-Based Models

The main objective of the project is the automatic identification of patterns that enable a better understanding and management of COVID-19. This is achieved through the integration of clinical data (from structured sources such as laboratory test results or extracted automatically from clinical notes) and medical images, with the aim of applying or extending our methods to make predictions that contribute to patient care and clinical decision-making in the context of COVID-19.

Institutions: Institución Universitaria Pascual Bravo, Universidad Politécnica Salesiana

State: Concluded

Synthetic Response Generation to Contrast Agent Application in Medical Imaging for Improved Automatic Breast Cancer Diagnosis

The use of contrast agents has shown significant potential in the field of diagnostic imaging, particularly for the detection, characterization, and differentiation of tumors associated with cancer development. This project proposes the use of deep neural network architectures to generate synthetic information from known data—such as other images or signals—for the creation of pseudo-medical images that retain diagnostic value.

Institutions: Instituto tecnológico Metropolitano, Institución Universitaria Pascual Bravo, Dinámica IPS (SURA), Broad Institute of MIT and Harvard

State: Concluded

Publications

Signal Processing

Anti-collision system for navigation inside an UAV using fuzzy controllers and range sensors, Dario Fonnegra Tarazona, Ruben; Lopera, Felipe Rios; Sanchez, German-David Goez. Aceptado para presentación oral y publicación en el XIX Simposio Internacional de Tratamiento de Señales, Imágenes y Visión Artificial-STSIVA 2014. Colombia. 2014.

Artificial Intelligence

Automatic Face Recognition in Thermal Images using Deep Convolutional Neural Networks, **Fonnegra, R. D.**; Cardona-Escobar, Andres Felipe; Perez-Zapata, Andres Felipe; Diaz, Gloria M. . Aceptado para presentación oral y publicación en la XVII Conferencia Latinoamericana de Control Automático CLCA 2016. Colombia. 2016.

Signal Processing

Sistema anti colisiones para navegación en interiores de un Quacopter usando un controlador difuso y sensores de rango, **Fonnegra Tarazona, Ruben Dario**; Lopera, Felipe Rios; Sanchez, German-David Goez. En: Revista de Investigaciones Universidad del Quindío. 2016.

Artificial Intelligence

Performance comparison of deep learning frameworks in image classification problems using convolutional and recurrent networks, **Fonnegra, R. D.**; Blair, B.; Diaz, G. M. . Aceptado para presentación oral y publicación en IEEE Colombian Conference on Communications and Computing (COLCOM) 2017.

Image processing

MSpecFace: A Dataset for Facial Recognition in the Visible, Ultra Violet and Infrared Spectra., **Fonnegra, R. D.**, Molina A., Pérez-Zapata A.F., Díaz G.M. Botto-Tobar M., Esparza-Cruz N., León-Acurio J., Crespo-Torres N., Beltrán-Mora M. (eds) Technology Trends. Communications in Computer and Information Science, vol 798. Springer, Cham

Artificial Intelligence

Speech Emotion Recognition Based on a Recurrent Neural Network Classification Model, **Fonnegra, R. D.**, Díaz G.M. In: In: Cheok A., Inami M., Romão T. (eds) Advances in Computer Entertainment Technology. Lecture Notes in Computer Science, vol 10714. Springer, Cham

Artificial Intelligence

Deep Learning based Video Spatio-Temporal Modeling for Emotion Recognition, **Fonnegra, R. D.**, Díaz G.M. In: Masaaki Kurosu (ed) Human-Computer Interaction: Theories, Methods and Human Issues (Part I). Lecture Notes in Computer Science, vol 10901. Springer, Cham.

Artificial Intelligence

Speech Emotion Recognition Integrating Paralinguistic Features and Auto-encoders in a Deep Learning Model, **Fonnegra, R. D.**, Díaz G.M. In: Masaaki Kurosu (ed) Human-Computer Interaction: Theories, Methods and Human Issues (Part I). Lecture Notes in Computer Science, vol 10901. Springer, Cham.

Artificial Intelligence

Estimación de orientación de un vehículo aéreo no modelado usando fusión de sensores inerciales y aprendizaje de máquina, **Fonnegra, R. D.**, Góez G.D., Tobón A.F. In: Revista Iberoamericana de Automática e Informática industrial, [S.l.], v. 16, n. 4, p. 415-422, sep. 2019. ISSN 1697-7920.

