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Video and Voltage Card for Security Camera System Interface Center Functionality

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Abstract– ***The research conducted has a high relevance due to the growing need to improve the efficiency of interface control panels in security camera systems. The overall objective is to develop a video and voltage card that improves the functionality of a Security Camera System interface station. To carry out this study, a quantitative approach and a pre-experimental design were used, with a population of 150 CCTV cameras. As for the sample, 30 cameras were considered by means of a non-probabilistic convenience sampling. Data collection was carried out through direct observation using an observation form. Therefore, the results obtained showed that the development of the card significantly improves the functionality of the central interfaces because it provided improved functionality for stability, monitoring and interoperability. In conclusion, it can be stated that this technical advance optimized the efficiency of the security camera systems allowing more accurate monitoring and greater resilience to failures or high-loads conditions.***

Keywords-- Video Card, Voltage, Functionality, Central Interface, Security Cameras

I. Introduction

Today, businesses and society in general value security camera systems (SCS) or also known as closed-circuit television (CCTV) because they protect people and property.

Therefore, the closed-circuit television, or known as internet protocol (IP) security camera comes from about 40 years ago, where its manufacture was only made in military and governmental environments to have a security control. Subsequently it became a method to ensure protection extending its use in the world. Nowadays, there are more video surveillance systems with many devices in different places. Therefore, the adoption of the use of security cameras has spread to the world where we can highlight that the highest uptake is presented in the United States. Thus, the use of security cameras is indispensable for every establishment, which helps to prevent accidents. Police officers also wear mini security cameras inside their uniforms to monitor their surroundings [1].

Security cameras play an important role in reducing burglaries, robberies, and thefts. As a result, confidence in urban security has increased because their use has been crucial in identifying suspects and exposing criminal behavior [2]. It has also been shown that having security cameras in both public and private places not only keep criminals away, but also provides useful visual evidence in criminal investigations and for recognizing criminal behavior [3].

However, SCS often have drawbacks such as lack of visibility, vulnerable installations and defective coverage. This implies possible failures in protection [4]. Therefore, to avoid these problems in the SCS, a central interface (CI) is used, which is a device responsible for managing the workflow of the security cameras, providing stability to prevent errors in the system [5]. That is why a CI acts as an intermediary that provides stability in the SCS, this implies that it increases the efficiency of the system. But a CI usually presents regular problems, which decreases its efficiency and among these limitations are quality and energy, which decreases the lifetime of the system. Thus, the development of a new technology focused on improving the functionality of CCTV systems is necessary to obtain an expected result [6].

In turn, the need to overcome the current limitations of the SCS due to inefficient CI results in blind monitoring areas, ineffective placement, lack of full coverage, low video throughput and low voltage supply. Therefore, these problems make it difficult to perform continuous and effective monitoring, which implies the search for a solution is essential. Because of this, the objective was set to develop a video and voltage card that improves the functionality of a central interface of the Security Camera System. Thus, the improvement not only seeks to optimize the system in terms of image and voltage, but also to improve the infrastructure to achieve better management. The solution focuses on the design and development of the video and voltage card, using the cascade methodology. Since, this methodology is a sequential development model where each phase must be completed before the next one begins, thus ensuring a rigorous and systematic control of the development process [7].

On the other hand, according to [8] explained that security camera systems must provide interoperability between cameras to prevent errors. Therefore, each system must have an efficient and adaptable infrastructure to support new components or prevent failures. At the same time, the constant functionality of security camera systems must be continuous and in real time in order not to lose transmission quality, although the quality varies between cameras. Furthermore, for a SCS to remain efficient with constant use, preventive means must be implemented to prolong its operation. In conclusion, for a SCS to be feasible for a company, it must have an efficient infrastructure, connection and performance, where the prolongation will also depend on the maintenance provided [9].

It is important to have a complete SCS that does not contain faults in its operation is key to provide security to people [10]. As well, an SCS must provide confidence to the environment where it is installed and to achieve this, it must have a safe and quality system [11].

