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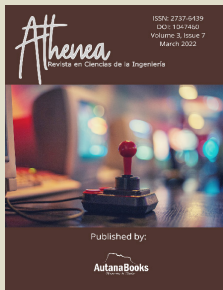
  
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## ATHENEA JOURNAL

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Our cover



An image alluding to video games is shown as our magazine highlights their relevance in the modern world.

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## EDITORIAL

*The Athenea Magazine in Engineering Sciences presents its 8th edition, with works related to a technology that has motivated the youth of all generations since its creation. And not only young people, but adults and children have been captivated by different video game developments. Nowadays, it is a subject of much controversy, due to its numerous advantages and also important disadvantages, but without a doubt, a very useful technological tool for teaching in different scenarios.*

*In addition, the Athenea magazine shows a classic theme, but with new analyses, such as the squirrel-cage motor, which always offers aspects of interest to industry and engineering in general.*

***Franyelit Suárez***  
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## Videogames in Education and Culture

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**Abstract:** This document presents the highlights of the influence of video games on teaching and disseminating culture in recent years. An exhaustive review was carried out on how education has benefited and enhanced using video games and their technological advances and their benefits to ensure the continuity of the curricula during the COVID-19 pandemic. Video games and their constant developments provide a tool that fosters the competencies and skills of students at all educational levels. New and better playful experiences have been developed that present players with more immersive situations are encouraging students to a greater interest in their learning process.

**Keywords:** Video games, Education, Culture, Teaching.

## Videojuegos en la Educación y la Cultura

**Resumen:** En este documento se presentan los aspectos más destacados sobre la influencia de los videojuegos en los procesos de enseñanza y difusión de la cultura en los últimos años. Se realizó una revisión exhaustiva sobre la manera en que la educación se ha visto beneficiada y potenciada por el uso de videojuegos y sus avances tecnológicos, así como sus beneficios para asegurar la continuidad de los planes de estudio en tiempos de pandemia por COVID-19. Los videojuegos y sus constantes desarrollos proporcionan una herramienta que fomenta las competencias y habilidades de los estudiantes en todos los niveles educativos, se han desarrollado nuevas y mejores experiencias lúdicas que presentan a los jugadores situaciones más inmersivas fomentando en los estudiantes un mayor interés en su proceso de aprendizaje

**Palabras Clave:** Videojuego, Educación, Cultura, Enseñanza.



## I. INTRODUCTION

Studies have been addressed considering multiple points of view of users, psychologists, educators, and video game creators who have seen an opportunity for teaching innovation in the educational aspect. Using video games encourages users' communicative attitudes regardless of origins and beliefs and allows collaborative work. The dynamic visualisation that accompanies video games facilitates the dissemination of knowledge using three-dimensional graphics that make the experience more attractive for students [1].

A new feature that videogames have today is the co-creation of content from a dynamic system of interaction that promotes participation, information, and dissemination of knowledge, which in turn allows promoting the critical thinking of users.

At present, many children and young people occupy video games as an entertainment option, in some cases, in addition, skills and abilities are developed. Due to the early contact that many children have with technology, the skills in the use of video games are easily acquired and offer great advantages compared to previous times, causing a transformation in interaction with other students, encouraging storytelling, facilitating activities, and improving learning. The ability to play with other users online improves interactions in two styles: social-mediated interaction between players and interaction between the player and the interface [2].

Many of the people related to the Gamer culture, use new live-streaming platforms, which are a new option to create a network of followers and even generate economic benefits, these are seen by many companies as a new way to advertise to young people and thus generate influence on consumers, where the goal is to encourage them to buy those games that are very popular in an environment.

## II. DEVELOPMENT

This section presents some aspects that have been evidenced about the impact of video games and their technologies in the field of education and culture.

### A. Influence of video games on education

Since video games appeared as a leisure and hobby option, their contribution to intellectual development and learning has been evaluated, improving teaching or the acquisition and improvement of specific cognitive skills in people who consume this type of entertainment. Currently, video games are used for recreational purposes within educational institutions looking for ways to attract the attention and concentration of students. Video games can strengthen attitudes such as perseverance, commitment, or effort, facilitate learning, and dynamically provide information to players. In addition, it has been proven that video games have a wide correspondence in the development of skills such as spatial processing, mathematical analysis, and computational analytical thinking [3].

According to, it is proposed that video games are a versatile technological tool fully integrated into society and can be directed to be used as a didactic element, taking advantage of its playful advantages. The communication of visual languages, sound effects, textual and graphics, can be better used within the class with the use of video games.

Video games can be used as a strategy to encourage reading habits since they have textual content and interaction boxes that allow the player to increase their concentration and improve their reading abilities. In addition, video games can favour phonetic development in word reading, comprehension, vocabulary, or memory performance [4]. It has been proven that the cognitive capacity developed depends on the genre of video game used, some of these abilities are the improvement of memory, comprehension, problem-solving, visual skills, perceptual discrimination, and spatial coordination.

Creativity is a skill of the human being, is also one of the primary objectives of education, therefore, video games such as Minecraft allow the player to create environments with infinite possibilities for their interaction. This video game has already been used in schools in Europe for several years [5].

Many of the skills that video games strengthen are widely used and demanded in adult life, such as the ability to solve problems and conflicts, rapid decision-making, and the ability to communicate information concisely and effectively.

With a moderate time of use of video games, children can improve some aspects such as response time, teamwork, creativity, focus, visual memory, strategy, leadership, improvement in language learning, and critical thinking [6].

Some platforms are used for the development of computational thinking in children, a clear example is a software called: SCRATCH, whose methodology allows children to create video games through a simpler programming language making this activity-friendly and attractive for early ages due to its functionality with blocks that contain different commands that encourage the use of the logic of the infant.

The most prestigious companies, today, look for those professionals who possess skills such as handling teamwork, efficient communication, punctuality, decision making under pressure, critical thinking, concentration, competitive strategy, among others, it is for this reason that video games have reached a level of integration complexity that together with practice allow to develop and strengthen the skills mentioned above. In several video games, to reach high levels, more than skill, qualities are valued to overcome challenges. Practices such as the applied to the workplace, show results such as increased productivity, leadership, problem-solving in critical situations, ability to communicate correctly in a concise way and work as a team to achieve objectives [7].

Given the current circumstances due to the effect of COVID-19, teachers have had to incorporate virtual alternatives to supplant recreational and practical activities. An example of this is the case of a history teacher, who cannot take his students to Greece, has chosen to teach Greek history and culture through the video game *Assassin's Creed*, which presents its plot in Ancient Greece, so that students when playing can know scenarios of that time and at the end make a report of their learning.

Due to the adaptation of new teaching strategies by teachers, video game developers have improved access on their platforms to educators, so that they use their video games as teaching methods for respective subjects [62]. This is the case of the video game called CAFET which consists of a card game where players represent the entrepreneurs of the coffee industry in Colombia. Following this, a study [8] analyzed how video games can develop innovation skills and understand observed behaviours. The results showed that participants perform actions that can engage and develop the innovator's DNA skills, specifically observe, associate and experiment.

Video games, today, are used as a powerful curricular resource within education [64], which has been used by teachers to motivate students of the new generation of "digital natives" through educational tools that meet their learning expectations motivating them towards knowledge, making the classroom a dynamic space, participatory and attractive. Serious games, gamification, and virtual reality are considered suitable to contribute to the social need to engage and entertain in learning and whose use has been accepted by the government of many countries by incorporating them into their educational programs [9].

According to [68, 69], a video game has to be of three types: sensorimotor, symbolic and rule-based. The first allows children to experiment with the movement of their body; symbolic play transfers experiences and fantasies about objects and actions important for the growth of the individual and finally, the game of rules that allows children to free them from egocentrism, leading them to structure models of problem solving (indispensable for growth and personal-social maturation). Video games have been shown to produce improvements in cognitive skills by improving the rate of learning on new tasks, which is associated with "learning to learn" [10].

Some video games have been created to cause interest in certain educational fields, as is the case of "Chemistry: the videogame", or academic programs for the area of mechanical engineering, these developments seek to transform the complexity of conception of problems into more inspiring situations for the student. Facilitating interactive participation can improve performance by at least 14% on the topics addressed in video games.

Longer time in video game use has been associated with a decrease in verbal intelligence, including evidence of changes in increased mean diffusivity in some areas of the brain and regardless of IQ [11].

### **B. Influence of video games on culture**

The video game is considered a product of contemporary culture since it has cultural values that can be reproduced in multiple formats, generating a cultural and industrial development that attracts the attention of the consumer. This influence is representative given that video games are used by a diversity of age groups, genders, sexualities, races, religions, ethnicities, and nationalities; and, in addition, they are present in fields such as education, mobile technology, workplaces, social events, as exhibition support in museums, the development of family interactions and other areas of daily life [12].

The video game industry has developed applications in the cultural field allowing the visualization of three-dimensional figures in motion, from light patterns that are reflected in animations to produce spatial images with transparency.

Within the video game industry, Microsoft Research has set a trend in the development of holographic

systems with its Holodeck project [78], which combines an optical screen and a Kinect camera to recreate an illusion of 3D interaction, whose digital objects respond to stimuli made by the hand, to perform bodily actions, such as: collect and rotate objects [79]. This possibility allows the viewer to manipulate and visualize an object of historical or cultural interest improving the visual quality and user interaction in the plot of the game. The inclusion of holograms is limited by processing capacity [13].

An example of a video game that promotes culture is the case of Paper Mario: The Origami King, which pays homage to Japan through a game where Japanese culture is captured throughout the development of this new saga, thus demonstrating locations such as samurai park and popular culture references such as songs and transformations of mythological animals that represent the four elements.

The video game that promotes a culture in Fortnite, is a multiplatform game that creates different themes in each season, allowing the user to experience different survival techniques in each game that is made up of 100 players. The new generations are increasingly involved within this culture that goes hand in hand with technological advancement, thus creating a gamer culture that extends among children and young people.

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The video game has been considered as a new form of art, because it has some fundamental elements that are by the classic concepts that have manifested themselves within the sociology of art, such as: transcending the object, focusing on reactions, and focusing on the sensations it generates in people, thus being a medium that not only allows to entertain people but to create new environments or worlds that help generate knowledge in society [84]. Video games are used as a method of teaching history, whereby involving the player in different scenarios, they can know the culture or way of life of a place, such is the case of the game East of the Rockies, a game that shows students the life of the Japanese throughout the development of World War II.

Some video games use virtual reality, which includes the most important features: (1) It is ideal for the dissemination of archaeological content since it allows an attractive presentation mode thanks to stereo visualization and realistic immersion sensations; (2) provides a high level of detail throughout the sailing experience, without incurring any damage to archaeological remains; (3) allows users to observe more details than they would observe on an on-site visit to the site; (4) makes it possible to convert an archaeological site into portable heritage, opening up the possibility of extending the visit to vulnerable groups, in particular, those with reduced mobility. [15]

In the field of games, film adaptations are an increasingly common feature within modern culture making it more common. The video games played today are different from those played two decades ago, just like the movies we watch, as well as the types of movies you watch about video games differ greatly from those before. How video games adapt cinematic techniques and stories are also different. This is because both media are shaped by the intersection of historical, technological, social, cultural, and economic factors.

### III.METHODOLOGY

To obtain the criteria addressed in this document, a bibliographic search was carried out in related scientific articles, websites of video game industries, reports of socialization events of new advances in video games and informative magazines published on the web.

The keywords used in the search were very diverse and specific groups of articles were not located to perform filtering with a significant number.

The review contemplated the criteria and arguments raised from the educational approach and the practicality presented by video games in their contribution to the teaching process.

### IV.RESULTS AND DISCUSSION

The educational field has benefited strongly since multiple video games were incorporated into the academic



curriculum at all educational levels.

The reach of video games has expanded to other forms of culture such as cinema, which has gone on to create scripts based on video games. The sculpture has also benefited in the visualization that virtual reality takes through the form of video games that allow a better interaction and experience for the visitor.

Many Universities have chosen to include in their academic programs, the use of video games to strengthen their teaching processes, video games have become more specific in the development of competencies related to some subjects, however, one of the best contributions are video games that allow learning to learn, since, with their use, students strengthen their attitude towards study.

