Universidad Politécnica de Tulancingo

Informe Trimestral de Actividades

Dirección de Investigación y Posgrado

Trimestre	julio-septiembre	**Fecha**	28 de septiembre de 2023

Componente	3. Investigación	**Actividad**	3.1 Productos de Investigación
Nombre del Indicador	Porcentaje de productos de investigación científica y tecnológica realizados		
Resumen Narrativo	3.1 Realización de productos de investigación científica y tecnológica de educación superior		
Supuestos	Los investigadores participan en las convocatorias para el desarrollo de proyectos de investigación científica y tecnológica.		
Medios de Verificación	Informe trimestral de productos de investigación científica y tecnológica realizados generado y ubicado en la Dirección de Investigación y Posgrado adscrito a la Secretaria Académica de la Universidad Politécnica de Tulancingo.		

Metas Trimestrales			
Programada	3	**Alcanzada**	3

Descripción de Actividades

Durante el trimestre julio – septiembre 2023, se programaron 3 metas, que derivan en 3 productos de investigación. Estos productos de investigación (artículos de corte científico tecnológico o publicaciones de artículo como capítulo de libro de investigación colaborativa a nivel Latinoamérica) fueron presentados en revistas de corte internacional o en libros con relevancia a nivel internacional y son los siguientes:

1.-Nombre del artículo: **Varroa Destructor Classification Using Legendre–Fourier Moments with Different Color Spaces**
2.-Nombre del artículo: **Motion-Tracking Control of Mobile Manipulation Robotic Systems Using Artificial Neural Networks for Manufacturing Applications**
3.-Nombre del artículo: **Microcontrollers programming for control and automation in undergraduate biotechnology engineering education**

Desarrollo de Actividades, Evidencia Documental y Fotográfica

1.-Nombre del artículo: **Varroa Destructor Classification Using Legendre–Fourier Moments with Different Color Spaces**

Autores: ***Alicia Noriega-Escamilla, ****César J. Camacho-Bello ***, *****Rosa M. Ortega-Mendoza, ******José H. Arroyo-Núñez and *******Lucia Gutiérrez-Lazcano**

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Revista: **Journal of Imaging (Natural sciences)**

Link: **https://www.mdpi.com/2313-433X/9/7/144**

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Universidad Politécnica de Tulancingo

Journal of *Imaging*

MDPI

Artide

Varroa Destructor Classification Using Legendre–Fourier Moments with Different Color Spaces

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Abstract: Bees play a critical role in pollination and food production, so their preservation is essential, particularly highlighting the importance of detecting diseases in bees early. The Varroa destructor mite is the primary factor contributing to increased viral infections that can lead to hive mortality. This study presents an innovative method for identifying Varroa destructors in honey bees using multichannel Legendre–Fourier moments. The descriptors derived from this approach possess distinctive characteristics, such as rotation and scale invariance, and noise resistance, allowing the representation of digital images with minimal descriptors. This characteristic is advantageous when analyzing images of living organisms that are not in a static posture. The proposal evaluates the algorithm's efficiency using different color models, and to enhance its capacity, a subdivision of the VarroaDataset is used. This enhancement allows the algorithm to process additional information about the color and shape of the bee's legs, wings, eyes, and mouth. To demonstrate the advantages of our approach, we compare it with other deep learning methods, in semantic segmentation techniques, such as DeepLabV3, and object detection techniques, such as YOLOv5. The results suggest that our proposal offers a promising means for the early detection of the Varroa destructor mite, which could be an essential pillar in the preservation of bees and, therefore, in food production.

Keywords: Legendre–Fourier multichannel moments; honey bee; Varroa destructor

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1. Introduction

The honey bee (Apis mellifera) is a species native to Africa, Europe, and western Asia; its management has contributed to the presence of this species in all continents except Antarctica and some oceanic islands [1]. They are vital as pollinators, visiting more than 90% of the world's principal crops [2]. They also generate essential products such as honey, pollen, propolis, and royal jelly, producing jobs mainly in rural areas [3]. Hence, reducing their population could affect the production and quality of food whose crops depend on insect pollination [4]. Despite its relevance, a decline in bee diversity has been recorded due to climate change, pesticide use, and loss of natural habitats [5]. In addition, diseases associated with fungi, bacteria, viruses, and invertebrate parasites threaten the health of bees [2]. These diseases tend to spread to nearby bee populations due to commercial management, mass breeding, transport, trade, and physical contact between bees, especially during harvesting, representing a problem for conserving wild bee species.

