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DEVELOPING A SURVEILLANCE SYSTEM USING AUTOMATIC STATIC IMAGING TECHNOLOGY FOR ESTABLISHMENTS

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Abstract

This study aimed to fabricate surveillance capturing devices for business establishments in securing and monitoring their premises. Its main focus is to capture images of guests coming in and out of the establishment for monitoring purposes. The design applied the descriptive type of research methods and based the development using the CDIO Framework of the device. The researchers developed this device to supplement the CCTV output with still images with high-definition photos of guests entering and exiting the establishment's premises. The device provides transparency and balancing in the manual logbook entry of front desk employees. Due to the researcher's doubt on the number of guests by the personnel that check in on the specific time and date and payment of extensions stay. To solve this problem, this study was developed to enhance the capturing of high resolution still images using a digital camera, applying the principle of electronic sensors to automate the process instead of manual trigger. Furthermore, users and experts have the same thoughts in assessing the device. A survey questionnaire was used to determine the system's effectiveness as the users and experts rated it. The study found that users and experts recommended the technology for implementation as they believed it was beneficial in surveillance. Lastly, formulation of policy and guidelines is advisable in utilizing the device in any business establishment.

Keywords: Surveillance, Image Capturing, Infrared Sensor, CDIO Framework, CCTV Device.

Introduction

One of the many areas where surveillance is prevalent is in business, wherein various image recognition, security, and other applications and monitoring purposes are being utilized. One of the most utilized devices in the business security application is a Closed-Circuit Television (CCTV), using video cameras for transmitting readable signals to any monitor connected for surveillance monitoring. Video monitoring has been used to watch security-sensitive sectors like banks, department stores, roads, congested public spaces, and borders [1].

The relevance of developing excellent practices for each of these technologies has increased due to their broad adoption. [2] Closed-circuit television (CCTV) has become popular. Some issues come with CCTV in specific counting and monitoring guests in a business establishment. For example, using CCTV has many challenges in reconciling several guests checked-in in a logbook when you counter-check with CCTV recording because it is usually live streaming, and it takes time to replay since it is not still images.

Because of the challenges cited, there is an opportunity to enhance the process of capturing high resolution still images using a digital camera, applying the principle of electronic sensors to automate the process instead of manual trigger. The researcher developed an Automatic Static Imaging Technology device to help monitor the presence of persons entering the vicinity of an establishment. The study would perfectly supplement the CCTV output perceived by users and experts. The device is designed to trigger a digital camera; however, it is run and operated by a sensor to push the camera shutter button automatically. The device can capture a higher and clearer image quality than CCTV because it has a 20-megapixel resolution and cheaper cost. The camera and the process of capturing images in a specific location are the main concerns of this research. In this case, the sensor is used as a detection device to trigger the camera button; once the sensor's infrared proximity distance heats an image, the image is captured by the built-in digital camera in the system device. Hence, this technology innovation aimed to deal with the problems that exist in the business application of monitoring and counting guests or customers in an establishment with a hassle-free and simple process that is less tasking because without the use of PC and Wi-Fi, thus economically feasible and at the same time enhancing the still image capturing capability.

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Framework

This study was anchored on the Theories of Innovation, Automata Theory, Control Theory and Theory of Acceptance Model. These four theories are all relevant in this present endeavour. Thus, it would be helpful in all aspects of this Automatic Static Image Capturing Shutter Switch. As shown in the theoretical framework of the study. It can be seen that the four theories: the Automata Theory, the Control Theory, Theory of Innovation and The Theory of Acceptance Model, serves as an anchor in this present study as it has essential elements in the development of an Automatic Static Imaging Technology Innovation

Lastly, the National Privacy Commission (NPC) Advisory No. 2020-04 entitled "Guidelines on the Use of Closed-Circuit Television (CCTV) Systems" support the study as the legal basis for the impact of CCTV systems on data subjects' rights and freedoms must be considered, and their usage must be reviewed regularly to verify that it is still essential for defined and legitimate reasons [3]. The Data Privacy Act of 2012 considers the capture, use, retention, and destruction of video or audio footage received from CCTVs to be the processing of personal data (DPA).