II. LITERATURE REVIEW

According to [12], the objective was to analyze the use of power system optimization to mitigate voltage instability problems. To achieve this, they considered particle swarm optimization (PSO) technology to obtain a result based on the analysis of the power voltage. Thus, thanks to the results after using the PSO algorithm, they established that its use helps to improve the voltage quality and avoid network failures. Finally, in conclusion, the development of this PSO algorithm provided a significant improvement in the quality of voltage that can have the network systems, which will help to improve its functionality.

According to [13], the objective was to analyze the monitoring of security cameras to obtain a suicide prevention measure. To arrive at the result, they searched and analyzed a large amount of information from repositories, using scientific research. In conclusion, they highlighted the importance of further research and improvement of technologies that can help in the early identification and prevention of suicide through camera monitoring of SCS.

According to [14], the objective was to incorporate intelligent event detection cameras (EDICAM) in the context of a multithreaded real time executor application (MARTe) to process data in real time. In this way, a General Application Module (GAM) was developed with the purpose of managing EDICAM data, while functioning as a repository to experiment with new and improved algorithms in a disconnected manner. Where, they used the prototyping methodology. Thus, they included the development of automatic installation scripts and the creation of specific components for MARTe based on design and then development. In conclusion, the inclusion of EDICAM in MARTe provided significant progress in the implementation of an innovative real-time information processing technology.

According to [2] focused on the relevance of installing CCTV cameras in different locations to enhance security and monitoring effectiveness. Therefore, they aimed to analyze the impact of developing an online security camera system. Where, they obtained a relationship of interoperability between different systems. Therefore, as a result, they were able to establish that security camera systems can be optimal anywhere, where it does not matter the type but the connection that is given for the system to work properly. In conclusion, the installation of a security system provides security; therefore, its implementation must be total.

Aaccording to [15], the objective was to create a reliable monitoring system using Internet of Things (IoT) technology, including an intelligent incorporation of video synthesis using a method to identify key moments in the frames and an image protection system. In turn, in its methodology, it addressed the issue of visual attacks by proposing a fast and lightweight algorithm to encrypt key frames with the use of probabilities, to safeguard them before sending them in an alert. Where, it was achieved to identify events by employing encrypted key frames. In conclusion, this method proved to be very effective in increasing the security of surveillance systems through the application of new encryption strategies.

In addition [16] employed machine learning to analyse the processed images based on registered data to detect based on an algorithm analysis the faults in the culverts. Therefore, the results achieved showed an accuracy of 86% in detecting tree root intrusions. In conclusion, the feasibility and effectiveness of using image processing and machine learning methods to automatically detect and classify defects in sewer network inspections via CCTV was demonstrated.

According to [17] their goal was to create a reliable monitoring system using Internet of Things (IoT) technology, including an intelligent incorporation of video synthesis using a method to identify key moments in the frames and an image protection system. In conclusion, this method proved to be very effective in increasing the security of surveillance systems through the application of new encryption strategies.

On the other hand [18] aimed to recognize and examine the key technologies and solutions to enhance security and privacy in smart urban environments. In conclusion, the research helps to make progress in the development of new strategies to provide better security and privacy in smart cities.

In addition [19] developed an algorithm that helps to calculate the distance between people to have a measure of analysis. To do this, they used machine learning to analyse the distance between people based on a trained model that can calculate the distance between people. In conclusion, this new technology opened new possibilities for innovation in the field of electronic security.

They [20] also implemented an IoT-based environmental monitoring system for a poultry house, capable of processing, analysing and storing sensor data. After twelve days of testing, the detection time for temperature, humidity and air quality was reduced to 28 seconds, demonstrating that the system is a useful tool for automatic monitoring of the poultry house environment.

According to [21] optimised the design and simulation of a solar-powered electric vehicle charging station, determining that the optimal configuration includes 3 photovoltaic systems with 19 modules in 5 strings each, generating a daily average of 684 kWh.