The developments and technologies that have been driven by the advancement of video games are becoming learning tools such as augmented, virtual and mixed reality glasses. It can be considered that these technologies in a short time will be useful not only in the educational aspect but also in all other areas of society.

## V.CONCLUSIONS

Playing video games daily improves visual attention span, efficiency in changing and performing tasks, speed in tasks related to visual search or discrimination of objects and tools by colors and shapes. In addition, it contributes to the involvement by achieving multiple objectives and the execution of different tasks in the same temporary space.

Learning with video games is possible. In fact, they present very diverse and generally more playful contexts, which is why they tend to increase the motivation of the youngest. They also help children with learning disabilities or who are at risk of social exclusion. In short, the little ones can learn while having fun through these virtual games.

Sex is a fundamental part in the stories of some video games. The illustration of disproportionate bodies and the presentation of women as a single sexual object causes, in some cases, the assimilation by the players of these factors as if they were real.

Those children who play violent games can be affected in the medium and long term by negative effects that prevent them from developing a sense of social justice and belonging. The absence of dialogue in many video games also encourages violence as a way to resolve conflicts.

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## Simulación de fallas de motores de inducción tipo jaula de ardilla en media tensión

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**Recibido (04/03/22), Aceptado (07/04/22)**

**Resumen:** El presente trabajo tuvo como objetivo principal modelar fallas de los motores de inducción rotor jaula de ardilla, presentamos las ecuaciones matemáticas que modelan las variables de la máquina, simulamos un motor de inducción en el software Matlab, para conocer y evaluar los efectos de los devanados estáticos cuando el motor experimenta faltas a su funcionamiento como cortocircuito entre espiras que existen muchas metodologías de diagnóstico para cada clase de falla. La técnica de mayor uso es el análisis del espectro de frecuencias de una o varias señales del motor. Una falla en el motor, representa una asimetría con respecto a su construcción, en consecuencia, en las señales eléctricas aparecen componentes armónicas que se relacionan con la falla presente el análisis espectral de firmas de corriente del motor aplicando la transformada rápida de Fourier (FFT) a la corriente ya que estas, contienen información relevante que se distingue en un espectro de frecuencias.

**Palabras Clave:** Maquina inducción, cortocircuito, detección de fallo, FFT.

## Fault simulation of medium voltage squirrel cage induction motors

**Abstract:** The main objective of this paper is to model failures of squirrel cage rotor induction motors, it presents the equations that model the machine variables, we simulate an induction motor in the Matlab-Simulink software, to know and evaluate the effects of the stator windings when the motor experiences failure to function as a short circuit between spirals that there are many diagnostic methodologies for each class of failure. The most widely used technique is the analysis of the frequency spectrum of one or several motor signals. A fault in the motor represents an asymmetry with respect to its construction; consequently, harmonic components appear in the electrical signals that are related to the present fault, the spectral analysis of motor current signatures applying the fast Fourier transform (FFT) to the current since these contain relevant information that is distinguished in a spectrum of frequencies.

**Keywords:** Induction machine, short circuit, fault detection, FFT.



## I. INTRODUCCIÓN

Desde que Mikhail Dolivo Dobrovolsky en 1889 construyó a escala comercial el primer modelo de prototipo de un motor de inducción trifásico, este actualmente se conserva en todas las máquinas de inducción [1]. El mismo se ha convertido en el más usado en la industria, debido a que la mayoría de los sistemas actuales de distribución de energía eléctrica suministran corriente alterna además que son robustos y sencillos en diseño, construcción y reparación. En el ámbito industrial se emplean generalmente motores grandes, trifásicos con elevado costo de mantenimiento y reparación. Dada la abundancia que tienen en la mayoría de los sectores industriales, son de mucha importancia y de especial atención en el área de mantenimiento puesto que el correcto funcionamiento en las industrias va a depender del porcentaje de estas máquinas presentes en la instalación. Cada día resulta más necesario conocer el estado de las máquinas de inducción, para así poder realizar la detección de fallo que puedan aparecer, incluso cuando todavía se encuentran en un estado incipiente. Existen numerosas razones que pueden causar falla en un motor, como un corto entre espiras, pérdida de aislamiento, etc. Si estas fallas no son atendidas, se puede originar una rápida degradación del devanado; requiriendo al final, un reemplazo de motor. Existen diversas investigaciones publicadas donde se muestra, que existen muchas metodologías de diagnóstico para cada clase de falla. La técnica de mayor uso es el análisis del espectro de frecuencias de una o varias señales del motor. Una falla en el motor, representa una asimetría con respecto a su construcción, en consecuencia, en las señales eléctricas aparecen componentes armónicas que se relacionan con la falla presente. Dentro del análisis espectral está el análisis de firmas de corriente del motor, en la cual se aplica la transformada rápida de Fourier (FFT) a la corriente de una de las fases del estator cuando existe alguna asimetría, las corrientes del estator contienen información relevante que se distingue en un espectro de frecuencias.

## II. DESARROLLO

### A. Modelo del Motor de Inducción con resistencias explícitas

Resulta fundamental conocer los modelos de las máquinas eléctricas respecto al diagnóstico de fallas de las mismas, y en particular, el software Matlab implementa un Modelo dinámico del motor de inducción [2]. El programa permite la simulación dinámica de motores eléctricos en Simulink, plataforma que proporciona un entorno gráfico y un conjunto de bibliotecas de bloques, Simcape una extensión de bloques que nos permite modelar máquinas eléctricas, estos bloques de la máquina implementado en el software, usa la teoría de la máquina generalizada (modelo dq) y puede modelar motores con jaula de ardilla simple.

#### Modelo del motor

El modelo parte de la teoría clásica del motor de inducción expresando las variables eléctricas en forma compacta por las siguientes ecuaciones [3]:

$$\begin{aligned}
 v_s^{abc} &= [v_{as} \ v_{bs} \ v_{cs}]' \\
 v_r^{abc} &= [v_{ar} \ v_{br} \ v_{cr}]' \\
 v_s^{abc} &= [v_{as} \ v_{bs} \ v_{cs}]' \\
 I_s^{abc} &= [I_{as} \ I_{bs} \ I_{cs}]' \\
 I_r^{abc} &= [I_{ar} \ I_{br} \ I_{cr}]' \\
 \lambda_s^{abc} &= [\lambda_{as} \ \lambda_{bs} \ \lambda_{cs}]'
 \end{aligned} \tag{1}$$

$$\lambda_r^{abc} = [\lambda_{ar} \ \lambda_{br} \ \lambda_{cr}]'$$

$$R_s^{abc} = \begin{bmatrix} R_S & 0 & 0 \\ 0 & R_S & 0 \\ 0 & 0 & R_S \end{bmatrix}$$

$$R_r^{abc} = \begin{bmatrix} R_r & 0 & 0 \\ 0 & R_r & 0 \\ 0 & 0 & R_r \end{bmatrix}$$

Al transformar el modelo en el marco de referencia arbitrario se convierte en:

$$T_{qd0}(\theta)v_s^{abc} = T_{qd0}(\theta)R_s^{abc}T_{dq0}^{-1}(\theta)T_{qd0}(\theta)I_s^{abc} + T_{qd0}(\theta)p[T_{dq0}^{-1}(\theta)T_{qd0}(\theta)\lambda_s^{abc}] \quad (2)$$

$$\begin{aligned} T_{qd0}(\theta - \theta_r)v_r^{abc} \\ = T_{qd0}(\theta - \theta_r)R_r^{abc}T_{dq0}^{-1}(\theta - \theta_r)T_{qd0}(\theta - \theta_r)I_r^{abc} \\ + T_{qd0}(\theta - \theta_r)p[T_{dq0}^{-1}(\theta - \theta_r)T_{qd0}(\theta - \theta_r)\lambda_r^{abc}] \end{aligned}$$

Donde

$$T_{qd0}(\theta) = \frac{2}{3} \begin{bmatrix} \cos\theta & \cos\left(\theta - \frac{2\pi}{3}\right) & \cos\left(\theta + \frac{2\pi}{3}\right) \\ \text{sen}\theta & \text{sen}\left(\theta - \frac{2\pi}{3}\right) & \text{sen}\left(\theta + \frac{2\pi}{3}\right) \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \end{bmatrix} \quad (3)$$

La ecuación (3) se reduce a

$$v_s^{dq0} = T_{dq0}(\theta)R_s^{abc}T_{dq0}^{-1}(\theta)I_s^{dq0} + w \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \lambda_s^{dq0} + p\lambda_s^{dq0} \quad (4)$$

$$v_r^{dq0} = T_{dq0}(\theta - \theta_r)R_r^{abc}T_{dq0}^{-1}(\theta - \theta_r)I_r^{dq0} + (w - w_r) \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \lambda_r^{dq0} + p\lambda_r^{dq0} \quad (5)$$

Si las resistencias de los devanados del estator son iguales ( $R_{sa} = R_{sb} = R_{sc} = R_s$ ) entonces resulta:

$$T_{dq0}(\theta)R_s^{abc}T_{dq0}^{-1}(\theta) = T_{dq0}(\theta) \begin{bmatrix} R_s & 0 & 0 \\ 0 & R_s & 0 \\ 0 & 0 & R_s \end{bmatrix} T_{dq0}^{-1}(\theta) = \begin{bmatrix} R_s & 0 & 0 \\ 0 & R_s & 0 \\ 0 & 0 & R_s \end{bmatrix} = R_s^{dq0} \quad (6)$$

Es decir, la transformación es invariante para los elementos estáticos, de igual forma, si las resistencias de los devanados del rotor son iguales ( $R_{ra} = R_{rb} = R_{rc} = R_r$ ) Se tiene:

$$T_{dq0}(\theta - \theta_r) R_r^{abc} T_{dq0}^{-1}(\theta) = T_{dq0}(\theta - \theta_r) \begin{bmatrix} R_r & 0 & 0 \\ 0 & R_r & 0 \\ 0 & 0 & R_r \end{bmatrix} T_{dq0}^{-1}(\theta - \theta_r) = \begin{bmatrix} R_r & 0 & 0 \\ 0 & R_r & 0 \\ 0 & 0 & R_r \end{bmatrix} = R_r^{dq0} \quad (7)$$

Sin embargo al considerar las resistencias desiguales, resulta:

$$\begin{aligned} T_{dq0}(\theta) R_s^{abc} T_{dq0}^{-1}(\theta) &= T_{dq0}(\theta) \begin{bmatrix} R_{Sa} & 0 & 0 \\ 0 & R_{Sb} & 0 \\ 0 & 0 & R_{Sc} \end{bmatrix} T_{dq0}^{-1}(\theta) \\ &= \begin{bmatrix} \frac{2}{3}R_{Sa} + \frac{1}{6}R_{Sb} + \frac{1}{6}R_{Sc} & \frac{\sqrt{3}}{6}(R_{Sb} - R_{Sc}) & \frac{2}{3}R_{Sa} - \frac{1}{3}R_{Sb} - \frac{1}{3}R_{Sc} \\ \frac{1}{6}(R_{Sb} - R_{Sc}) & \frac{1}{3}(R_{Sb} - R_{Sc}) & \frac{\sqrt{3}}{3}(R_{Sb} - R_{Sc}) \\ \frac{1}{3}R_{Sa} - \frac{1}{6}R_{Sb} - \frac{1}{6}R_{Sc} & -\frac{\sqrt{3}}{6}(R_{Sb} - R_{Sc}) & \frac{1}{3}(R_{Sa} + R_{Sb} + R_{Sc}) \end{bmatrix} \\ &= \begin{bmatrix} R_{s11} & R_{s12} & R_{s13} \\ R_{s21} & R_{s22} & R_{s23} \\ R_{s31} & R_{s32} & R_{s33} \end{bmatrix} \end{aligned} \quad (8)$$

De igual manera para el rotor se tiene

$$T_{dq0}(\theta) r_s^{abc} T_{dq0}^{-1}(\theta) = \begin{bmatrix} R_{r11} & R_{r12} & R_{r13} \\ R_{r21} & R_{r22} & R_{r23} \\ R_{r31} & R_{r32} & R_{r33} \end{bmatrix} \quad (9)$$

Sustituyendo (8) y (9) en (2)