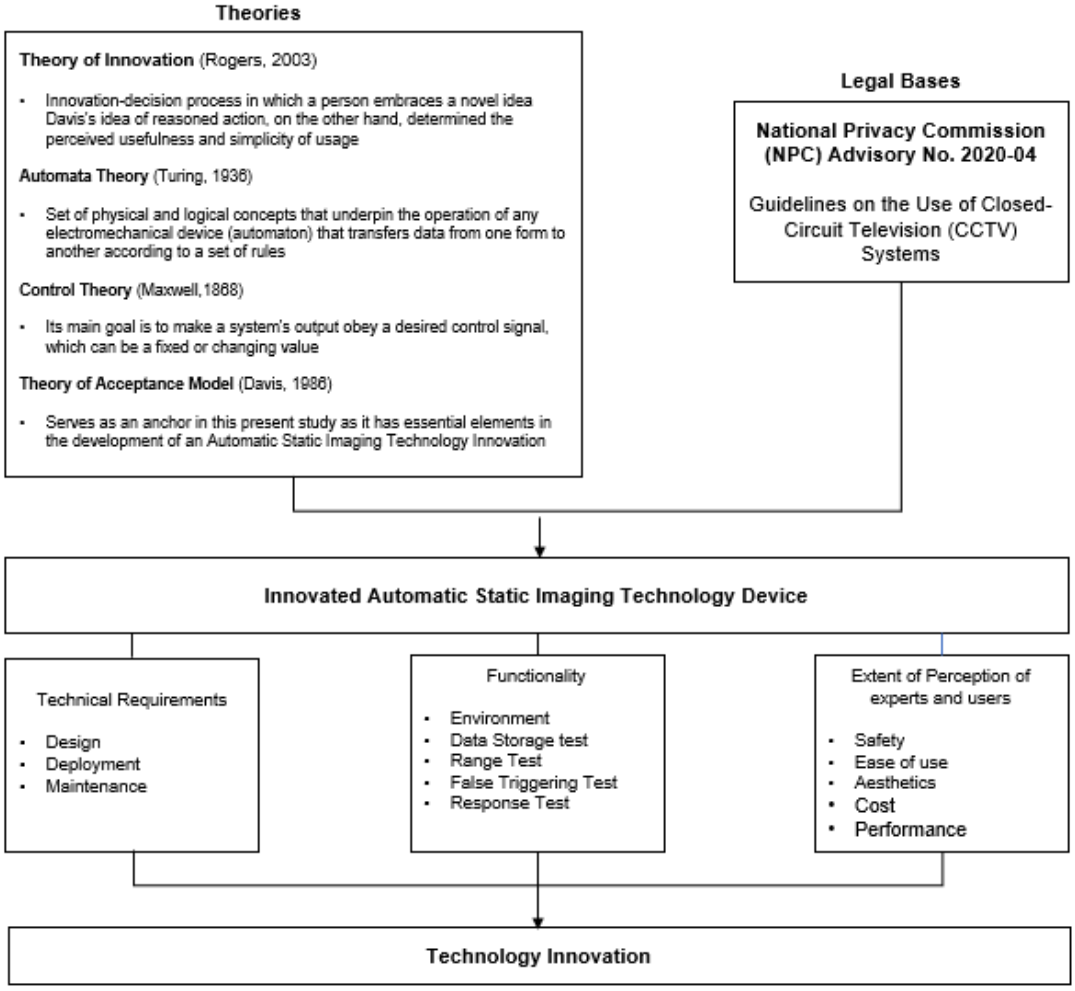

Figure 1: The Framework 0f The Study

Objectives

1. Aimed to innovate a Surveillance System using Automatic Static Imaging Technology to the identified establishment.
2. Identify the technical requirements for the design and development of the Automatic Static Imaging Technology.
3. Tested the functionality of the Automatic Static Imaging Technology as to the performance as tested by the users and experts.
4. Enhanced the capturing high resolution still images using a digital camera, applying the principle of electronic sensors to automate the process instead of manual trigger.

Methodology

The project applied the methods of descriptive research and the CDIO framework to further the system's development. The CDIO framework is known as design, implement, and operate as defined by CDIO Initiative [4]. This framework was used to design the device process or the planning stage, its development, and the educational program in becoming a global standard in engineering education.