On the other hand [22] illustrates the optimisation of the design and simulation of an electric vehicle charging station integrating solar energy After sizing, it was found that the optimal charging station should have 3 photovoltaic systems with 19 modules distributed in 5 strings each, providing an average daily electrical power of 684 kWh.

III. METHODOLOGY

A quantitative approach with a pre-experimental design was used to analyze the changes in stability, monitoring and integration after the implementation of the video and voltage card for a security camera system. Thus, this research collected data based on observation and processed the data using statistical tools to provide authenticity and reliability of the results.

This research is applied because the problems encountered are solved because of innovative developments to remove the difficulties [23].

For this reason, there is a population of 150 security cameras, and 30 security cameras were considered for the sample. Since the study variable is the functionality of a central interface of a security camera system, it was the functionality of a central interface of a security camera system [24] in turn in the dimensions: stability [25], monitoring [26] and integration [27]. Thus, the target study population consisted of security CCTV cameras in the Pacific Tower building.

Inclusion criteria:
- CCTV cameras in good condition.
- Easily accessible CCTV cameras.

Exclusion criteria:
- CCTV cameras with poor visibility.
- CCTV cameras positioned in non-visible areas.

According to, the waterfall methodology was applied to the development of the solution because it is a sequential and structured approach to project management, where each phase of the project must be completed before the next phase begins. This approach is ideal for projects with clearly defined requirements from the outset [25].

A. Requirements

1. Functional Requirements

To develop the video and voltage card, the following functional requirements are taken into consideration. See Table I.

TABLE I
HARDWARE FUNCTIONAL REQUIREMENTS

Item	Requirement	Description	Priority	Risk
FR1	Processing of multiple simultaneous video inputs	Ability to process real-time video from multiple cameras	High	Medium
FR2	Conversion of analog to digital signals	Convert analog video signals to digital	High	Low
FR3	Optimization of energy consumption	Reduce the energy load of the system	Medium	Medium
FR4	Improved image quality	Improve video sharpness and clarity	High	High
FR5	Video format support	Compatibility with standard video formats	High	Low
FR6	Voltage control for powering cameras	Efficient power supply to the chambers	High	Medium
FR7	Support for night vision	Manage night vision cameras	High	Medium
FR8	Communication interface	Provide connectivity with other devices	High	Low
FR9	Integration capability with monitoring software	Compatibility with CCTV software platforms	Medium	Low

The requirements were developed based on the analysis of the reports made based on technical visits, where thanks to the problem and the meetings to find out what the new component needs, the functional requirements were devised as shown in Table I.

2. Materials

The following components were used in the development of the video and voltage card:

- Single port RJ45 connector
- Precision resistance 1k
- Green led spotlight
- Voltage terminal block
- Video card board
- Aerial fuse holder

3. Implements

On the other hand, for the implementation of the video card and voltage according to the requirements of the company, the following implements must be used:

- Uniform
- Helmet
- Vest
- Lenses
- Gloves
- Ladder
- Toolbox

B. Design

1. Prototype sketch

The Fig. 1 shows the base design of the video card and voltage.

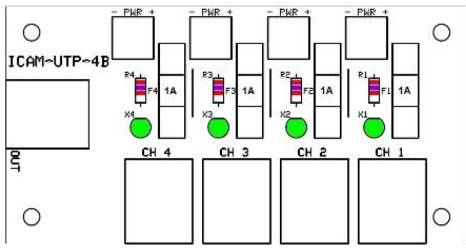

Fig. 1 Video card base design and voltage

2. Video Board

This component is used to run the hardware operation, since it is the board that sends, receives and processes all the IC power. Therefore, when assembled with the other parts, they converge into a component that enhances the functionality of the security camera system. See Fig. 2.

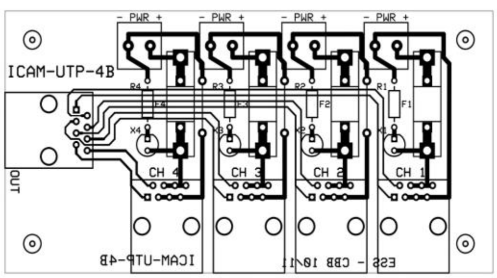

Fig. 2. Design of the video card board.