Artificial Intelligence

Emotion Recognition from Time-Frequency Analysis in EEG Signals Using a Deep Learning Strategy., **Fonnegra, R. D.**, Campáz-Usuga P., Osorno-Castillo K., Díaz G.M. In Narvaez-Espinoza, F. (eds). Communications in Computer and Information Science, Springer, Cham, Dic 2019.

Artificial Intelligence — *Integration of Machine Learning Models in PACS Systems to Support Diagnostic in Radiology Services* , Osorno-Castillo, K., **Fonnegra, R. D.**, & Díaz, G. M. , In Applied Computer Sciences in Engineering: Workshop on Engineering Applications, WEA 2020, Sept 2020.

Artificial Intelligence — *Quality Enhancement of Breast DCE-MRI Images Via Convolutional Autoencoders*, Campáz-Usuga, P., **Fonnegra, R. D.**, & Mera, C. In 2021 IEEE 2nd International Congress of Biomedical Engineering and Bioengineering (CI-IB&BI) (pp. 1-4). IEEE.

Artificial Intelligence — *Outcome Prediction of Covid-19 Patients from Clinical Admission Data Using Machine Learning Models*, Cartagena, J. P., **Fonnegra, R. D.**, & Espinoza, F. R. N. In 2nd International Conference on Smart Technologies, Systems and Applications (SmartTech-IC 2021)

Artificial Intelligence — *Automatic Identification of COVID-19 in Chest X-Ray Images Based on Deep Features and Machine Learning Models*, **Fonnegra, R. D.**, Narváez, F. R., & Díaz, G. M. In International Conference on Smart Technologies, Systems and Applications (pp. 360-369). Cham: Springer International Publishing., 2021

Artificial Intelligence — *Analysis of the Generation of a Synthetic Response to the Application of Contrast Agents in Breast Medical Images Using Generative Adversarial Networks.*, Rincón, J. S., Mera, C., **Fonnegra, R. D.**, & Díaz, G. M. In International Conference on Smart Technologies, Systems and Applications (pp. 332-344). Cham: Springer International Publishing., 2021

Artificial Intelligence — *Early-to-Late Prediction of DCE-MRI Contrast-Enhanced Images in Using Generative Adversarial Networks*, **Fonnegra, R. D.**, Hernandez, M. L., Caicedo, J. C., & Díaz, G. M. In 2023 IEEE 20th International Symposium on Biomedical Imaging (ISBI) (pp. 1-5). IEEE. 2023

Artificial Intelligence — *Analysis of cellular phenotypes with unbiased image-based generative models*, **Fonnegra, R. D.**, Sanian, M., Chen, Z., Paavolainen, L., & Caicedo, J. In NeurIPS 2023 Generative AI and Biology (GenBio) Workshop, 2023.

Artificial Intelligence — *Síntesis de imagen médica postcontraste en estudios de DCE-MRI de mama usando aprendizaje profundo.* Cañaveral, S., Mera-Banguero, C., & **Fonnegra, R. D.** TecnoLógicas 27.60 (2024): 1-20.

Biomedical imaging — *LA-Breast: A Latin American multiparametric breast DCE-MRI dataset with benign and malignant annotations.* **Fonnegra, R. D.**, Mera, C., Díaz, G. M., & Hernández, L. (2024). Data in Brief, 57, 110995. 2024

Artificial Intelligence — *Synthesizing Late-Stage Contrast Enhancement in Breast MRI: A Comprehensive Pipeline Leveraging Temporal Contrast Enhancement Dynamics.* **Fonnegra, R. D.**, Hernández, M. L., Caicedo, J. C., & Díaz, G. M. arXiv preprint arXiv:2409.01596. 2025

Patents

Artificial Intelligence — *Decoupled Encoder-Decoder Networks for Image Simulation and Modification*
Inventors: Juan C. Caicedo, **Rubén D. Fonnegra**, Alex Quach, Mohammad Sanian, Zitong Chen, Lassi Paavolainen.
Institutions: Massachusetts Institute of Technology (MIT), Broad Institute Inc.
Link: https://patents.google.com/patent/US20240378869A1/en
Status: Patent pending.