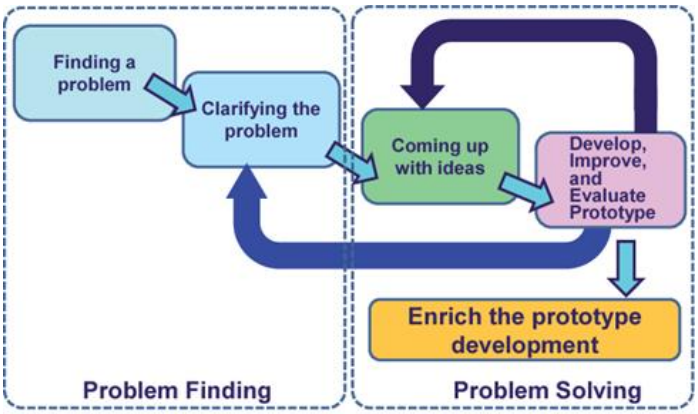

Figure 2: Flowchart of The Project Activities (K. Takemata et al., 2013) [4]

This research method is used to determine the performance of Automatic Static Imaging Technology Innovation (ASITI device) in real applications. The details in the device's construction include planning and designing, where concepts and ideas are studied and analyzed, then conceptualized through designs and block diagrams, the materials, tools and equipment, and the cost of production was determined were identified. It also showcased the presentation of different steps in realizing the project.

Planning

Planning and designing were conceived after a thorough analysis and brainstorming of concepts and ideas. Working drawings were created to guide the development of the Automatic Static Imaging Innovation Device throughout the entire process. The device's block diagram was produced to provide insight into the project's principal, concept, and system function.

A schematic diagram was constructed based on the block diagram, which detailed the linkages between electronic component elements. The diagram was used to establish traces and connections on the printed circuit board, and it served as the foundation for all electronic components to stay in place.

Figure 3 shows the interconnection of parts consisting of lines and arrows to specify the connections of parts and modules that determine system operation principles. The entire system is divided into two basic parts; the external circuits and internal circuits where it begins from the main utility power source or 220VAC as commonly found in household utility grid outlets, using a 12VDC power converter to step down the voltage required by the internal circuits as set by its designed.

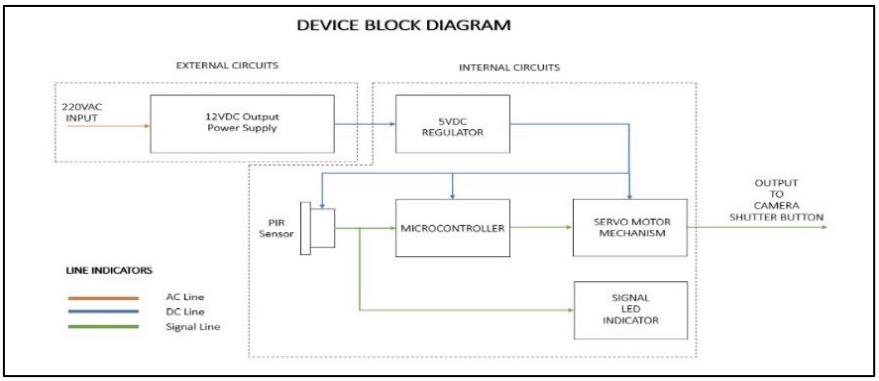

Figure 3: Device Block Diagram

When the shutter button receives pressure from the Servo mechanism, it triggers the camera to capture an image synchronizing the detection of the PIR sensor part of the ASITI device. The captured

images are then sent to the storage device of the Digital Camera, and Data Access Port will be used to retrieve captured images for transferring data to another device, specifically Personal Computer (PC), for further use. Figure 4 presents the system configuration of the Digital Camera block diagram used as the image capturing device and the interrelation of operation from the ASITI device that act as the automatic shutter control.

