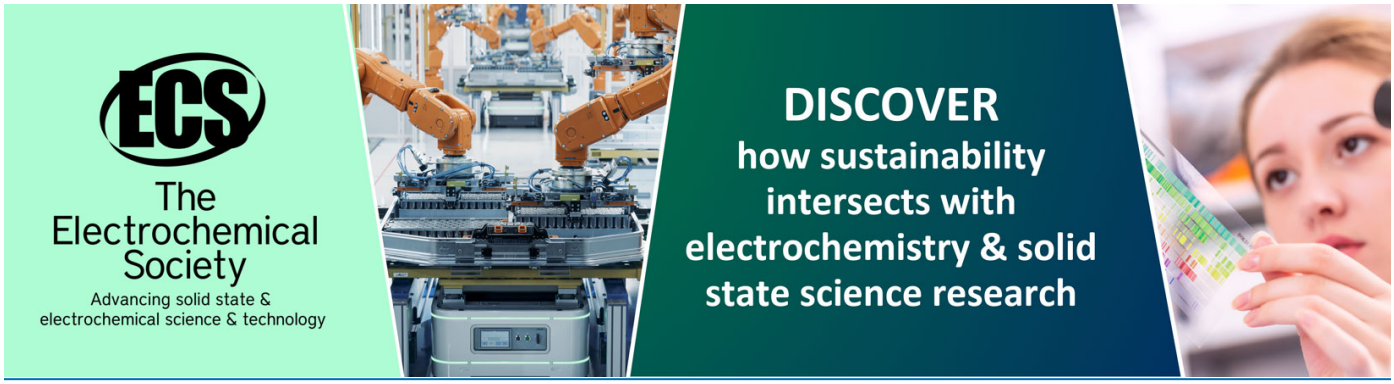
Design of intelligent camera-based security system with image enhancement support



Design of intelligent camera-based security system with image enhancement support

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Abstract. Security is a desired condition in order to achieve stability in the life of society. Security issues are often related to efforts to prevent and detect criminal acts in the community and along with technological developments various methods and devices are created and implemented to support security procedures. This research focuses on designing intelligent camera-based security systems with the support of image enhancement feature. The developed security system is the type of active security system that has the advantage of intercepting or providing real-time information on potential criminal acts that occur and this is done through system automation without involving humans as system supervisors. The developed security system is supported with digital image processing software to process snapshot and recorded images from system cameras with the aim of improving quality of visual images for the analysis purpose and also as digital forensic evidence that can be used in law enforcement related to criminal activity. The output of this research is active security system devices with the support of image quality enhancing software that can be used in various security and surveillance needs.

1. Introduction

The rapid development of urban areas presents a consequence of increasing criminal action [1-2]. The high potential of security threats faced by the community can be seen from various criminal acts that occur and became daily news in mass media. In dealing with this condition, some people, including the government and police, utilize the advance in information and communication technology by using various security system tools to prevent and anticipate criminal acts. Network-based security camera system CCTV (Closed Circuit Television) is a security system that is commonly used by the public for various needs such as deterrence effects, supervision, performance monitoring and as evidence [3]. The widespread use of CCTV can now be seen in various business centers to residential homes, including CCTV operated by the city government and police institutions to support the implementation of smart cities such as monitoring the city's atmosphere and traffic to electronic traffic ticket applications. In a review of system security science, CCTV is a system with a passive security model because in its operation CCTV requires humans as operators who actively monitor the area being monitored, moreover CCTV is usually used as a provider of evidence through image and video medium after the event of criminal act [4] Records of still image and video produced by CCTV sometimes have a low quality, distorted so that it is quite difficult to be used as an investigation and evidence tool. Active security systems have several advantages. In addition to having the same benefits as a passive security system, this model's security system provides additional benefits in intercepting or providing real time information on potential act of crime. As an illustration, when a house or building equipped with an active security system is broken into by a criminal, the property owner can know directly when the event will or is ongoing and can take the actions needed to deal with it and this is done through system automation without involving humans as supervisor operator [5]. This research was conducted to design an intelligent security system based on cameras with an image enhancement algorithm based on Bee Colony algorithm[6]. The intelligent security camera system that will be developed is a surveillance camera network system that utilizes broadband internet

connections for control and has special software that will be developed to improve active security procedures. Image quality improvement algorithm is applied as part of software features to overcome one of the disadvantages of conventional CCTV footage which in some cases, the resulting image is distorted, has low resolution and detail, so that it is inadequately used as evidence of crime . Bee Colony Algorithm is an algorithm that can be used in the image enhancing and restoration process, which is a process to improve the visual quality of images by selectively highlighting desired characteristics and suppressing unwanted characteristics of an image to produce an image that is more beneficial for humans to analysis process [7].

2. Methodology

For achieving the objectives of this study, research activities will be divided into three stages. In the first stage the research will focus on the installation and configuration of hardware (hardware) Then it will proceed to the second stage which focuses on microcontroller programming (software) that aims to control hardware. Finally, the third stage of the research is focused on developing system software, which is a medium used by users to control all the features and functions provided by this security system including image enhancement features that can be activated by users to improve image quality in still images (photo) and moving image (video) and at the end of the third stage, a comprehensive system implementation will be carried out to analyze and evaluate the system performance[8]. The details of the activities at each stage are elaborated as follows :

2.1 First Stage

In the first stage, research is focused on designing and configuring hardware consisting of three main components, namely the input unit, the main control unit (MCU) and the output unit. Each main component consists of each sub-component as seen in the block diagram in Figure 1. The input component provides input data to the main control unit obtained through the sensor sub-component that equipped with a collection of sensors consisting of motion sensors and infrared sensors. These sensors will be triggered by the movement and the light that may be caused by the efforts of the criminal. The main control unit component consists of the Central Processing Unit (CPU) which is the main controller that acts as a brain that processes data from input components and sends instructions to the output components. The output component is a component that gives output in the form of a certain action in accordance with the instructions given by the control unit.