En notación matricial:

$$V = (W \cdot L + R) \cdot I + L \cdot pI \quad (10)$$

Al despejar la derivada de la corriente se obtiene:

$$pI = -L^{-1}(W \cdot R)I + L^{-1}V \quad (11)$$

El modelo del motor de inducción en el marco de referencia fijo al estator, considerando los efectos de resistencias distintas es:

$$\begin{bmatrix} \dot{I}_{qs} \\ \dot{I}_{ds} \\ \dot{I}_{qr} \\ \dot{I}_{dr} \\ \dot{w}_r \end{bmatrix} = \begin{bmatrix} \zeta(-L_r R_{s11} I_{qs} - (L_r R_{s12} + n_p w_r M^2) I_{ds} + M R_{r11} I_{qr} + (R_{r12} - n_p w_r L_r) M I_{dr} + L_r V_{qs} \\ \zeta(-(L_r R_{s21} + n_p w_r M^2) I_{qs} - L_r R_{s22} I_{ds} + (R_{r21} - n_p w_r L_r) M I_{qr} + M R_{r22} I_{dr} + L_r V_{ds} \\ \zeta(M R_{s11} I_{qs} - (M R_{s12} + n_p w_r L_s M) I_{ds} + L_s R_{r11} I_{qr} + (R_{r12} - n_p w_r L_r) L_s I_{dr} + M V_{qs} \\ \zeta((M R_{s21} + n_p w_r L_s M) I_{qs} + M R_{s22} I_{ds} - (R_{r21} + n_p w_r L_r) L_s I_{qr} - L_s R_{r22} I_{dr} - M V_{ds} \\ \frac{3n_p M}{2J} (I_{qs} I_{ds} - I_{qr} I_{dr}) - \frac{B}{J} w_r - \frac{T_L}{J} \end{bmatrix} \quad (12)$$

Dónde:

$R_{sij}, R_{rij}$  = Resistencias del estator y rotor respectivamente para  $i, j : 1...3$

$L_s, L_r$  = Inductancias de los devanados del estator y rotor respectivamente

$M$  = Inductancia mutua  $p$  n Número de pares de polos del motor

$T_L$  = Par de carga

$B$  = Coeficiente de fricción viscosa

$J$  = Inercia total

$\Omega_r$  = Velocidad mecánica de rotación

$I_{ds}, I_{qs}, I_{dr}, I_{qr}$  = Corrientes de estator y rotor en el marco de referencia fijo al estator

$V_{ds}, V_{qs}$  = Voltajes de alimentación en el marco de referencia fijo al estator

### Fallas en el estator o armadura

El devanado del estator consta de bobinas de alambre de cobre aislado distribuidas en ranuras alrededor de la superficie del estator. Las fallas en el devanado del estator son a menudo causadas por fallas en el aislamiento entre dos espiras adyacentes en una bobina. Esto es llamado una falla entre vuelta-vuelta o cortocircuito en el devanado. Las corrientes inducidas resultantes producen calentamiento adicional y causan un desequilibrio en el campo magnético de la máquina. Se pueden dañar las máquinas debido al sobrecalentamiento de los sistemas de aislamiento, por lo que se pueden instalar en el estator sensores de temperatura en posiciones estratégicas.

Existe una expresión que nos permite encontrar la frecuencia característica de los cortocircuitos. [4]

$$f_{cc} = f_1 \left\{ \frac{n}{p} (1 - s) + / - k \right\} \quad (13)$$

Donde

$f_{cc}$  = frecuencia característica de la componente producida por el cortocircuito;

$f_1$  = frecuencia de la red de alimentación.

$n = 1, 2, 3, \dots$ ;

$k = 1, 3, 5, \dots$ ;

$p$  = número de pares de polos

$s$  = deslizamiento

### Ruptura de las barras del rotor y fallas en los anillos

La detección de este fallo se puede suceder debido a la fractura de una de las barras o de uno de los anillos del rotor, lo que convierte al rotor en un circuito trifásico (3I) desbalanceado. Este desbalance se manifiesta por medio de la circulación de corrientes de secuencia negativa. Como consecuencia de ello, se establece un campo magnético que gira en sentido contrario a la rotación del rotor, este campo giratorio provoca un nuevo par sobre el rotor, a una frecuencia [4]:



$$f_0 = 2 \cdot s \cdot f_1 \quad (14)$$

Este par, a su vez, ocasiona una oscilación en la velocidad del rotor, cuya amplitud depende de la inercia acoplada. Tales oscilaciones afectan a las corrientes del estator, sobre las cuales se inducen las denominadas bandas laterales, dadas a las frecuencias:

$$f_s = (1 \pm 2 \cdot s) \cdot f_1 \quad (15)$$

Estas bandas laterales permiten identificar claramente fallas en el rotor, las frecuencias a las que se manifiestan son función del deslizamiento del motor y su amplitud es fuertemente dependiente del estado de la carga. Un diagnóstico correcto exige como mínimo que el motor se encuentre por encima de la mitad de su carga nominal. Algunas cargas que presentan pares pulsantes (tales como los compresores) pueden provocar bandas laterales similares a las producidas por una falla e interferir en el diagnóstico.

### III.METODOLOGÍA

#### A.Simulación de fallas en el Motor de Inducción

El modelo presentado tiene la posibilidad de provocar fallas de corto circuito y circuito abierto en cualquiera de las tres fases, ya sea del estator o rotor, En esta parte se realizó la simulación en matlab simulink utilizando los parámetros de un motor de inducción de media tensión con las características siguientes:

Tabla 1. Características del motor.

<b>MOTOR</b>	
Tipo de Maquina	ABB TRAFO
Aislamiento/ aumento de temp.	POV/10.000/123
Ambiente de max. temperatura	1999
Potencia mecánica de salida nominal	1500HP
Voltaje Nominal	6600V
Frecuencia	60 Hz
Velocidad	892rpm
Corriente Nominal	123Amp
Factor de Potencia.	0.83
Torque	8834 lb-ft

Los parámetros, resistencias del estator y rotor, Inductancias de los devanados del estator y rotor, Inductancia mutua fueron estimados en el software Etap versión 12.6.0. A continuación mostramos el montaje en simulink del modelo del motor ensayado

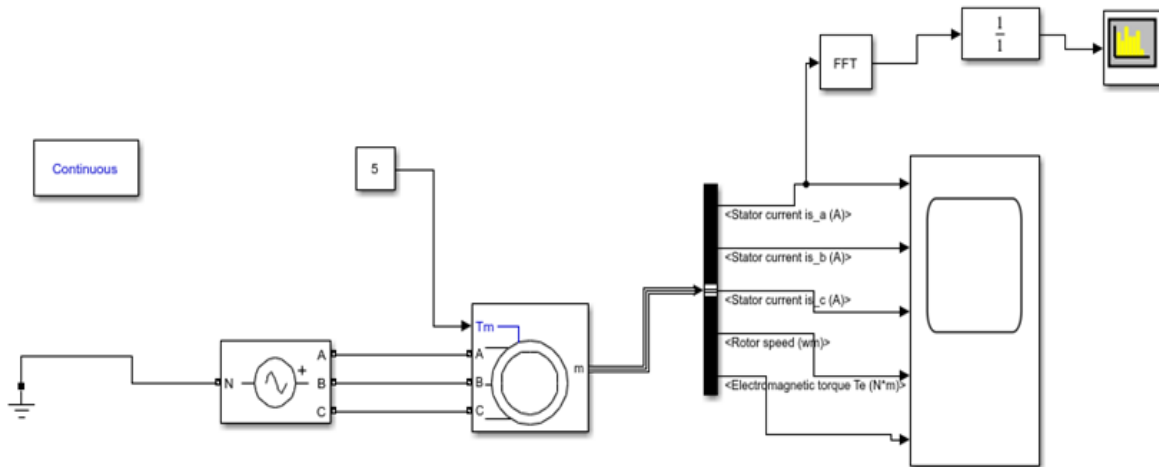


Fig. 1. Simulación de motor jaula de ardilla de media tensión en Simulink

#### IV.RESULTADOS

Se trata de simular el espectro de frecuencia del motor trabajando en condiciones ideales acorde a su diseño, como se muestra a baja carga no existen bandas laterales .

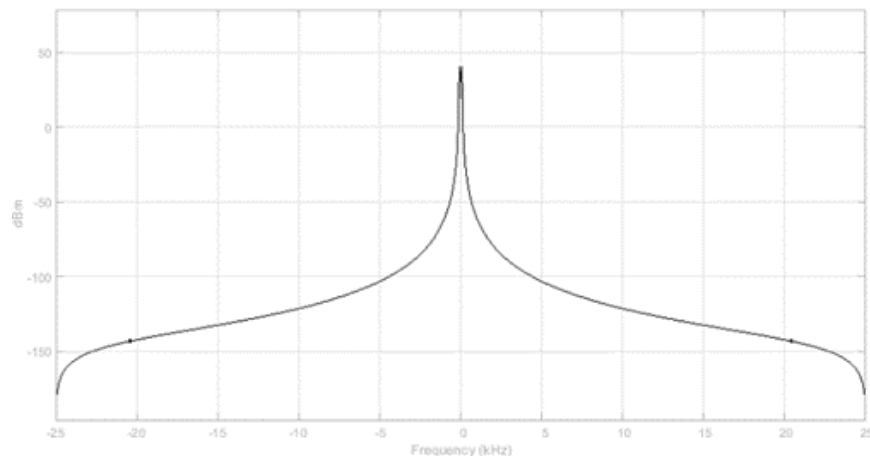
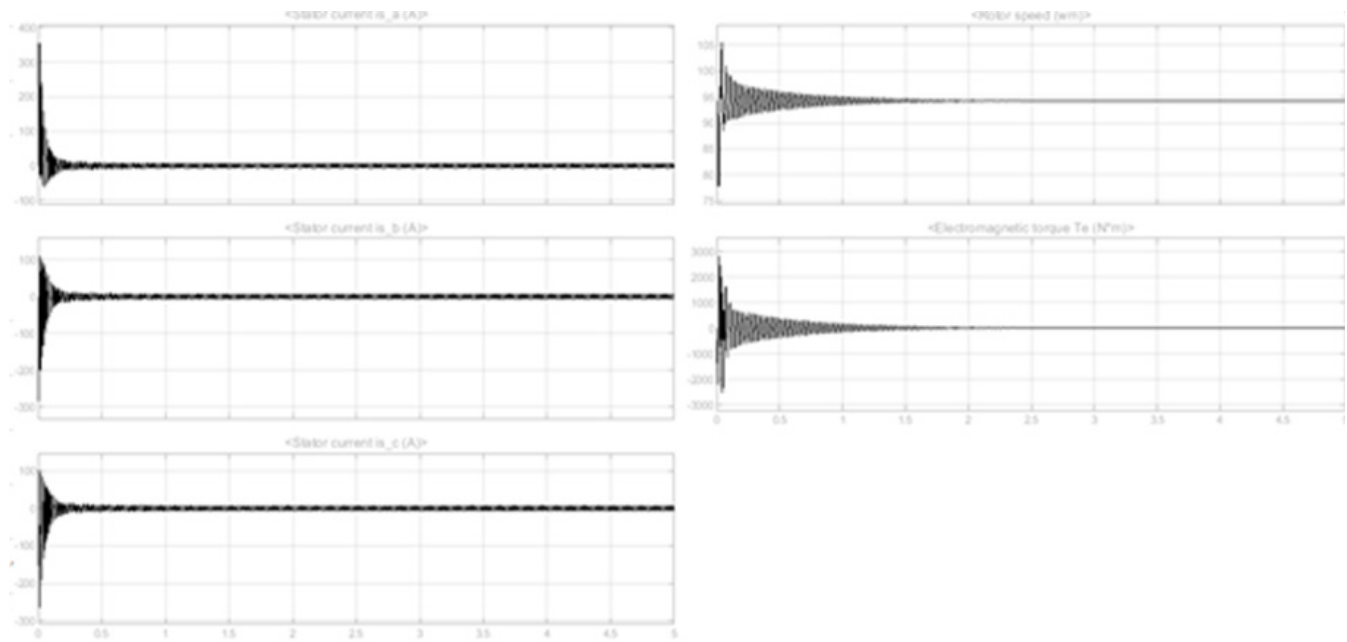
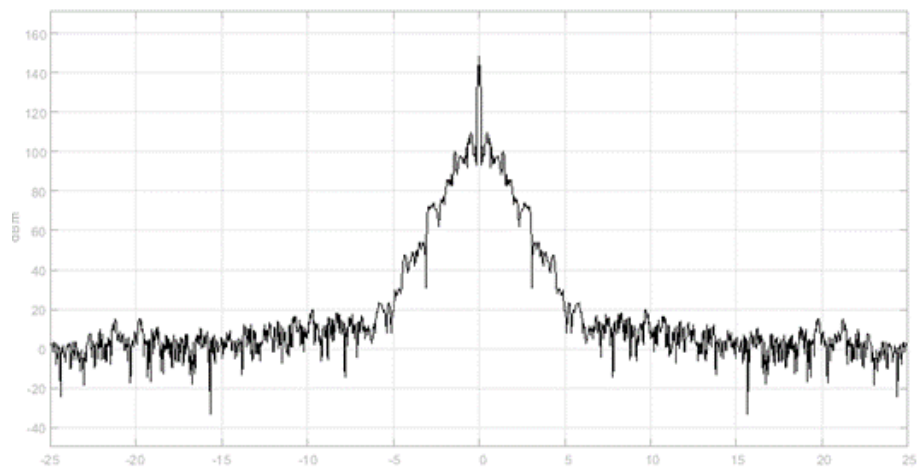


Fig. 2. Espectro de la corriente en la fase A motor sano.