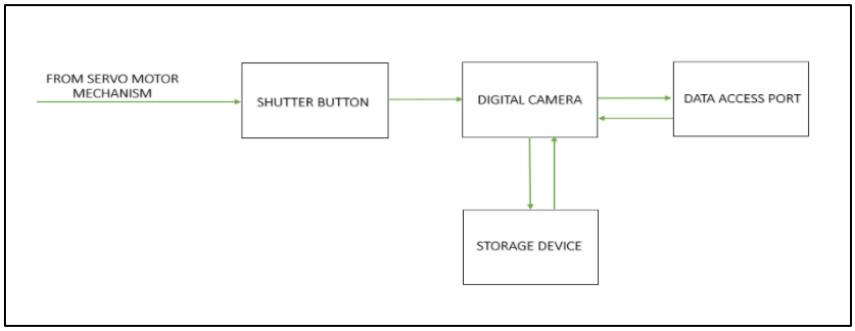

Figure 4: Digital Camera Block Diagram

12VDC input is connected from the External Circuit Diagram and further regulates the DC power set to 5VDC as other components require.

Figure 5 presents the Internal Circuit component connections using photos of devices, providing a more detailed overview of parts' interconnection in the created project. This figure will guide readers to establish more understanding of how the system was created to the function of its designed operation.

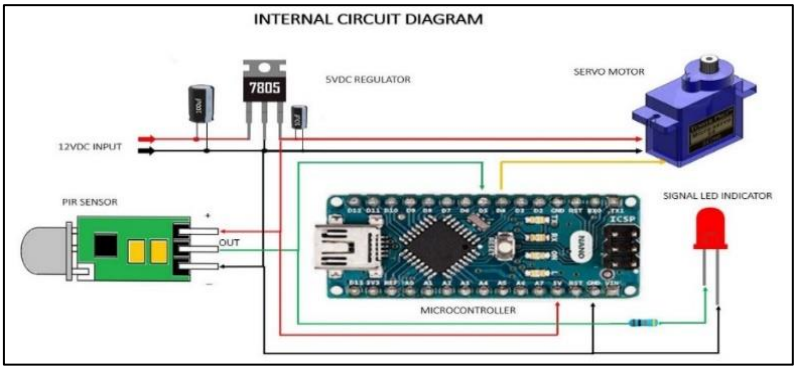

Figure 5: Circuit Diagram

Design

The device is designed to automatically trigger a digital action camera operated by a sensor to push the servo motor to the Shutter button automatically.

The idea was conceived from the baseboard, with all component pieces incorporated, including terminals and indicators. The block diagram, which showed the interconnection of every section based on the system operation; the schematic diagram, which showed the detailed connections of electronics parts, the printed circuit board, which showed all electronic parts arranged according to their connection, and other accessories, which were all part of the entire system operation, were also shown.

The camera and the process of capturing images in a specific location are the main concerns of this research. In this case, the sensor is used as a detection device to trigger the camera button once an image is heated by the infrared proximity distance of the sensor; by then, the capturing of the image is done by the built-in digital camera in the system device. Hence, this technology innovation aimed to address the issues faced in the business application of monitoring and counting guests or customers in an establishment with a hassle-free and simple process that is less tasking because without the use of PC and Wi-Fi, thus economically feasible and at the same time enhancing the still image capturing with 20 Megapixels resolution.

Internal Circuitry Description

220vac Input – Main power supply from utility grid outlet.

12VDC - Output Power Supply- Step down AC to DC power converter.
5VDC Regulator – Provide a stable DC voltage at 5 volts to power the small electronic circuits.
PIR Sensor – This is a (Passive Infrared) sensor used as the system detector device to capture the target object.
Microcontroller – Electronic signal processor circuit (Detect signal from PIR sensor. Set time delay, Control and set angle of the Servo motor)
Servo Motor Mechanism – Actuator device that performs the physical operation of the camera shutter button.
Output To Camera Shutter Button – Signal point to interface system project to a camera shutter button.
Signal LED Indicator – Used as a visual indicator for signal detection from the PIR sensor.
External Circuit – The ready-made power supply system.
Internal Circuit – The parts of the project.
Shutter Button – Camera control button to capture the image.
Digital Camera – Refers to the digital system that captures images.
Data Storage Device – A digital data recording device can be retrieved for the future.
Data Access Port – Refers to the connectivity terminal used for connecting another compatible device.