C. *Implementation*

1. *Product*

After the prototype design, the video card was developed, and the completed product is shown in Fig. 3.

Fig. 3. Design of the video card board.

D. *Installation*

For the installation of the video card and voltage was performed in the center of the corporate building Pacific Tower. Once this was done, we proceeded to make error tests to prevent possible failures before installation. Then, we proceeded with the arrangement of the cables that were inside; then, based on a welding, we proceeded to install the video card and voltage, where after installation the wiring was adapted to the new component. See Fig. 4.

Fig. 4. Video card and operating voltage.

After installation, the component became operational. Thus, the function is provided day and night as a new part of the system. It should be noted that failures often occur at night, so the LED lights are indicators that demonstrate the functionality of the video card and voltage.

1. *Verification*

For the verification of the development of the video card and its voltage, a collaboration with the company's security department was carried out. In this process, the performance of both the video card and the voltage were thoroughly evaluated, considering a detailed validation and confirmation response.

E. *Maintenance*

The proper installation of the video card and voltage adjustment was carried out with the purpose of optimizing and enhancing the efficiency of the camera surveillance system. Therefore, the installation of this component was executed following an established protocol, which stipulates the obligation to perform a monthly technical inspection for a period of twelve months to ensure a monitoring of the component's performance.

IV. RESULTS

This section presents the results obtained from the analysis of the implementation of the video and voltage card in the central interface of the security camera system. Key indicators such as stability, monitoring and system integration before and after the intervention were evaluated, providing a quantitative view on the impact of the technological improvement on the overall functionality of the system.

A. *Specific hypothesis test SH1*

SH_1: Development of a video and voltage card improved the stability of a central security camera system interface.

In the descriptive statistical report. Pre-study data were obtained from a central interface of the security camera system as well as post-study data to measure the stability improvement. It also describes the average value of the tests eventually after the study.

For the analysis of stability improvement, a table showing the statistics and standard error is used.

Table II presents the mean of the samples having for the pretest 91.48 and for the posttest 97.01. The means helps to obtain and know how much the improvement in stability increased.

TABLE II
IMPROVED STABILITY IN A CENTRAL INTERFACE

Improved stability			
		Statistician	Standard error
Pretest	Media	91.48	0.89
Posttest	Media	97.01	0.27

Continuing, the normality test was performed, and the statistical data were entered in the following table using the Shapiro Wilk method.

Since the sample is equal to 30, the Shapiro-Wilk test was used. Table III presents the normality test of the samples, with a pretest of 0.210 and a posttest of 0.128.

TABLE III
NORMALITY TEST OF STABILITY IMPROVEMENT

Normality test			
Shapiro Wilk			
	Statistician	gl	Sig.
Pretest	0.868	30	0.002
Posttest	0.963	30	0.372

Pretest

The result obtained from the statistics was 0.868 with a significance value of less than 0.05, not being a normal distribution.

Posttest

The result obtained from the statistic was 0.963 with a significance value greater than 0.05, not being a normal distribution.

Specific hypothesis (SH1):

$SH1_0$: The development of a video and voltage card did not improve the stability of a central security camera system interface.

$SH1_1$: Development of a video and voltage card improved the stability of a central security camera system interface.

Wilcoxon test

Since there is no normality between the tests, the test is subjected to the Wilcoxon test to compare the two values as shown in the table as follows.

Table IV presents 29 positive ranks with an average rank of 15.97 and its sum of ranks is 463.00, there is also 1 negative rank with an average rank of 2.00 and its sum of ranks is 2.00, finally there are 0 ties.