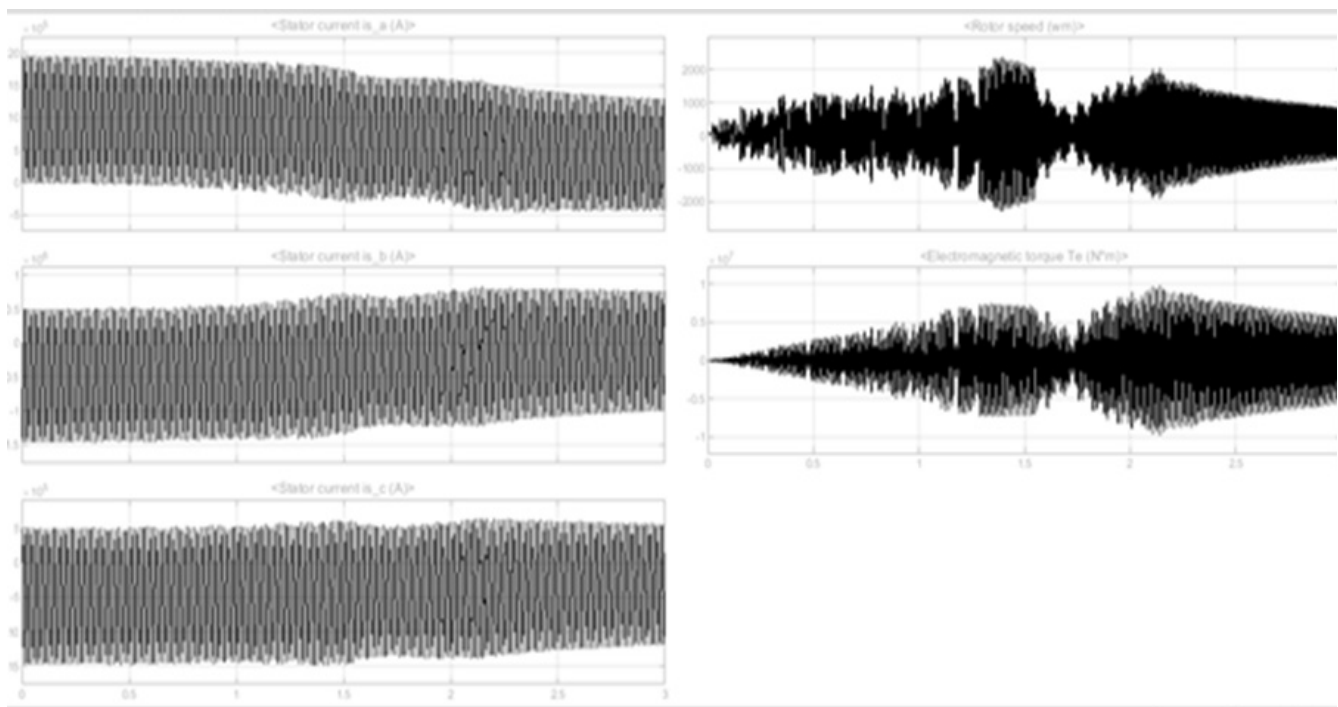


**Fig. 3** Corriente en la fase A, Corriente en la fase b, Corriente en la fase C, Velocidad del rotor Torque electromagnético de la máquina, motor sano

En las figura 2 y 3, en 2 se muestra el espectro de frecuencia de la corriente y en 3 el desarrollo de la corriente en cada fase, velocidad, el par generado, a continuación alteramos las resistencias e impedancias de la máquina para inducir una falla del sistema y observar el comportamiento del patrón del espectro de frecuencia.



**Fig. 4.** Espectro de la corriente motor en falla



**Fig. 5. Corriente en la fase A, Corriente en la fase b, Corriente en la fase C, Velocidad del rotor Torque electromagnético de la máquina, motor Fallado**

En las figura 4 y 5, en 4 se muestra el espectro de frecuencia de la corriente con el motor fallado y, en 5 el desarrollo de la corriente en cada fase, velocidad, el par generado, cuando hemos alterado las resistencias e impedancias de la máquina para inducir una falla del sistema y observar el comportamiento del patrón del espectro de frecuencia, podemos observar la aparición de las bandas laterales en todo el espectro de frecuencia, si bien otros autores han demostrado que existe patrones alterados cuando se aumenta la carga del sistema es de notar que se puede estudiar más a fondo haciendo comparación con inteligencia artificial, técnicas de análisis de datos, o recurrir al estudio de los invariantes de la dinámica para establecer comparaciones cuando existen fallas o cuando existen cambios en la carga y poder discriminar las fallas del sistema y caracterizar cada una de ellas.

## V. CONCLUSIONES

Al contar con los modelos de fallas experimentados en simulación, es posible obtener un conjunto de datos que permitan caracterizar el comportamiento de los devanados de un motor trifásico, cuando este es sometido a condiciones anormales de funcionamiento. La caracterización de los resultados podría permitir obtener modelos de comportamiento para la detección de fallos y diagnosticar la máquina de inducción. A partir de estos resultados se daría la posibilidad de crear sistemas expertos que permite detectar las fallas en los motores eléctricos y así planificar acciones preventivas para evitar fallas catastróficas en el futuro. Algunos de los tipos de fallas presentes en los devanados se pueden detectar por análisis de la FFT de la corriente, cuando aún se encuentren en estado prematuro. El principio para encontrar las frecuencias de falla es preciso, ya que los valores de frecuencias de falla que aparecen en el espectro de la FFT de la corriente se pueden determinar a través búsqueda en dicho espectro.

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## RESUMEN CURRICULAR



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## Technologies and Videogames: Influences on society

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**Abstract:** In the following paper we present the result of an exhaustive review on how contemporary video games influence multiple social aspects such as health, psychology, family, entertainment, economics and international conflicts. It also addresses the trends for the near future on the use and influence of video games in society, their consequences and trends. Multiple scientific articles and websites specialised in the video game industry were reviewed, from which information has been obtained on how they contribute to society. The video game industry quickly incorporates solutions to many social problems directly and indirectly, and their incorporation into society will soon become a prevailing need.

**Keywords:** Video Games, Technologies, Influence, Society

## Tecnologías y Videojuegos: Influencias en la sociedad

**Resumen:** En el siguiente trabajo presentamos el resultado de una revisión exhaustiva sobre la manera en que los videojuegos contemporáneos influyen en múltiples aspectos sociales como la salud, psicología, familia, entretenimiento, economía y conflictos internacionales. Se aborda además las tendencias a un futuro próximo sobre el uso y la influencia de los videojuegos en la sociedad, sus consecuencias y tendencias. Se revisaron múltiples artículos científicos y sitios web especializados en la industria de los videojuegos, a partir de los cuales se ha obtenido información sobre la manera en que estos aportan a la sociedad. La industria de los videojuegos incorpora a gran velocidad soluciones a muchos problemas sociales de manera directa e indirecta y su incorporación en la sociedad muy pronto se tornará una necesidad imperante.

**Palabras Clave:** Videojuegos, Tecnologías, Influence, Sociedad.



## I. INTRODUCTION

Video games, since their appearance, caught the attention of a society that, in principle considered them a leisure tool, while, at present, they are perceived by users, as an alternative to the improvement of emotional well-being as opposed to the classic point of view that games incite violence and antisocial behaviours.

Multiple studies have been developed on topics related to the influence of video games on society, some works defend the view that their use increases aggressive behaviour, increases emotional outbursts, and decreases inhibition [3].

The points of view that have been raised around the components of violence in video games have been relative to the time, being, in the beginning, the game *Missile Comand* (1980) was catalogued as violent even though it represented bombs and missiles through dots and stripes respectively. *PacMan* was later considered violent as he ate those who persecuted them, while, at present, violence has a more realistic and three-dimensional approach with dismemberments and blood that conveys violent messages as an attractive element for video games.

In addition, it is important to note that many people can be influenced by their environment, falling into an addiction, in which young people invest a large part of their time to interact through virtual environments, whose behaviour does not correspond to their conventional way of interacting between people in their real environment.

The industries dedicated to the production of video games develop events that aim to bring together high-level Gamers to compete in tournaments with international participation to promote their new developments and disseminate them through platforms such as Twitch, YouTube Gaming, and Mixer [6].

In the field of entertainment, the most accepted video games by young people are *Fortnite*, *GTA*, and *The Legend of Zelda*, which generate an addiction in their users causing great concern in parents due to the considerable time their children invest in these games. The concern is that the player diverts his attention to these games by downplaying the importance of studies, adopting changes in behaviour and isolation by not conventionally sharing new experiences with the outside world.

Experts state that the use of video games as a hobby potentiates cognitive and social skills, by the fact of fulfilling the sole purpose of winning and exceeding their expectations. The player is prone to conceive, through the video game, a world valued between good and bad in a way that rewards successes and punishes errors, and problems can arise when the user applies these assessments in real life.

Despite the violent content with the use of weapons, malicious feelings, and their possible alterations in real life, experts explain that video games allow adolescents to reflect on values and behaviours through their use and allow them to recognize the consequences of the actions they carry out virtually. These reflections happen because the social environment of video games allows users to exchange socio-cultural norms and values to generate perspectives of participation and apply their conclusions [11]. In contrast to the previous statement, they have developed video games that induce the intention to steal and murder, as is the case of games of the *Grand Theft Auto* type, in which these actions are essential to winning the game by acquiring both skills and abilities.

## II. DEVELOPMENT

Despite the existence of a great variety of social aspects that are influenced by video games, the following areas have been considered and grouped in this study: family, psychology and health, education, culture, entertainment and leisure, politics and international conflicts, economics, and finally as a service [12].

### A. Influence of video games on the family environment

Social and family relationships are influenced by the quality of their communication and ways of obtaining information from the environment. Video games are also a means of communication and require families to intervene, promoting a rational and critical consumption of video games, whose users are mostly young.

According to, the bond between parents and children was greater when they played video games together and suggests that the relationship is strengthened to a greater extent if the act of playing represents a shared interest of both. He also warns that playing as a family regularly can have a positive impact on strengthening intra-family relationships. The considerable time that a family compares a video game contributes positively to their communication. A family member may not like a specific conversation, however, common interest in a video game can facilitate family interaction [17].

Families with poor family communication benefit much more from shared play than those with high family communication. Additionally, the use of kinetic controllers in addition to benefiting health, promotes a time shared

with the family promoting physical activity.

As for the mood of people, the use of Wii-type games generates a lower sense of loneliness for the elderly and concerning those who only watch television.

Gambling addiction has as its origin in many cases, poor quality in the family relationship. For example, female gamblers begin their taste for gambling by trying to escape childhood disorders as if the game were anaesthesia or hypnotic effect.

Dysfunctional households that present a family problem between members increase the probability of exposure in young members to dysfunctional situations in a virtual context, such as the use of violent video games.