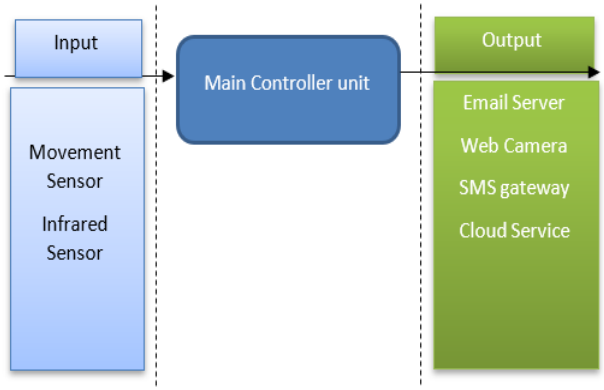

Figure 1. Block Diagram of Proposed Security System

2.2 Second Stage

The second stage of the research is focused on the design of electronic circuits and programming of software (software) PIC microcontrollers to control sensors that support the function of the security

system. The MCU acts as an interface that synergizes between input components and output components based on events that trigger input sensors.

2.3 Third Stage

The third stage of the research is carried out to develop system software which is an interface that is used by administrators / system users to control all system functions such as activating or deactivating security features, configuring account settings for email servers, sms gateway and cloud services. Included in the development of system software is the design and implementation of image enhancement features that can be activated by users to improve image quality in both still images (photos) and moving images (videos) resulting from system output in the form of snapshots and video recordings.

3. Result

Hardware design includes the selection of image capture devices (IP cameras), Network Video Recorder (NVR), Microcontroller and UART, infrared sensors and impact sensors.

- At the phase of hardware design, an image camera (IP camera) is selected that is in accordance with the specifications needed in designing an active security system. Some specification requirements are needed for, among others, HD resolution (1080p) image sharpness, having infrared sensors for night vision , and supports motion detection, supports wireless connection via NVR. The ip camera and nvr selected can be seen in figure 2 and figure 3.

Figure 2. Network Video Recorder (NVR)

Figure 3. IP Camera

- Infrared sensor: a passive infrared sensor is used and connected via the control unit. Later this sensor will act to detect movement and will trigger the ip camera to do recording
- Impact sensor: this sensor will be installed on the door which if detected there is a collision, the sensor will send a signal to the microcontroller which will then turn on the LED light and sound the Buzzer in response
- Microcontroller and UART: The microcontroller used is PIC184522 from third party vendor. The microcontroller is interfaced to a PC through the Universal Asynchronous Receiver / Transmitter (UART). UART works to receive and transmit data bytes sequentially. UART support communication between the sensor and the software. UART is configured so that the module designed on software can be corresponded to the transimitted signal triggered from sensor nodes

Supporting software is needed to support system performance. System support software includes mail servers, sms gateways and cloud storage. These three software are needed to support the early warning system and reporting from security devices. Based on the system design, this security system is equipped with 3 sensors : infrared sensors, movement sensors and impact sensors that are connected with several output components, included led light, buzzer, web cam, email server, cloud services and

sms gateway. The interaction between sensor components and output components is controlled by the main control unit based on the occured events and the level of the threat. Table 1 shows the interaction of input and output components based on triggered events and figure 4 shows the GUI of monitoring system.

Table 1. Input and Output Interaction Based on Triggered Events

Input	Output	Triggered Events
Infrared Sensor	Led light, Web Camera	The circuit will be triggered when the sensor detects changes in light and signals will be sent to the MCU and the LED light component and Web camera start recording
Movement Sensor	Led Light, Buzzer, Web Camera and Email Server	The circuit will be triggered when the sensor detects movement of humans or objects and signals will be sent to the MCU and the component of the led light is on, the buzzer sounds and the Web camera will start taking photos snapshot and record in certain time interval and sent to the user's email via an email server
Impact Sensor	Led Light, Buzzer, Web Camera, Email Server, Cloud Service, and SMS Gateway	The circuit will be triggered when the sensor detects an impact on objects fitted with sensors such as doors / window and signal will be sent to MCU and the component of the led light is on, the Web camera will start recording and taking snapshots and results emailed, video recordings are stored on cloud storage and alert services sent via SMS to the user.

Figure 4. Interface of camera monitoring system

The enhancement algorithm used in the system is stated below the maximum entropy criteria. Therefore the optimal fuzzy parameter selection is the optimization parameter below the value of the entropy and the value can use fuzzy entropi as a fitness function directly. To reduce processing time significantly [9], the population size is limited to 25 and the termination size is 80. The initial value of the fuzzy parameter inside Adaptive Bee Colony (ABC) algorithm is generated randomly. Therefore the termination value is chosen. Figure 5 displays contrast graphics between the original image and the image that has been processed using the Adaptive Bee Colony algorithm.

Figure 5. The original image (left) and the image after enhancement process (right)

4. Conclusion

The designed security system is a camera-based intelligent security system solution that is able to actively play a role in preventing, intercepting and providing information about crime against a protected property while implementation of the enhancement algorithm used on system software can improve the quality of image significantly.

Acknowledgments

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