The worldwide transmission and spread of the ectoparasitic mite Varroa destructor is the main factor in increasing viral infections. Furthermore, it inoculates in the larvae and adults, causing the death of hives [6]. A decrease in production of 45% is estimated in a swarm of domestic bees infested with Varroa, which causes economic losses due to sanitary treatments, the repopulation of the packs, the treatment of secondary diseases, and labor [7]. Currently, different chemicals and application methods keep the mite population

2.-Nombre del artículo: **Motion-Tracking Control of Mobile Manipulation Robotic Systems Using Artificial Neural Networks for Manufacturing Applications**

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mathematics

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Artide

Motion-Tracking Control of Mobile Manipulation Robotic Systems Using Artificial Neural Networks for Manufacturing Applications

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Abstract: Robotic systems have experienced exponential growth in their utilization for manufacturing applications over recent decades. Control systems responsible for executing desired robot motion planning face increasingly stringent performance requirements. These demands encompass high precision, efficiency, stability, robustness, ease of use, and simplicity of the user interface. Furthermore, diverse modern manufacturing applications primarily employ robotic systems within disturbed operating scenarios. This paper presents a novel neural motion-tracking control scheme for mobile manipulation robotic systems. Dynamic position output error feedback and B-Spline artificial neural networks are integrated in the design process of the introduced adaptive robust control strategy to perform efficient and robust tracking of motion-planning trajectories in robotic systems. Integration of artificial neural networks demonstrates performance improvements in the control scheme while effectively addressing common issues encountered in manufacturing environments. Parametric uncertainty, unmodeled dynamics, and unknown disturbance torque terms represent some adverse influences to be compensated for by the robust control scheme. Several case studies prove the robustness of the adaptive neural control scheme in highly coupled nonlinear six-degree-of-freedom mobile manipulation robotic systems. Case studies provide valuable insights and validate the efficacy of the proposed adaptive multivariable control scheme in manufacturing applications.

Keywords: robotics; mobile manipulation robotic systems; artificial neural networks; laser-based manufacturing; robust control; active disturbance control

MSC: 93C10

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1. Introduction

The robotics industry has experienced unprecedented growth in recent decades, transforming manufacturing operations completely [1–3]. Mobile manipulation robotic systems have emerged as efficient and versatile tools for automating various tasks in industrial environments [4–6]. This progress, however, has presented challenges in controlling the motion of robotic systems in manufacturing applications that require high levels of precision and reliability [7]. The need for enhanced accuracy in robotics comes from the requirement for precise manipulation of objects in manufacturing scenarios [8]. Accurately planned

3.-Nombre del artículo: **Microcontrollers programming for control and automation in undergraduate biotechnology engineering education**

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Original article

Microcontrollers programming for control and automation in undergraduate biotechnology engineering education

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ARTICLE INFO

Keywords:
Microcontroller programming
Sensors and actuators
Internet connection
Control theory

ABSTRACT

This paper presents the utilization of the ESP32 microcontroller as a teaching tool for signal acquisition, processing, and control theory in biotechnological engineering. The ESP32 microcontroller, equipped with Bluetooth and WiFi capabilities, offers an affordable and versatile solution for educational purposes. By leveraging the Arduino© software, students can easily learn microcontroller programming and utilize various peripherals such as sensors and actuators. Several practical exercises related to process control have been conducted using this microcontroller. Additionally, remote process monitoring and control are enabled through integration with a database. Furthermore, concepts of artificial intelligence are explored using the Edge Impulse platform to obtain an artificial neural network that can be downloaded onto the ESP32. Positive feedback from students highlights the effectiveness and engagement of utilizing these microcontrollers, and the integration of internet connectivity enhances the overall learning experience.

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1. Introduction

In recent years, the rapid advancement of technology, particularly the internet, has led to significant transformations in both industry and education. Industry 4.0 has brought about a digital revolution, where digitalization has become a pervasive factor in various aspects of industrial processes (Kakkar et al., 2021). Intelligent manufacturing has become a reality, and the Internet of Things (IoT) has enabled the seamless acquisition and transmission of data from numerous sensors. This has facilitated remote access and control, allowing individuals to remotely monitor and manipulate machines and systems from anywhere. The COVID-19 pandemic has further highlighted the importance of IoT, as it has facilitated remote work and allowed for effective factory monitoring and control via the internet.

Similarly, the field of education has also embraced these technological advancements. In Mexico, it is increasingly common to find universities that have adopted a competency-based approach (CBA) to learning (Malhotra et al., 2023). This approach places the learner at the center of the educational process, where students actively construct their knowledge by integrating information from diverse sources. In this context, the role of the professor shifts from being a sole provider of knowledge to that of a facilitator, guiding and supporting students in their learning journey.

In Mexico, there is a notable disparity in budget allocation between private and public universities. While competency-based approach (CBA) is commonly adopted in public universities as the preferred learning model, the utilization of specialized software is often limited due to licensing fees. This issue is even more pronounced in developing countries, where the integration of technology in education is slow and sometimes inadequate (Jhurree, 2005). As a result, the use of open-source software has emerged as a viable alternative to facilitate teaching and equip students with valuable skills and abilities. For instance, Barry (2009) highlighted the benefits of free software for education in Sudan, while Thapa and Gautam (2021) discussed a similar case in Nepal.

SuperPro Designer© is a remarkable software widely used in various industrial applications, including the simulation of chemical reactions, phase separation, homogenization, chromatography, and evaporation. It offers powerful capabilities for process optimization and has been extensively studied for economic evaluations, such as debottlenecking analyses (Foo, 2023). However, the accessibility of SuperPro Designer©

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