Figure 6: Device Design

Development

Steps in realizing the project:

1. Identified the electronic circuit and actuator to cope with the Automatic Static Imaging Technology Innovation Device requirements.

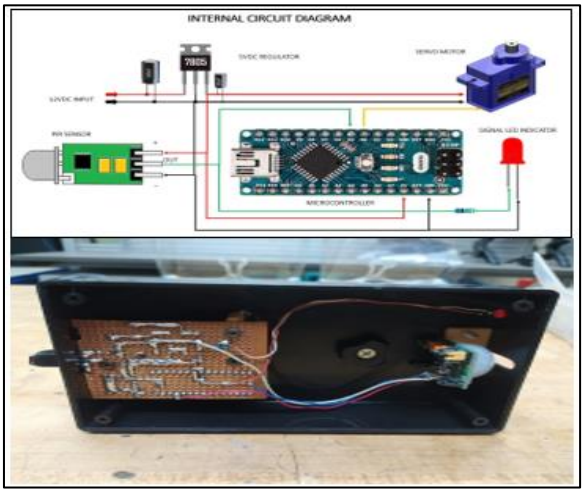

Figure 7: Electronic Circuit Assembling

2. Prepare the materials for assembling of Automatic Static Imaging Technology Innovation Device.

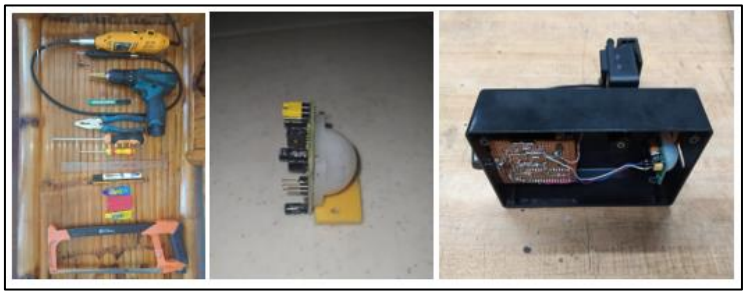

Figure 8: Materials (sensor, circuit board, screwdriver, ruler, glue, glue gun, saw, and marker)

3. The layout was the based box for the camera holder and the device sensor.

Figure 9: Based Box Camera Holder

4. Prepare the camera holder.

Figure 10: Camera Holder

5. Preparing the shutter mechanism.

Figure 11: Shutter Mechanism

6. Calibration of the camera shutter.

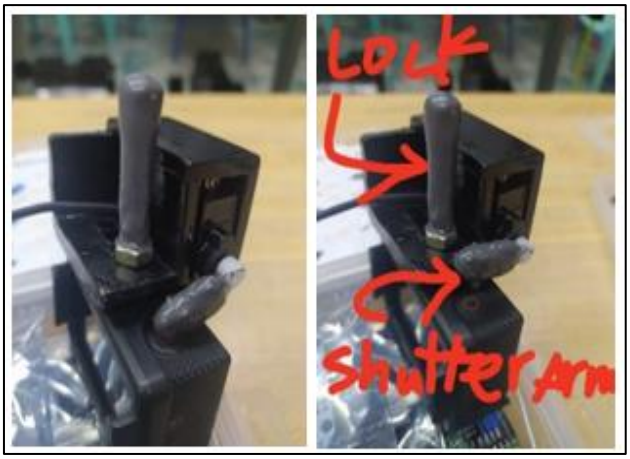

Figure 12: Camera Shutter Calibration

7. Calibration of the sensor for the specified angle and distance for detection.

Figure 13: Calibrating Angle and Distance for Detection

After the construction of Automatic Static Imaging Technology Innovation (ASITI). It was tested for functionality.

The study respondents were fifty-five establishment personnel of the different Inn, Lodge, and Resorts in Negros Oriental. Five experts evaluated the innovative machine as they significantly impacted the performance effectiveness and efficiency, which are trained in telecommunications and information technology, such as electronic engineers, computer technicians, and electronic technicians employed in the private and public sectors in Negros Oriental.