Research Internships

Doctoral research internship at the Broad Institute of MIT and Harvard, under the supervision of Prof. Juan C. Caicedo.
Duration: 7 months
Year: 2022

Participation in academic events

Signal processing

XIX Simposio Internacional de Tratamiento de Señales, Imágenes y Visión Artificial-STSIVA 2014
Place: Armenia, Colombia
Fecha: 17 al 19 de septiembre de 2014
Organizer: Universidad Uniquindío
Role: Speaker

Robotics

Parque I para todos
Place: Medellín, Colombia
Date: 19 de mayo de 2015
Organizer: Instituto Tecnológico Metropolitano
Role: Associate in organizer comittee

Artificial intelligence

XVII Conferencia Latinoamericana de Control Automático CLCA 2016
Place: Medellín, Colombia
Date: 13 al 15 de octubre de 2016
Organizer: Universidad EAFIT
Role: Speaker

Artificial intelligence

IEEE Colombian Conference on Communications and Computing (COLCOM) 2017
Place: Cartagena de Indias, Colombia
Date: 16 al 18 de Agosto de 2017
Organizer: IEEE Computer Society
Role: Speaker

Academic

Cumbre Colombo-Francesa de Investigación, Innovación y Educación Superior COL-IFRI 2019.
Place: Medellín, Colombia
Date: 12 al 14 de Junio de 2019
Organizer: Colifrí, Agregado de cooperación universitaria y científica de la embajada de Francia en Colombia y universidad EAFIT.
Role: Speaker

Biomedical analysis

IEEE EMBS-SPS International Summer School on Biomedical Imaging
Place: Saint Jacut de la mer, France
Date: 19th-25th June, 2022
Organizer: IEEE EMBS Society
Role: Participant

Computational

Cytodata Symposium
Place: Seattle, Washingtong (Estados Unidos)
Date: 17th-20th October, 2022
Organizer: Allen Institute
Role: Participant

Data science

Expotecno-Hackatón
Place: Medellín, Colombia
Date: 29th september to 1st october, 2023
Organizer: Institución Universitaria Pascual Bravo
Role: Organizer committee

Personal and academic achievements

Winner of the fully funded national scholarship program for doctoral studies under "becas excelencia doctoral del Bicentenario". May, 2020
Institution: Minciencias, Colombia.

Summa cum Laude for master's thesis work titled "Automatic Emotion Recognition From Multimodal Information Fusion Using Deep Learning Approaches". April, 2019
Institution: Instituto Tecnológico Metropolitano (ITM), Medellín, Colombia.

Winner of the fully funded interrnational internship program on agreement 161 signed between the Instituto Tecnológico Metropolitano (ITM) and Sapiencia, April, 2017.
Objective: To propose an experiment in the laboratory of the Autonomous Systems and Robotics of the Department of Informatics and Systems Engineering (U2IC) of l'École Nationale Supérieure de Techniques Avancées (ENSTA) ParisTech; to perform emotion modeling through human-robot and human-human based interactions
Advisor: Prof. Adriana Tapus, Ph.D.
Institution: Instituto Tecnológico Metropolitano (ITM)

Skills and abilities

Research Areas Deep learning. Machine learning and pattern recognition. Medical image processing and analysis. Data analysis.

Hardware Skills Database management. Server administration and advanced infrastructure for data processing (HPC). Deployment of AI-based systems on mobile and/or embedded platforms.

Software Skills Advanced programming in Python, C++, and Bourne-again shell (Bash) for artificial intelligence applications.

Other Skills Management of microservers for data processing and deployment of applications locally and in the cloud (GCP and AWS).

Personal and professional references

- JACKELINE VALENCIA LONDOÑO
  M.A Second Language Learning and Teaching Processes
  Assistant professor
  Institución Universitaria Pascual Bravo
  Medellín, Colombia.
  jackeline.valencia@pascualbravo.edu.co

- JUAN CARLOS CAICEDO RUEDA
  Ph.D. Computer sciences
  Associate Professor
  University of Wisconsin-Madison
  Wisconsin, USA.
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- CARLOS ANDRÉS MERA BANGUERO.
  Ph.D. System engineering
  Assistant professor
  Universidad de Antioquia
  Medellín, Colombia.
  carlos.mera@udea.edu.co

- JUAN CARLOS BRIÑEZ DE LEÓN.
  Ph.D. System engineering
  Assistant professor
  Instituto Tecnológico Metropolitano.
  Medellín, Colombia.
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