Inclusive video games have been implemented, which help children with neuromotor disabilities, and incorporate them into society starting with their own family and interacting with it through video games [23].

Parenting styles and family rules within the home about video games are a significant factor in reducing the negative effects due to video game use, especially with increased aggressiveness.

### **B. Influence of video games in the field of Psychology and Health**

Since the beginning of the video game boom, psychologists have expressed a controversy between whether video games are considered malicious or good for human behaviour from the point of view of their short- and long-term effects.

Due to the considerable time invested by users to entertain themselves with video games of violent content, psychologists have conducted Stroop tests to evaluate the cognitive effects and lack of attention in such users. The results reflected in these tests are positive effects on people who invest a short time in playing video games and who test all their senses to understand the gameplay of video games [27].

In the use of online video games, frequency and duration are the most important parameters that influence effects on users. Positive effects of online video games have been found in children, including decreased anxiety, obesity, autism, amblyopia, psychiatric disorders, improved intrinsic motivation, visual attention, visual-spatial ability, and physical activity.

There is evidence that the use of video games combats sleep difficulties and poor quality of life in adolescents, an effect observed during the COVID-19 pandemic, anxiety has been reduced and with it its influence on the effects of sleep disorders and insomnia.

According to, if the user remains playing video games for a reasonable time, possible benefits can be maximized and be safe (that is, not to induce behavioural and emotional lack of control). However, this topic needs to be studied further, also considering the variables related to psychopathological dysfunctions.

The high state of anxiety of young people due to the disorder and load of daily activities can affect their overall performance. Experts affirm that today, video games are an effective therapy to reduce anxiety and conflicting behaviours in the socialization of young people. This is the case of the new genre of video games: "serious games" or games for therapeutic purposes, whose purpose is to create gamer entertainment content, which can rehabilitate the various disorders of young people [31].

Most video games produce greater interest to users of the male gender, this has caused the female gender not to feel identified or comfortable with the use of many video games. Currently, the video game industry generates developments that improve the inclusion of both genders, promoting gender equality and expanding its target market. The "My Game My Name" movement invites users to use nicknames according to their preferences without the fear of being judged.

According to what is stated in, it is proposed that playing video games increases the satisfaction of improving the living conditions and mental well-being of the player positively, allowing him to improve his mood, minimize his emotional disorders, promote relaxation and reduce daily stress.

Medical research highlights that video games can be used in the field of health as a type of analgesic therapy that can be provided to young people and children before surgical interventions to reduce states of stress and anxiety, keeping them focused on the gameplay of video games. Doctors say that the cognitive distraction provided by video games causes pediatric cancer patients to suffer less from the pains of chemotherapies.

According to, video games bring benefits in improving the multitasking approach and working memory. While, as risks, it is possible to incur a lower educational and professional level, problems of interrelating with peers, and reduction of social skills. The therapeutic effects of video games include treatments on some identified risks such as difficulty making new friends in real life, stress and maladaptive coping, lower social well-being and feelings



of loneliness, psychosomatic problems, and decreased academic performance [38].

Motor coordination, attention, memory, and problem-solving are additional benefits that provide the proper use of video games, also allowing to generate skills such as visual and auditory skills in players.

Video games are useful in the field of physical rehabilitation therapy, however, their usability is limited for some groups, such as the elderly or patients with Parkinson's diseases. Cases of patients with Parkinson's have been studied.

The video game industry has also developed its products so that people with physical disabilities, limited mobility, and communication problems can use video games and therefore benefit from their contributions to health.

### **C. Influence of video games on entertainment and leisure**

For the creators of the first video games, these were not developed for use in entertainment but rather as a means of knowing if a computer could solve problems with a series of algorithms, after which the video game industry once consolidated evolved in its technology, tools and applications; it gradually increased its market towards consumers from other age groups, becoming one of the most profitable. Today video games are one step away from becoming the largest of the cultural and entertainment industries, ahead of books, cinema, or music. Video games of a violent nature and the use of weapons, according to [45], have even contradictorily become a way to turn the mechanics of panic and terror into fun and entertainment.

What in the past represented a mere form of distraction, has now been transformed into an immersive experience that allows the video game player to experience the same type of sensory perceptions, feelings, and emotions already experienced in other entertainment media, such as literature, music, theatre or movies; with the advantages of offering an appreciable improvement in the personal experience of the user, since it offers the possibility of concentrating on the narrative from a directive and active interaction.

In the current COVID-19 pandemic, it drew attention as the World Health Organization recommended the use of video games in periods of confinement, strictly for the aspect of understanding, and avoid addiction to it, it was amended that these are used for times less than 4 hours per week.

According to [48] Everyday video games are located within the fundamental aspects of culture since people from all over the world migrate to digital spaces for social purposes and entertainment. According to, young men between the ages of 21 and 30 have decreased working hours by 12% in the last 15 years to devote to leisure with video games and other activities, which represents a drop of 3.4 hours a week.

Over the past few years, technological development has led to changes in several areas, including playfulness. However, little attention has been paid to its role as pure entertainment. Leisure according to, is important as it refreshes the mind, maintains long-term health and provides peace of mind. Therefore, it is helpful to use a video game that meets the needs of leisure with the use of interactive and computer content that stimulates the emotions of its users.

In the 1980s, children and adolescents were the main consumers of video games with arcade games, later in 2009, the market diversified for more mature audiences being the average age of 35 players leading to its consumption of the Call of Duty saga whose content was adjusted to the adult audience [52].

Regarding the influence of video games in cinema, at first, these were derived from some popular movies, television programs or books, examples of these are Star Wars, Harry Potter and South Park. The 1980s produced television shows such as "The Super Mario Bros, Super Show" and later "Pokemon", whose intention was to promote the video games of the time. Series such as Tomb Raider had as their origin the video game and games such as Final Fantasy, Assassin's Creed, Resident Evil and other video games have been brought to the big screen, which shows the great influence of video games in entertainment.

Video game films such as Super Mario Bros (1993), Silent Hill (2006) and Sonic the Hedgehog (2020) have been proposed and have been created as adaptations of previous video games. While Jumanji: Welcome to the Jungle (2017) and Wreck-It Ralph (2012), are films that start from adaptations of various genres of video games and their stories and plot become widely familiar to players.

Sports video games provide a connotation as a spectacle in which players have a certain degree of belonging by being part of clans with their participation in leagues and tournaments.

### **D. Video games in politics and international conflicts.**

They have adapted to video games [57] as a medium that uses linguistic, iconographic, and thematic codes of

contemporary culture to transmit their information to the public and are particularly attractive when considering their ability to simulate real war conflicts or fictitious conflicts that allow exposing some of the most important processes or situations of international politics, transmitting information about what war is like and offering a space for the actors of these games to communicate with the audience, dissolving the line between real and simulated war, to generate dialogues, for example, new routes for peace activism.

There are videogames with great success worldwide such as *Animal Crossing: New Horizons*, conducive to social vindication and political promotion, while in its beginnings it gave rise to the demands of demonstrators in Hong Kong against Beijing. In the recent electoral campaign of the United States, it served as a virtual space to look for followers whose objective was the young population. A congresswoman from New York generated her own video game as a virtual space for interaction with the user and whose objective was to increase its popularity in society. In the last presidential campaign in the United States, the players of *Animal Crossing: New Horizons* could support the candidacy through signs within the video game.

As a video game, candidates have converted their images to holograms allowing them to be seen from multiple places in the world, including with the ability to interact with attendees in real-time also seeking to create meanings through non-narrative elements and transmit certain ideologies.

America's foreign policy has changed its view of war, defining it as an activity that will never end against a diffuse and omnipresent (ubiquitous) enemy, thus generating new arguments for expanding the battlefield and having surveillance at the global level. An example of this case is the video game *Call of Duty*, a war game that aims to influence the user thought about the need for war and legitimacy when a person assumes a role in different sides, materializing the vision of a military doctrine since the 2000s where it aims to generate a dominant force in the development of a conflict [65].

In this last decade, war conflicts have been the inspiration for a greater content of video games, because its plot emotionally traps its players and involves them developing their tactical skills and sense of survival. On certain military fronts worldwide, the use of video games has been used as a means of simulation to train soldiers in a virtual war environment in which they face the enemy, acquire skills and make tactical decisions to fulfil missions.

America's *Army: Special Forces* is a war simulator for military tactical training of members of the United States armed forces, who must perform missions in simulated environments as close to reality as possible. The purpose of this training program is to convey a positive image of the work of the military to revalue military practice among young people.

Some video games reproduce wars and all kinds of violence based on facts of life reality, which allows the user to reflect on the way of life and culture of modernity. The video game within the modern conflict has not only served as a manifestation and representation of past events but also exposes decisive moments when making military decisions of a country. Games like *Call of Duty* and *Sledgehammer*, in addition to presenting the environment of the Second World War, provide an immersive experience that invites players to lead and form armies, control the economy or overthrow governments, and this close relationship between them causes the feeling of being learning. *Call of Duty WWII* has become a video game with more than 20 million users which has allowed them to experience virtually a Second World War in which no genocide took place.

### **E. Video games in the economy**

The research carried out by [70] shows that the acquisition of video games triggers the purchase of an additional series of products and indicates that it not only promotes new sales but also that these are capable of being in other industries of a technological, entertainment, and commercial nature for their application and increase their productivity, which represents an important contribution to the economy in general.

Video games generate a great economic impact today due to their business strategy where it allows the user to interact with the game, such is the case of the E-sports company that transformed the stereotype of the traditional solo game and led it to generate several interactions with different players in a single game, thus achieving 453 million users who generated an income of more than 1000 million dollars for this company.

Within an economic theme, the video game *Sim City*, a city simulator that allows the player to create and manage the expansion of the territory, allows him to assume the responsibility of mayor, winning or losing the game depending on his decision making.

One of the economic aspects with greater representativeness in video games is the consumerism of its users with the content of new trends. In this last decade, the video game industry has developed a volatile evolution with

the massive publication of extensive digital content, which adheres in society as a fashion trend that drives people to buy this content.

The great success of video games has been reflected within the Twitch platform where great "streamer" characters such as AuronPlay, Rubius, and Ibai Llanos have managed to extend their popularity around the world through the gaming industry, but it is not until January 11, 2021, where The Greg a Spanish streamer manages to break the record for the highest number of views on this platform by presenting his new skin within the video game Fortnite, with 2,468,668 simultaneous viewers in the live stream [74].

Both in the economy and real life, there must be an interaction between people, whether these families or companies, to make a certain decision. Video games are a mathematical tool to support business decision-making that answers the question of how to make strategic decisions in a situation of conflict of interest.

In general, gamers are considered professionals in the virtual world since their job is to play online, even they invest by buying special devices to enhance their plays. Making money by participating in online video games has become so popular that there are world tournaments, which distribute thousands and even millions of euros. Within the online video game industry, games to make money are called Play to Earn (P2E) and consist of buying or selling digital assets called tokens, i.e., the native currency. Unlike traditional games where you had to level up while adding points, here the currency does have real value. The goal is to redeem your reward in a virtual wallet, this is the work and like any task, you receive a remuneration.

### **F.Video games as a service**

From the English "Gaming as a service" (GaaS), the term video games as a service refer to the set of technological solutions or services available that seek to provide video games or access to video game content experiences through a continuous payment model, such as a monthly subscription, or annual, like the popular business model of technology platforms. Some of the biggest advantages of this new video game distribution model have to do with benefits for both developer companies and consumers. This model is a very effective solution against piracy since the content of the video game is stored on a secure server in the cloud, which is provided through secure online protocols.

In addition, the business model of a GaaS platform provides a lot of flexibility in terms of payments for the consumer, being the most popular in its branch, giving access to video games or their content despite not needing a specialized console, but through mobile devices, or smart TVs. The difference between a console and a mobile device is to replace the powerful hardware of the terminal (or console) to run the video games, with a high-speed Internet connection that supports the transfer of upload and download data simultaneously.

GaaS solutions can be classified into two large subsets: local rendering (LR-GaaS) or remote rendering (RR-GaaS) solutions. As for LR-GaaS solutions, any video game subscription service can be considered as a specific subscription to a massively multiplayer online game, as is the case of World of Warcraft, or a subscription service to video game libraries such as EA Play or Xbox Game Pass. These options allow access to the content through that subscription, but the video game as such runs on the computer where the content is downloaded, whether it is a console or a computer.