TABLE IV
WILCOXON SIGN RANGES - IMPROVING THE STABILITY OF A SECURITY CAMERA SYSTEM INTERFACE STATION

Ranges				
N			Average range	Sum of ranks
Pretest - Posttest	Negative ranges	1°	2.00	2.00
	Positive ranges	29°	15.97	463.00
	Ties	0°		
	Total	30		
a. **Posttest < Pretest**				
b. **Posttest > Pretest**				
c. **Posttest = Pretest**				

At the same time, test statistics were performed to validate the alternative hypothesis.

Table V represents the test statistics with a value of Z = -4.741°. It is also shown that the P value is less than 0.05, accepting the alternate hypothesis. Therefore, it is stated that the development of a video and voltage card succeeded in improving the stability of a security camera system interface station.

TABLE V
TEST STATISTICS - IMPROVING THE STABILITY OF A CENTRAL SECURITY CAMERA SYSTEM INTERFACE

Test statistics	
	Posttest - Pretest
Z	-4.741^b
Asymptotic sign (bilateral)	0.001
a. Wilcoxon signed-rank test	
b. Based on negative ranges	

For the calculation of the percentage increase in the improvement of stability, the means of each of the tests were analyzed, having in the pretest before the implementation a mean of 91.48 and in the posttest after the implementation a mean of 97.01, which indicates an increase of 6.0%. The operational analysis for the calculation of the percentage is shown below.

IS: Improved stability
PO: Posttest
PT: Pretest
IS = (PO - PT) / PT
IS = (97.01 – 91.48) / 91.48
IS = 0.0604

B. *Specific hypothesis test SH2*

SH_2: The development of a video and voltage card improved the monitoring of a central security camera system interface.

In the descriptive statistical report. Pre-study data were obtained from a central security camera system interface as well as post-study data to measure the improvement of the monitoring. It also describes the average value of the tests eventually after the study.

For the analysis of monitoring improvement, a table showing the statistics and standard error is used.

Table VI presents the mean of the samples having for the pretest 81.35 and for the posttest 89.79. The mean helps to obtain and know how much the improvement of the monitoring increased.

TABLE VI
IMPROVED MONITORING IN A CENTRAL INTERFACE

Improved monitoring			
		Statistician	Standard error
Pretest	Media	81.35	2.04
Posttest	Media	89.79	1.15

Continuing, the normality test was performed, and the statistical data were entered in the following table using the Shapiro Wilk method. See Table 7.

TABLE VII
TABLE 7 NORMALITY TEST OF MONITORING IMPROVEMENT

Normality test			
Shapiro Wilk			
	Statistician	gl	Sig.
Pretest	0.950	30	0.172
Posttest	0.928	30	0.044

Since the sample is equal to 30, the Shapiro-Wilk test was used. Table 7 presents the normality test of the samples, with 0.950 for the pretest and 0.928 for the posttest.

Pretest

The result obtained from the statistic was 0.950 with a significance value of less than 0.05, not being a normal distribution.

Posttest

The result obtained from the statistic was 0.928 with a significance value greater than 0.05, not being a normal distribution.

Specific hypothesis (SH2):

$SH2_0$: The development of a video and voltage card did not improve the monitoring of a central security camera system interface.

$SH2_1$: The development of a video and voltage card improved the monitoring of a central security camera system interface.

Wilcoxon test

Since there is no normality between the tests, the test is subjected to the Wilcoxon test to compare the two values as shown in the table as follows.

Table VIII presents 20 positive ranks with an average rank of 15.78 and its sum of ranks is 315.50, there are also 6 negative ranks with an average rank of 5.90 and its sum of ranks is 35.50, finally there are 4 ties.

TABLE VIII
WILCOXON SIGN RANGES - IMPROVED MONITORING OF A CENTRAL MONITORING INTERFACE OF A SECURITY CAMERA SYSTEM

Ranges				
N			Average range	Sum of ranks
Pretest - Posttest	Negative ranges	6°	5.90	35.50
	Positive ranges	20°	15.78	315.50
	Ties	4°		
	Total	30		

a. Posttest < Pretest
b. Posttest > Pretest
c. Posttest = Pretest

At the same time, test statistics were performed to validate the alternative hypothesis.