Table 1: Distribution of Respondents

Respondents	Frequency	Percentage
Users	55	95%
Experts	5	5%
Total	**60**	**100%**

The instrument is an adopted, and modified questionnaire from ISO/IEC 9126-1 Software Engineering – Product quality or the Software Evaluation Criteria are given to the users and experts. The tool is divided into two (2) parts. The first part collects information on personal data. The second part includes the items for assessing the experts in rating the system in the performance based on the experiment and perception of the extent of the functionality and was structured using the Likert scale.

Table 2: Likert Scale

Scale	Description	Mean Range	Interpretation
4	Highly acceptable	3.26 – 4.00	The developed ASITI device is highly acceptable when tested by experts and users.
3	Acceptable	2.51 – 3.25	The developed ASITI device is acceptable when tested by experts and users.
2	Moderately acceptable	1.76 – 2.50	The developed ASITI device is less acceptable when tested by experts and users.
1	Less acceptable	1.00 - 1.75	The developed ASITI device is not acceptable when tested by experts and users.

The frequency count and simple percentage formula were used in data for counting and percentage. The weighted mean method was used to determine the responses to be obtained from the Likert Scale of 4 to 1 on the affectivity of the device.

Results and Discussion

Data Storage Test

The data storage test is conducted to evaluate the storage capability of the camera concerning the captured still images using the innovative ASITI device.

As presented in table 3, the users rated the device based on its functionality in terms of data storage test with an average mean of 3.93 and a verbal description of Highly Acceptable. The Experts rated the device with an average of 3.80 with the same verbal description of Highly Acceptable. Surveillance systems produce and need to store a huge amount of data and execute specific image analysis in real-time to detect safety events. A video surveillance system based on Cloud Computing collects multimedia streams generated by surveillance cameras, optimizes their transmissions according to network conditions, and stores them in a cloud storage system efficiently and securely [5].

Table 3: Rating of Functionality in Terms of The Data Storage

Items	Respondents				Average	Description
	Users		Experts			
	WX	Description	WX	Description		
The ASITI data storage can store thousands of images per day	3.89	Highly Acceptable	3.60	Highly Acceptable	3.87	Highly Acceptable
The ASITI data storage can be replaced with bigger memory	3.91	Highly Acceptable	4.00	Highly Acceptable	3.92	Highly Acceptable
The ASITI data storage can capture duplicated photos	3.91	Highly Acceptable	3.80	Highly Acceptable	3.90	Highly Acceptable
The ASITI data storage can store images 24/7 in a week	3.93	Highly Acceptable	3.80	Highly Acceptable	3.92	Highly Acceptable
Composite Mean	**3.93**		**3.80**		**3.90**	
Description	Highly Acceptable		Highly Acceptable		Highly Acceptable	

Range Test

The test was conducted to increase the distance at an interval of 1 meter until reaching the maximum range.

The result in table 4 implies that both users and experts "Highly Accepted" that the device has all the quality characteristics in terms of its distance [6]. The respondents highly accepted the device detection range and capturing method. As a result, the average distance between CCTV cameras and clients is kept close, improving service rates.

Table 4: Rating of Functionality in Terms of Range Test

Items	Respondents				Average	Description
	Users		Experts			
	WX	Description	WX	Description		
The sensor of the developed machine can detect moving objects	3.95	Highly Acceptable	3.80	Highly Acceptable	3.93	Highly Acceptable
A person is allowed to pass the camera's panoramic view within 1 meter, 2 meters, 3 meters and 4 meters and 5-meter range.	3.87	Highly Acceptable	3.80	Highly Acceptable	3.87	Highly Acceptable
The Infrared Sensor (IR) can detect objects at a maximum range of 7 meters	3.91	Highly Acceptable	3.80	Highly Acceptable	3.90	Highly Acceptable
The sensor detects an object's inaccurate capture when it is within the maximum range	3.95	Highly Acceptable	3.80	Highly Acceptable	3.93	Highly Acceptable
Composite Mean	**3.92**		**3.80**		**3.90**	
Description	Highly Acceptable		Highly Acceptable		Highly Acceptable	

False Triggering Test

The test is performed by continuous and successive passing of persons in the range area of the sensor and a panoramic view of the camera to check its triggering sequence.