In RR-GaaS solutions, the content of the video game runs remotely on cloud servers, and the video output of the video game, as well as the player's input controls, are transferred over the Internet to each other, and in this way, the terminal can be a low-end computer, a mobile device, or a smart TV. In this case, the quality of local rendering and game latency are sacrificed, for the flexibility of accessing the content from anywhere through the Internet, some of the services that currently offer this modality are PlayStation Now, Google Stadia, or the recently presented Amazon Luna.

### **G.Future expectations in Video Games and their influences on society.**

According to, the video game industry today is the largest and most successful in the world, as its sales, diffusion, and users do not stop growing over the years. Current trends and developments such as serious games, cloud gaming, videogame on demand, prospects for online downloads in video games, the online pass, will give impetus to video games in the future. The game of the future will be characterized by having a very social character, being unusual to play alone. The three-dimensional developments will gain strength and will stop using conventional controls, to give way to video games that allow the total immersion of the player in other worlds as it happens in films such as Avatar or Matrix. Video game users consider that virtual reality will have many applications even

beyond those of a game. In medicine, a kind of video game will simulate surgical operations before performing them with the real patient. Players with an average of 35 years believe that there are many expectations regarding the use of virtual reality, foresee that video games of this type will be used at all levels of education.

According to research conducted by, there will be a new interactive way of playing, an improved version of virtual reality games in which, the player has more control over the movement of the video game character. It is expected that virtual and interactive game rooms will be built in the future.

Through the perspective about the future of learning for users, it has been proposed that personalization, collaboration, and informalization (informal learning) will be the core of learning in the future through education technologies with the use of video games.

Video games and everything related to communication technologies will be part of daily life in the population around the world; for this reason considers that systematic studies should be carried out to determine the long-term effects of this exposure

In, it is considered that social media will influence the evolution and future of video games much more than other aspects within the industry. It also indicates that the most influential trends are online and shared games, while smartphones are revolutionizing the market, with Apple and Google vying for the biggest profits.

The prospects of video games are enriching from the point of view that video games will help to improve the quality of life of users in general, especially in children and the elderly; that is, a benefit of constant learning in branches of science and technology for young people, as for adults, a benefit to the management of new technologies causing adaptation with the future.

Faced with new development challenges and technological inclusions, state that younger generations will take advantage of video games to become familiar with communication technologies. Therefore, video games will represent a powerful medium for digital literacy for children, young people, and adults.

### III. METHODOLOGY

From the review carried out both in scientific articles and web pages specialised in video games and mass media, constant technological development is evidenced, with a growing target market in the video game industry. Due to the pandemic, society had to opt for video games to mitigate the effects of the confinement at the beginning of 2020, when the pandemic was lying in its stage of proliferation worldwide. Organisations and countries have encouraged the use of video games to avoid psychological affectations due to the confinement produced by the quarantine.

Much of the reference documentation has advantages of video games on the psychological aspect and how this activity can supplant the usual action, especially in youth, who is one of the most affected by quarantine and the cessation of their usual social activities.

The educational field has been strongly benefited since multiple video games were incorporated into the academic curriculum at all educational levels.

There have been developments that explain contributions in the improvement of family communication, improvement of the quality of life, strengthening of digital literacy, and dissemination of new technologies, while in the disadvantages is the problem of addiction, distracting effects of daily obligations, and aggressive attitudes.

The scope of video games has even expanded to other forms of culture such as cinema, which has gone on to create scripts based on video games. The sculpture has also benefited in the visualization that virtual reality takes through the form of video games that allow better interaction and experience for the visitor.

New experiences such as multiple games in which users become spectators of the video game environment as a spectacle. In addition to this, the political sphere has found with video games an effective means of communication to attract and transmit its political precepts and campaign proposals.

The video game has taken the form of service for the user, who, to have access to multiple games, pays a subscription without necessarily having to acquire specific video game platforms and with the possibility of using it on

smartphones, tablets, and computers.

As for the future, there are current trends in the dissemination of video games that are expected to grow and have had an excellent impact on users, you want to have been expanding their range of influence in older players.

#### IV.RESULTS

From the review carried out both in scientific articles and web pages specialized in video games and mass media, constant technological development is evidenced and with a growing target market in the video game industry. Due to the pandemic, society had to opt for the use of video games to mitigate the effects of the confinement at the beginning of 2020, when the pandemic was lying in its stage of proliferation worldwide. Organizations and countries have encouraged the use of video games to avoid psychological affectations due to the confinement produced by the quarantine.

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As for the future, there are current trends in the dissemination of video games that are expected to grow and have had an excellent impact on users, you want to have been expanding their range of influence in older players.

#### V.CONCLUSIONS

Excessive consumption generates different effects such as anxiety, depression, obsessive behaviors, loneliness and even a decrease in emotional intelligence, in addition to a lower expression of emotions.

Video games are useful for people with mental and physical problems. Without going any further, they have a positive impact on users with reduced mobility in the arms or with difficulties in personal relationships, as is the case, for example, with autistic people.

Las desventajas de los juegos violentos son evidentes. Algunos videojuegos de contenidos agresivos contribuyen a la existencia de agresiones físicas y a la radicalización de ideologías en el mundo real. Estos efectos pueden ser de corto o largo plazo según la edad y las habilidades sociales de cada persona.

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**Resumen:** En este documento se describen las nuevas alternativas tecnológicas en sistemas para el monitoreo del estado de salud de los trabajadores, así como sistemas de seguridad para reducir los contagios debido a la pandemia por COVID-19. La visión artificial ha tomado fuerza y más aplicaciones en sistemas de identificación de la identidad de los trabajadores, técnicas de inteligencia artificial junto con avances en visión, permiten obtener información precisa de grupos de personas en movimiento, estos sistemas dinamizan las tareas de control en accesos a lugares de trabajo y zonas comunes por donde transitan a diario los trabajadores. Se realizó una revisión bibliográfica de la que se identificaron 25 trabajos relevantes de donde se recopilaron las características de estos sistemas, las aplicaciones y las tendencias futuras. Se concluye que el uso de la Visión e Inteligencia artificial es más frecuente para el control de la seguridad industrial y se adaptan de mejor manera y se alinean a los intereses de la Industria 4.0 permitiendo la adquisición de datos, transmisión y almacenamiento en bases de datos de la información.

**Palabras Clave:** Tecnologías de la Información, Salud, Seguridad Ocupacional

## Information Technologies for Occupational Health and Safety

**Abstract:** This document describes the new technological alternatives in personal protection systems and equipment proposed and implemented in industries due to the current COVID-19 pandemic. System developments include devices that employ Machine Vision database connectivity and act as support for controlling workers' industrial safety. Advances in personal protective equipment include modern materials with better performance, strength and benefits for its users. An exhaustive review of scientific articles was carried out in which current developments in the two themes raised are presented and have been reflected and described in this document. It is concluded that the use of Vision and Artificial Intelligence is more frequent for the control of industrial security and is better adapted and aligned with Industry 4.0, allowing the acquisition of data, transmission, and storage in databases of information.

**Keywords:** Information Technology, Health, Occupational Safety





## I. INTRODUCCIÓN

De la misma manera en que la tecnología influye en todos los aspectos del diario vivir [1], también se han documentado múltiples avances en sistemas y equipos para su uso en beneficio de las seguridad industrial y Ocupacional [2]. Algunos de estos equipos permiten de manera remota conocer el estado de salud y signos vitales de los trabajadores a fin de monitorizar su salud [3], [4]. Muchos de estos dispositivos fueron incorporados en las organizaciones debido a la necesidad de proteger al personal y reducir los contagios debido a la pandemia por la COVID-19.

En este trabajo en la sección Desarrollo, se describirán las tecnologías empleadas, principios de operación, aplicaciones y posibilidades que poseen para su implementación con bases de datos de utilidad para las empresas. En la sección Metodología se describen detalles de la revisión realizada, finalmente en la sección resultados se describe de forma breve una breve visualización de los hallazgos obtenidos en el desarrollo del presente trabajo.

## II. DESARROLLO

La incorporación de sistemas de visión artificial y su operación con el uso de inteligencia artificial (IA), son cada día más frecuentes en las grandes industrias. La pandemia obligó en muchos casos a la adopción de este tipo de sistemas que en inicio ganaban interés debido a la medición de la temperatura e identificación de la identidad del trabajador, sin embargo, el desarrollo continuó y ahora estos sistemas ofrecen comunicación y conectividad con aplicaciones que permiten tomar decisiones para generar horarios flexibles a fin de brindar condiciones que eviten el estrés a los trabajadores.

Las nuevas exigencias que se han incorporado para llevar a cabo las actividades laborales han exigido la implementación de protocolos de salud y seguridad que se están convirtiendo en nuevos estándares para la prevención de enfermedades futuras. Para el caso de la industria, estas exigencias de seguridad han influenciado en la manera de realizar el trabajo dentro de la organización. El uso de la Visión Artificial permite a las empresas garantizar la salud y seguridad de sus trabajadores.

Existen soluciones como las comentadas en [5], en las que a través del análisis de video en tiempo real, cuyo objetivo es controlar el cumplimiento de los protocolos de seguridad establecidos, para lo cual una seguir de cámaras captura imágenes y estas son analizadas para a partir de estas genera un mapa de calor identificando así las zonas que presentan mayores riesgos y frecuencia de incidentes. La figura 1, presenta el entorno de un sistema que identifica las zonas de riesgo [6]

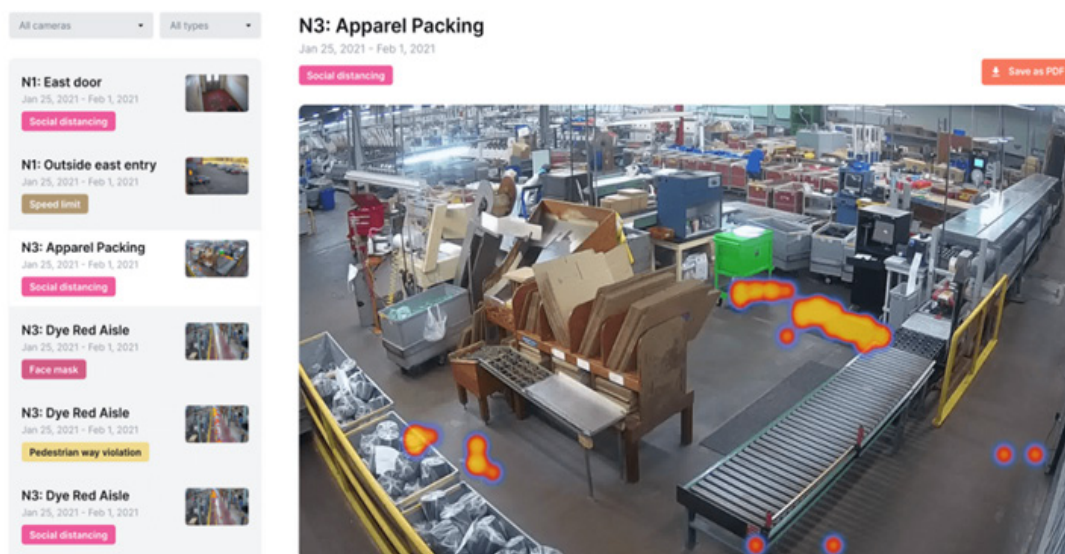


Fig. 1. Mapa de calor que identifica zonas riesgosas en un entorno laboral

Los sistemas de visión en las industrias en la actualidad permiten realizar algunas tareas como inspecciones automatizadas con uso de Inteligencia Artificial (IA), Rastreo de comportamientos no adecuados por partes de los trabajadores valorados con puntuación, fácil implementación al usar cámaras de video ya existentes y notificaciones de alerta en caso de presentarse violaciones potenciales graves que pueden causar lesiones graves en los trabajadores.

Algunas de las ventajas que proporciona el uso de estos sistemas de visión con IA, son: la reducción de gastos en reparación de daños y reemplazos, al mantener en buenas condiciones el entorno laboral, la productividad se ve beneficiada directamente, el cumplimiento de las normativas y reglamentaciones implica menores gastos ya que se presentan menos incidentes, multas y gestiones innecesarias, a través de la evidencia recopilada con estos sistemas de visión, se puede reducir las incertidumbres en el manejo de conflictos y mejorar los procesos internos de la empresa mejorando así su transparencia.