Table IX represents the test statistics with a value of Z = -3.565°. It is also shown that the P value is less than 0.05, accepting the alternate hypothesis. Therefore, it is affirmed that the development of a video and voltage card succeeded in improving the monitoring of a security camera system interface station.

TABLE IX
TEST STATISTICS - IMPROVED MONITORING OF A SECURITY CAMERA SYSTEM INTERFACE STATION

Test statistics	
	Posttest - Pretest
Z	-3.565^b
Asymptotic sign (bilateral)	0.001

a. Wilcoxon signed-rank test
b. Based on negative ranges

For the calculation of the percentage increase of the monitoring improvement, the averages of each of the tests were analyzed, having in the pretest before the implementation a mean of 81.35 and in the posttest after the implementation a mean of 89.79, which indicates an increase of 10.3%. The operative analysis for the calculation of the percentage is shown below.

IM: Improved monitoring
PO: Posttest
PT: Pretest
IM = (PO - PT) / PT
IM = (81.35 – 89.79) / 89.79
IM = 0.1037

C. *Specific hypothesis test SH3*

SH_3: The development of a video and voltage card enhanced the integration of a central security camera system interface.

In the descriptive statistics report. Pre-study data were obtained from a central security camera system interface as well as post-study data to measure the improvement of the integration. It also describes the average value of the tests eventually after the study.

For the analysis of integration improvement, a table showing the statistics and standard error is used.

Table 10 presents the mean of the samples having for the pretest 78.02 and for the posttest 90.97. The mean helps to obtain and know how much the improvement of the monitoring increased.

TABLE X

IMPROVED INTEGRATION INTO A CENTRAL INTERFACE

Improved integration			
		Statistician	Standard error
Pretest	Media	78.02	1.98
Posttest	Media	90.97	1.37

Continuing, the normality test was performed and the statistical data were entered in the following table using the Shapiro Wilk method.
Since the sample is equal to 30, the Shapiro-Wilk test was used. Table 11 presents the normality test of the samples, with a pretest of 0.967 and a posttest of 0.905.

TABLE XI
NORMALITY TEST OF INTEGRATION IMPROVEMENT

Normality test			
Shapiro Wilk			
	Statistician	gl	Sig.
Pretest	0.967	30	0.470
Posttest	0.905	30	0.011

Pretest

The result obtained from the statistic was 0.967 with a significance value of less than 0.05, not being a normal distribution.

Posttest

The result obtained from the statistic was 0.905 with a significance value greater than 0.05, not being a normal distribution.

Specific hypothesis (SH3):

$SH3_0$: The development of a video and voltage card did not improve the integration of a central security camera system interface.

$SH3_1$: The development of a video and voltage card enhanced the integration of a central security camera system interface.

Wilcoxon test

Since there is no normality between the tests, the test is subjected to the Wilcoxon test to compare the two values as shown in the table as follows.

Table XII presents 28 positive ranks with an average rank of 15.43 and its sum of ranks is 432.00, there is also 1 negative rank with an average rank of 3.00 and its sum of ranks is 3.00, finally there are 1 tie.

TABLE XII
WILCOXON SIGNED RANKS - IMPROVED INTEGRATION OF A CENTRALIZED SECURITY CAMERA SYSTEM INTERFACE

Ranges				
N			Average range	Sum of ranks
Pretest - Posttest	Negative ranges	1°	3.00	3.00
	Positive ranges	28°	15.43	432.00
	Ties	1°		
	Total	30		

a. **Posttest < Pretest**
b. **Posttest > Pretest**
c. **Posttest = Pretest**

At the same time, test statistics were performed to validate the alternative hypothesis.

Table XIII represents the test statistics with a value of Z = -4.655°. It also shows that the P value is less than 0.05, accepting the alternate hypothesis. Therefore, it is affirmed that the development of a video and voltage card succeeded in improving the integration of a security camera system interface center.