Table 5 result means that the device is "Highly Acceptable" for the users in securing and monitoring their guests coming in and out of the establishment and the experts in terms of the functionality for the false triggering test. This concept's definition and prime objective enable both users to impart and perceive better business management. Additionally, it allows them to be checked remotely from any location without being physically present face-to-face.

Table 5: Rating of Functionality in Terms of The False Triggering Test

Items	Respondents				Average	Description
	Users		Experts			
	WX	Description	WX	Description		
The switch of the device does not trigger if the IR sensor detects no moving object	3.87	Highly Acceptable	3.80	Highly Acceptable	3.87	Highly Acceptable
Any moving object within the detection range of the IR sensor is captured	3.89	Highly Acceptable	3.60	Highly Acceptable	3.87	Highly Acceptable
The switch of the device does not occur any delays in capturing the object	3.85	Highly Acceptable	3.60	Highly Acceptable	3.83	Highly Acceptable
The switch of the device capture objects is deemed, and ambient lights	3.91	Highly Acceptable	3.80	Highly Acceptable	3.90	Highly Acceptable
Composite Mean	**3.88**		**3.70**		**3.86**	
Description	Highly Acceptable		Highly Acceptable		Highly Acceptable	

Response Test

This test was conducted to establish the speed of the servo motor response at an average distance from 2 to 7-meter objects and a 1-second delay of a shutter click.

Table 6 presents the acceptability rating of the device in terms of the range test. The users and the experts have the same thoughts in evaluating the device as Highly Acceptable for recommending it be utilized in any business establishments to capture images of guests entering the premises. The respondents also evaluated the device that the distance of the sensor's detection meets the standard view between 2 – 6 meters.

Table 6: Rating of Functionality in Terms of Response Test

Items	Respondents				Average	Description
	Users		Experts			
	WX	Description	WX	Description		
The switch of the device triggers automatically when an object passes in the trigger distance below 1 second's delay in a shutter click	3.95	Highly Acceptable	3.60	Highly Acceptable	3.93	Highly Acceptable
The switch triggers repetitive capture every 1 second	3.89	Highly Acceptable	3.60	Highly Acceptable	3.87	Highly Acceptable
The device capture images of successive and continuous passing of object in the panoramic view of the camera, and the sensor range between 2 – 6 meters	3.89	Highly Acceptable	3.60	Highly Acceptable	3.87	Highly Acceptable
The device response during deemed and ambient lights	3.87	Highly Acceptable	3.60	Highly Acceptable	3.85	Highly Acceptable
Composite Mean	**3.90**		**3.60**		**3.88**	
Description	Highly Acceptable		Highly Acceptable		Highly Acceptable	

Conclusion

The Automatic Static Imaging Technology Innovation Device is a good, precise, and reliable equipment for surveillance and image capturing. The concept and design of the Automatic Static Imaging Technology Innovation Device are instrumental in the Surveillance and Image identification of subjects that passes through the panoramic view. The Automatic Static Imaging Technology Innovation Device is very effective in its Data Storage Test, Range Test, False Triggering Test, and Response Test. The device can capture multiple high-definition images shots than the CCTV. It is way cheaper than CCTV. The only limitation is that it is not weather sealed in extreme conditions and has no built-in lights in the device; however, if there are artificial lights in the range area during nighttime, the device can still trigger.

Recommendation

The Automatic Static Imaging Technology Innovation Device Implementation of the system to any establishment is advisable. The Automatic Static Imaging Technology Innovation is very useful to monitor activities happening in the area of interest. It effectively monitors road intersections occurring events and surveillance of certain areas. This device provides benefits in monitoring workers' activities in the facilities. It also provides security and emergencies that take place in real-time. This participative research study certainly benefited the staff in monitoring their guest. This study is of great help in monitoring highly sensitive areas and abnormal events within the vicinity. It helps count and capture still photos of guests that enter the premises. It will provide transparency and balance in front desk employees' manual logbook entry. Formulation of policy and guidelines is advisable in utilizing the device in any business establishment.

Conflict of Interest

There is no conflict of interest between the authors in this manuscript.

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