Existen sistemas como la llamada *Thermy*, misma que emplea imágenes térmicas en tiempo real y que pueden capturar hasta 30 personas de forma simultánea con lo que se puede estimar su temperatura corporal, a partir de escaneos a una velocidad de 8.3 veces por segundo y con ello mejorar la precisión frente a sistemas convencionales de detección de temperatura.

Existen plataformas que permiten determinar la temperatura del cuerpo mediante el uso de lentes de visión y una computadora de elevadas prestaciones. Este equipo, para su análisis, identifica el rostro y toma la temperatura de toda la piel visible para con ello estimar la temperatura corporal a un nivel de precisión aceptable.

Los sitios en los que el uso de tecnologías de visión artificial e IA, no se limitan solamente a negocios, industrias y organizaciones ya que no solamente en estos sitios se evidencian riesgos, por ello algunas de estas soluciones se implementan también en lugares públicos, centros comerciales, estaciones de sistemas de trenes ya que existe contacto entre las personas pudiendo representar situaciones de riesgo. Estos sistemas otorgan una mayor confianza a los responsables del control de la seguridad ocupacional en vista de que permite adquirir más y mejor calidad en la información en tiempos extremadamente cortos y con elevada precisión.

A pesar de que los sistemas de visión son diseñados pensando en un gran volumen de personas, en lugares donde existe poca gente, las cámaras pueden monitorear distancias, uso de mascarilla y elementos del cuerpo como cascos y hasta guantes, esto permite generar alertas para el control de la seguridad. Adicional a esto, estos sistemas pueden ayudar en la vigilancia cuando las personas no cumplen las normativas de seguridad y alertar a la policía para que estos tomen acciones.

En los espacios públicos, la visión artificial posee múltiples aplicaciones con el aspecto de la seguridad, inclusive existen zonas que son muy utilizadas por los usuarios y a menudo son manipuladas, los sistemas de monitores pueden enviar señales para solicitar que se limpien ciertas zonas específicas, adicional a esto, estos sistemas pueden identificar si alguna persona está en una zona no admitida y requiere de atención médica y enviar las respectivas notificaciones. De la misma manera se puede identificar personas sospechosas cuya conducta no es la habitual.

Dentro de las industrias y empresas, los procesos de fabricación engloban una serie de peligros en los que el uso de la visión artificial puede aportar con soluciones limitando la responsabilidad y el peligro para la empresa y el individuo, ofreciendo beneficios para todas las partes.

Como todo sistema existente, siempre existen las posibilidades que fallos y de situaciones que generan incertidumbre en la adquisición de datos con el uso de sistema de visión artificial. Dado que múltiples sistemas se han programado para aprendizaje automático con IA, sin embargo, debe tomarse en cuenta que la adquisición de esta información incurre en la violación de la privacidad de los trabajadores, sobre todo cuando se trata de video e imágenes ya que en algunos casos se analizan todos sus movimientos y comportamientos y a pesar de todo, no se conoce claramente que criterios son tomados en cuenta para que una conducta sea riesgosa o no con respecto a las normativas vigentes en todos los países en los que se utilizan estos sistemas.

La empresa *Evenguard.ai* con sede en California, junto con el apoyo de *Boston Consulting Group* y *SeAH*, han comentado que su sistema de Visión Artificial reduce de forma elevada los incidentes y lesiones en los trabajadores tomando en cuenta para ello el uso de IA, Visión por computador y dispositivos industriales que operan con Internet de las cosas (IIoT), permitiendo aprender en el entorno implementado, mejorando la seguridad y mejorando la productividad. Sin embargo, lo que no se conoce es la manera en la que esos sistemas fueron entrenados, si se manejaron datos públicos, y si las personas con las que se ensayó conocen que fueron grabadas para esos fines, en fin, no se conoce el origen y las autorizaciones que empleó la fábrica *Evenguard* para el entrenamiento de sus sistemas.

Se conoce que los sistemas de Visión artificial son muy propensos a generar errores cuando las condiciones de iluminación y entorno no son lo suficientemente estables y controladas, por ello, la influencia del sol, variaciones del paisaje de fondo o la variabilidad en los modelos de cámara empleados en cuanto a su resolución y relación de aspecto, puede atribuir errores en la ejecución de un algoritmo que previamente ha sido entrenado. Inclusive se ha evidenciado situaciones en las que la tonalidad del color de la piel puede reducir el contraste y perjudicar a la identificación de los rostros.

Uno de los casos más relevantes sobre la influencia de los sistemas de visión por computador corresponde al sistema "Time off Task" empleado por Amazon, el cual alerta sobre el tiempo que un empleado se encuentra en una zona segura o se aleja de ella, frente a esta situación el sistema brinda información sobre el cumplimiento de las normativas de seguridad y con relación al tiempo productivo de los trabajadores, información que permite tomar decisiones en los altos cargos de la organización. Los requisitos en el uso de estos sistemas han dado lugar a la legislación AB-701 propuesta en California.

Existe un fenómeno relacionado con el uso prolongado de dispositivos electrónicos con pantallas visuales conocido como El Síndrome de Visión por Computador, término propuesto por la Asociación Americana de Optometría, American Optometric Association (AOA). Este síndrome se basa en el supuesto daño que causará en un futuro el exceso del uso de pantallas digitales que, si bien mejoran la productividad y condiciones de seguridad para los trabajadores, también influirán proporcionándoles fatiga visual lo cual desembocará en un notable problema de salud pública en el futuro según [7].

Uno de los sectores que más ha aprovechado los beneficios de los sistemas de visión artificial, es el sector de la construcción y se lo emplea a pesar de que no se evidencian estudios que relacionen la visión por computador directamente con la ciencia y gestión de la seguridad. Se ha reportado que la mayor causa de los accidentes en el ámbito de la construcción ocurre cuando el trabajador no se encuentra en su zona de trabajo, por ello un sistema automático permite brindar mejor efectividad frente a una tarea de control de carácter manual. Para estos casos, la visión por computador puede además reconocer patrones de movimiento como el agacharse trepar o levantarse, cuestiones que pueden ser más relevantes a la hora de identificar un riesgo.

En la figura 2 se observa un ejemplo proporcionado en [8], como se aprecia, los sistemas de visión artificial discriminan de manera adecuada el número de personas y posiciones en las que se encuentran, adicionalmente a ello, la altura del trabajador se encuentra identificada con una caja contenedora o bounding box. Con simples operaciones y dimensiones de esta caja se puede estimar la posición del trabajador en caso de que este se encuentre agachado o si levanta la mano a la manera de escalar para alcanzar una posición elevada.

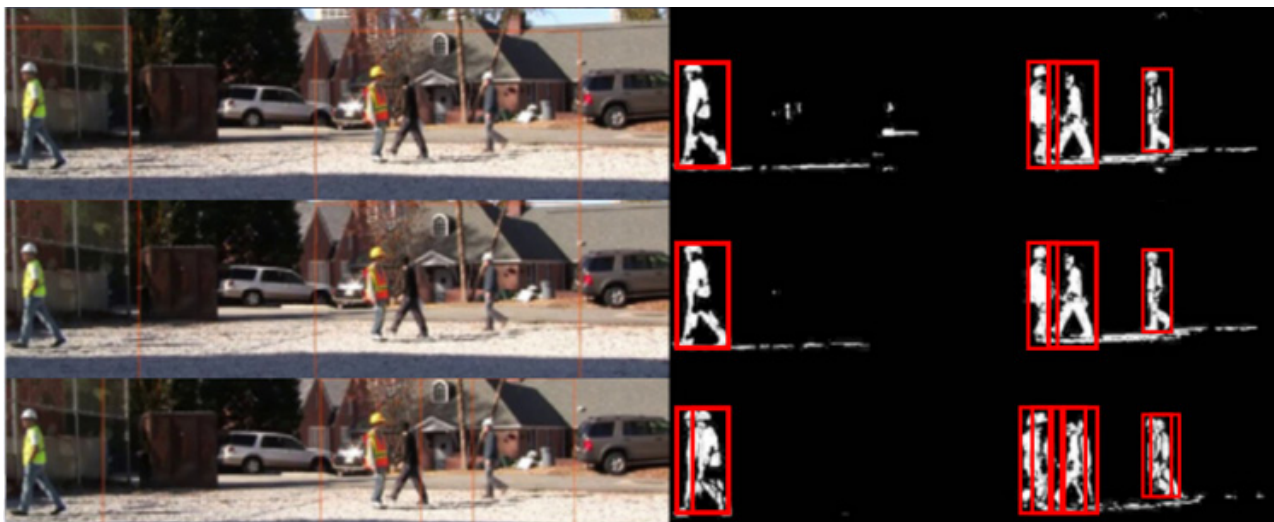


Fig. 2. Identificación de la posición de los trabajadores mediante Visión artificial

El tipo de sistemas de visión abordados se ha diseñado para resolver problemas específicos dentro de la industria, sin embargo, en su desarrollo se contemplan tres aspectos que aún son de interés para la investigación y son: detección de objetos, seguimiento de objetos y reconocimiento de acciones. Las tres áreas de interés antes men-

cionadas, junto a los desarrollos puede ayudar a resolver en buena manera los problemas de comprensión correcta de las situaciones y escenarios laborales. Adicional a esto, en el problema no se abordan múltiples variables como pueden ser el contexto de la seguridad, obstáculos presentes, condiciones dinámicas en los sitios de construcción y aspectos relacionados con la privacidad.

La tabla 1 presenta los roles que los sistemas de visión deben cumplir para desarrollos futuros de soluciones en salud y seguridad en el trabajo así como para aplicaciones más específicas dentro y fuera de las industrias [9].

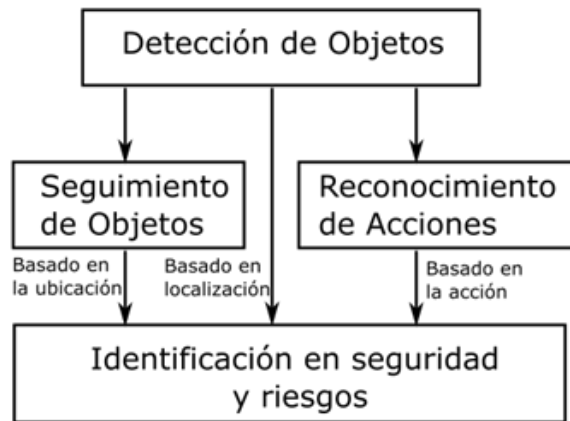
**Tabla 1. Roles de los sistemas de visión artificial**

<b>Enfoques</b>	<b>Descripción</b>	<b>Ejemplos de actos y condiciones inseguros dirigidos</b>	<b>Técnicas aplicadas de visión artificial</b>
<b>Identificación del riesgo en la escena</b>	Identificar actos y condiciones inseguras mediante comprensión de las escenas estáticas en obras de construcción	Falta de uso de protección personal equipamiento (EPI)	Detección de objetos
<b>Identificación del riesgo basado en la ubicación</b>	Identificación de actos inseguros basados en ubicaciones y movimientos de las entidades del proyecto (p. ej., equipos, trabajadores)	No advertir a los compañeros de trabajo que no sean golpeados por vehículos o equipo	Seguimiento de objetos
<b>Identificación del riesgo basado en acciones</b>	Identificación de violaciones de las normas de seguridad y salud con respecto a los movimientos	Movimientos inadecuados de la superestructura de vehículos pesados. Equipamiento, Levantamiento inadecuado con posturas incómodas, etc.	Reconocimiento de acciones

Cada uno de los enfoques propuestos en la tabla 1, se asocian con la resolución de problemas en el ámbito de la salud y seguridad en el trabajo, así el primer enfoque que se refiere a la identificación de riesgos en la escena puede identificar desde zonas inseguras por la presencia de sustancias tóxicas e inflamables, zonas de elevada altura por las que debe usarse equipo específico para evitar caídas y adicional a esto evitar colisiones en caso de vehículos y trabajadores que circulan por las mismas zonas.