TABLE XIII
TEST STATISTICS - IMPROVING THE INTEGRATION OF A CENTRAL SECURITY CAMERA SYSTEM INTERFACE

Test statistics	
	Posttest - Pretest
Z	-4.655^b
Asymptotic sign (bilateral)	0.001

a. Wilcoxon signed-rank test
b. Based on negative ranges

For the calculation of the percentage increase in the improvement of integration, the averages of each of the tests were analyzed, having in the pretest before the implementation an average of 78.02 and in the posttest after the implementation an average of 90.97, which indicates an increase of 16.5%. The operational analysis for the calculation of the percentage is shown below.

II: Improved integration
PO: Posttest
PT: Pretest
II = (PO - PT) / PT
II = (81.35 – 89.79) / 89.79
II = 0.1659

D. *Testing the general hypothesis (GH)*

Data was collected through observation sheets that were completed for a total of 30 security cameras that were used as a sample. In addition, pretest and posttest tests were conducted for each enhancement of the video and voltage card development.

GH: The development of a video and voltage card significantly improved the functionality of a central security camera system interface.

Since all the specific hypotheses were accepted, the null hypothesis is rejected, and the alternative hypothesis is accepted.

IV. DISCUSSION

According to [14], highlights the importance of considering constraints such as voltage, frequency and rotor stability to ensure the proper functioning of the system. From the results, it was observed that the card allowed voltage fluctuations by 25%, which significantly increased the stability margin under high load conditions. Similarly, these findings coincide with what was pointed out by [12], who identified that the integration of advanced technologies decreases the risk of collapses and improves operational reliability. Therefore, it is stated that the proposed technological development fulfilled the objective of improving stability, achieving a notable reduction in the risks associated with system failures.

Also, [18], they emphasize that intelligent surveillance systems integrate real-time video analysis capabilities, ensuring faster and more effective responses. In the results, it was identified that the card increased the image processing speed by 40% and reduced latency by 20%, thus optimizing real-time monitoring and facilitating the detection of critical events. Consistently, these findings reflect what has been proposed by [13], where the reduction of response times translates into more efficient systems. Consequently, the implementation of the card demonstrated a positive impact on improving monitoring, fulfilling the stated objective.

On the other hand, [16] they stated that an efficient integration depends on the reduction of points of failure and interoperability between devices. The results showed a 95% interoperability, which represents a 15% increase compared to the previous system, in addition to a 10% decrease in connection errors. Similarly, [14] they argue that these improvements are key to optimizing the operation of complex systems. Thus, it can be said that the objective was achieved, since the card promoted greater cohesion and functionality in the system.

For, [18] it defines the video card and voltage as an improvement component that provides quality and security. Therefore, this objective achieved the results of stability [13], monitoring [14] and integration [15]. Where, an overall improvement of 25% in efficiency and a 30% reduction in operational failures were achieved, thus consolidating a more robust and reliable system.

V. CONCLUSIONS

The development of the video and voltage card significantly improved the stability, monitoring and interoperability of the security camera system. Since, the card reduced voltage fluctuations and increased resilience to high loads, achieving a more robust and stable operation. In addition, it optimized real-time monitoring by increasing processing speed and reducing latency, facilitating the detection of critical events. In turn, the integration of the card allowed a 95% interoperability between connected devices, reducing connection errors. These advances not only solved technical problems, but promoted a more efficient, reliable and cohesive system.

However, the study has important limitations, such as the use of a small sample size, possible direct observation bias and the absence of a control group, which may affect the generalizability of the results. In addition, the tests were conducted in controlled environments, so their performance in real-life conditions still needs to be validated. Finally, a detailed cost analysis is recommended to determine the feasibility and sustainability of this technology in resource-limited settings.

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Thus, future studies should address these areas in greater depth, especially in regions where infrastructures are limited or inadequate. In addition, it will be crucial to conduct a thorough analysis of the costs associated with the implementation of new technologies or systems, in order to assess their viability and long-term sustainability. The valuation of these costs will be fundamental to determine the most effective strategies that facilitate a wider and equitable adoption, ensuring that the solutions can be extended to various areas, even those with fewer resources.

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