

**FACULTAD DE INGENIERÍA**

Escuela Académico Profesional de Ingeniería Mecatrónica

Tesis

**Proposal of a Swimming Pool Drowning Detection  
System using Cameras and Raspberry Pi based  
on Machine Learning**

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Para optar el Título Profesional de  
Ingeniero Mecatrónico

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**INFORME DE CONFORMIDAD DE ORIGINALIDAD DE TESIS: EN FORMATO ARTÍCULO CIENTÍFICO**

**A** : Felipe Gutarra Meza  
Decano de la Facultad de Ingeniería

**DE** : Jaime Antonio Huaytalla Pariona  
Asesor de tesis

**ASUNTO** : Remito resultado de evaluación de originalidad de tesis

**FECHA** : 13 de Octubre de 2023

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Atentamente,



JAIME A. HUAYTALLA PARIONA  
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Asesor de tesis

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Ante Usted, con el debido respeto me presento y expongo:

Declaramos que hemos participado en la ideación del problema, recolección de datos, elaboración y aprobación final del artículo científico.



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# Proposal of a Swimming Pool Drowning Detection System using Cameras and Raspberry Pi based on Machine Learning

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PÁGINA 1

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PÁGINA 2

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PÁGINA 3

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PÁGINA 4

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# Proposal of a Swimming Pool Drowning Detection System using Cameras and Raspberry Pi based on Machine Learning

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*Drowning deaths represent the third leading cause of accidental deaths worldwide. This is because traditional techniques for the supervision and care of people, especially children, in large pools are inefficient or, in some cases, non-existent. Nowadays, this problem has become a topic of interest for several researchers who seek to propose different methods of drowning detection. This research work seeks to propose the process to be followed to develop a drowning detection system in swimming pools using cameras and Raspberry Pi based on Machine Learning. To achieve the objective, the use of the Triple Diamond design methodology was proposed. In the development of the first diamond, the information was organized in a Lotus Blossom Diagram, then the problematic situation and the main objective were described. In the development of the second diamond, a bibliometric analysis was performed, searching for information with search equations and then sorting and filtering it, and finally including it in morphological matrices. As a result, an electrical diagram of the system and a flow diagram of the algorithm based on a Support Vector Machine were proposed.*

Keywords—*Lotus Blossom Diagram, Bibliometric Analysis, Search Equations, Morphological Analysis.*

## I. INTRODUCTION

The World Health Organization (WHO) states that nearly 236,000 people have died from drowning yearly since 2019. The most vulnerable population is people under 25, specifically children [1]. The main reason can be poor surveillance by trained personnel (lifeguards) and a lack of responsible parental supervision in public environments such as swimming pools [2].

Identifying a drowning remains a challenge even for experienced rescuers because not all individuals exhibit the same characteristics or signs when in danger of drowning [3]. Thanks to technology, these deficiencies can be covered by intelligent surveillance systems implemented with various algorithms, sensors, and cameras, among other methods that facilitate the early detection of drowning [4].

Among the most efficient methods is the use of cameras that, as in this research, are used to extract images or videos of the environment and then analyze them using Machine Learning algorithms [5] or through Neural Networks [6]. After a possible case of drowning in the pool is identified, the system performs a warning or warning action to the responsible lifeguards to act and prevent the individual from getting hurt or dying.

On the other hand, other research opts for simpler methods of design and implementation. The most common are cardiac sensors [7,8,9,10,11] and pressure sensors [12,13]. The former obtains parameters such as heart rate and pulsations, among others, that are important to identify a person in the early stage of drowning, and the latter monitor the depth at which the individual is and then emits an alert if they register anything unusual.

The main objective of this research work is to propose the process to be followed to develop a drowning detection system in swimming pools. Likewise, the system must be controlled by a Raspberry Pi, and the basis of the detection algorithm is Machine Learning.

## II. METHODOLOGY

In a research project, methodology refers to the set of procedures or guidelines that ensure that the objectives and goals set at the beginning can be met in a correct and orderly manner [14]. In other words, the methodology provides a guide to the researcher in the various stages required by the project to meet its expectations [15]. The following paragraphs detail the tools used to meet the requirements of the first two diamonds of the Triple Diamond Method. These tools were proposed according to the scope of the present research work, which is to propose a flow chart of the basic operation of the Support Vector Machine algorithm for drowning detection in a swimming pool, in addition to proposing an electrical diagram of the system. It should be noted that the present research work