El enfoque sobre la identificación de riesgos basado en la ubicación puede aportar soluciones identificando movimientos inadecuados en trabajadores así como zonas de riesgos de caídas y situaciones en las que el movimiento de otros elementos pueda involucrar riesgos hacia un trabajador. Por último, el enfoque de identificación basado en acciones puede ayudar en el control del uso de equipo de protección personal, mala utilización de elementos de izaje y uso de maquinaria, etc.

De manera general, los sistemas de visión artificial relacionan las técnicas de visión antes mencionadas para resolver problemas de identificación de riesgos en la salud y seguridad con los procesos descritos en la tabla 1, y como se ilustra en la figura 3.



**Fig. 3. Técnicas de Visión artificial para aportar en soluciones de identificación de riesgo y sus métodos**

La adopción del uso de tecnologías para el control de la seguridad sanitaria y en general, ha llamado la atención en el ámbito de la construcción, en donde se han presentado avances en torno a la traducción de reglas para mejorar la comprensión por parte de los usuarios de estos sistemas, sin embargo la complejidad y variabilidad de normas torna compleja la tarea de implementar estos sistemas aun en algunas zonas y países específicos.

Estudios como el de [10], se centra en las regulaciones de OSHA para validar la técnica de análisis propuesta utilizada para desarrollar una clasificación estructurada de las reglas de seguridad para un sistema de seguridad de construcción compacto basado en inteligencia de visión. A continuación, se especifican cada una de estas categorías.

Según OSHA, y sus regulaciones, es importante tomar en cuenta el monitoreo de la seguridad en las etapas: antes, con intervalos, durante el trabajo, luego del trabajo, se presentan ejemplos de las aplicaciones y sus funcionalidades en la figura 4, la que corresponde al trabajo realizado por [10] y que se han tomado como referencia para la elaboración de la figura 4.

Como se observa en la figura, para obtener una información de calidad, se requiere para este proceso, una ubicación adecuada de la cámara, que no interfiera con otros elementos ni que sea lugar de cruce de personas. En el primer ejemplo de la figura, el sistema detecta perfectamente la posición de un trabajador, un elemento volumétrico junto al soldador y la presencia de chispas generadas por el proceso de desbaste del material con un disco abrasivo. La segunda opción hace referencia a la alternativa de monitorizar los eventos a intervalos, de tal manera que escombros como los de la imagen no se desplacen creando una situación de riesgo y previniendo posibles desbordamientos del material. El ejemplo 3 corresponde al monitoreo de un andamio móvil del que se obtendrá información de la posición del andamio y de la persona que lo usa en el trabajo, este monitoreo permitirá comprender de mejor manera las situaciones que impliquen riesgos de caídas del trabajador, así como del andamio móvil. Finalmente, la visión artificial también debe monitorizar después del trabajo ya que si existiese desplazamientos o corrimientos de material, como el caso del ejemplo, podría generar una situación de riesgo que podría afectar en futuro a los trabajadores.

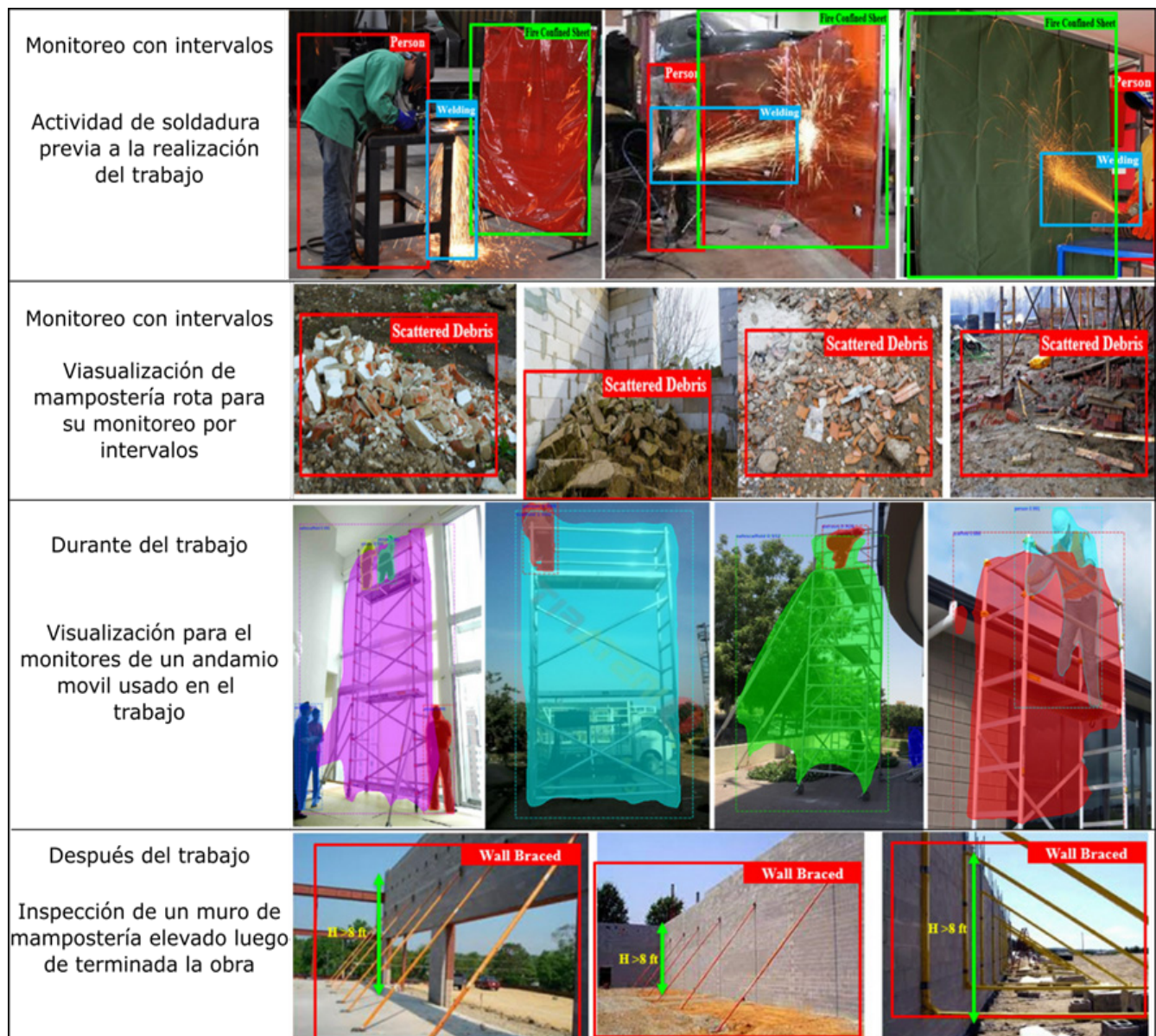


Fig. 4. Ejemplos de monitoreo de actividades antes, a Intervalos, Durante y Después del trabajo

Como se apreció en los ejemplos anteriores las posibilidades de aplicación de la Visión artificial en aspectos del monitoreo de la Salud y Seguridad en el trabajo puede ser desarrollada para múltiples situaciones.

### III.METODOLOGÍA

La revisión sistemática realizada en este documento contempló en una primera búsqueda a 81 artículos de las bases científicas SCIELO y SCOPUS, empleando para ello una búsqueda de las palabras claves: Tecnología, Seguridad y Salud Ocupacional, Visión Artificial. Se determinaron que 49 artículos podían excluirse debido a que no abordaban criterios de tecnologías vistos desde el punto de vista técnico, adicionalmente no centraban su estudio con respecto a desarrollos y aplicaciones con respecto a normas internacionales de referencia. De los 32 artículos restantes, se hallaron 17 artículos repetidos que se descartaron obteniéndose finalmente 15 artículos que en su mayoría fueron revisiones sobre las tecnologías de Visión artificial relacionadas con el monitoreo de la salud ocupacional.

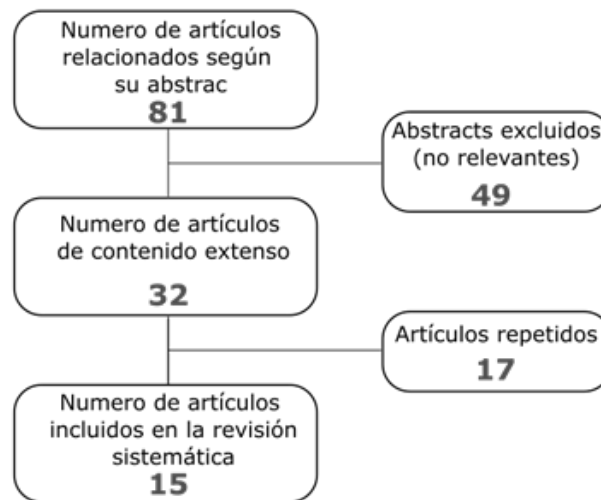


Figura 6. Flujo de trabajo de la revisión sistemática realizada

#### IV.RESULTADOS

De la información encontrada sobre las tecnologías de Visión por Computador para monitoreo de la salud y seguridad en el trabajo, se ha observado una gran necesidad e interés del ámbito científico para el desarrollo de estas temáticas. Se han hallado diversos criterios que han concluido en que existen tres técnicas que fundamentan áreas para la realización de futuras investigaciones y que permitirán generar un mejor conocimiento y mejora en las técnicas para el monitoreo y toma de decisiones por parte de los responsables de la empresa.

Existe una variedad de aspectos que no se consideran dentro de los estudios revisados, por ello es muy importante realizar a futuro una clasificación de base y profunda sobre los patrones de riesgos para desarrollar sistemas compactos de monitoreo de seguridad basados en la visión como lo menciona [11].

De los pocos casos en los que se abordan las normativas de seguridad de referencia empleados en este tipo de desarrollos científicos, la normas de la Occupational Health and Safety Assessment Series (OSHAS) son las que más se han empleado.

Una gran parte de las aplicaciones que se abordaron en esta revisión incluyen soluciones para el campo de la construcción y este aspecto va de la mano con la alta tasa de afectaciones de este campo que ha dejado por años pasar por alto una regulación adecuada para obras realizadas a campo abierto.

Se ha evidenciado criterios que ponen de manifiesto algunas problemáticas en la implementación de estas tecnologías en el ámbito laboral. Esta problemática se ve impulsada por la falta de estandarización de las reglamentaciones y normativas en varias zonas geográficas.

La totalidad de trabajos revisados han colocado limitaciones para un buen desempeño de los sistemas de visión artificial ya que en la actualidad, estas limitaciones deben abordarse según los entornos y objetivos de los sistemas, sin embargo se ha comentado que estos desarrollos aún están en etapas tempranas y que para poseer soluciones más robustas, se requiere de mayor capacidad de procesamiento y algoritmos de mayor desempeño.

#### V.CONCLUSIONES

El uso de sistemas de Visión artificial provee de múltiples soluciones para mejorar la salud y seguridad de los trabajadores en el ámbito laboral, los avances se hallan en continua evolución y representan un costo de inversión reducido para las empresas que poseen un número considerable de trabajadores, adicionalmente su uso reduce el tiempo en la ejecución de tareas del personal responsable del control de la Seguridad y Salud Ocupacional.

La manera en la que se realizan los trabajos se ha visto influenciada por las implementaciones de los sistemas de visión artificial ya que estos requieren de un ambiente estructurado, ciertas condiciones de iluminación y de cierta manera esto podrá contribuir a que, en un futuro, el flujo de trabajo deba adaptarse para un mejor aprovechamiento del control del entorno con el uso de Visión artificial.

Existen preocupaciones de algunos sectores que promueven que el uso de estos sistemas de control con visión artificial podría en algún punto sustituir la capacitación formal con una serie de señales que, si bien guiarían de

mejor manera el trabajo, también podrían aportar nuevos riesgos y disminuir la seguridad, el éxito consiste en hacer que los trabajadores no posean una falsa sensación de seguridad y estudiar los falsos negativos que estos sistemas pueden generar.

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**RESUMEN CURRICULAR**

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$$(x + a)^n = \sum_{k=0}^n \binom{n}{k} x^k a^{n-k}$$

$$(1 + x)^n = 1 + \frac{nx}{1!} + \frac{n(n-1)x^2}{2!} + \dots$$

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