Semiconductor Optoelectronics
ISSN: 1001-5868

AN EFFICIENT NOVEL ARCHITECTURE FOR SURVEILLANCE SYSTEM USING INTERNET OF THINGS

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Abstract
Over the most recent couple of years, we saw various episodes of psychological oppressor assaults and hazards in broad daylight swarmed areas. Requirement of effective observation across such areas forces improvement with latest efficient mechanized answers for such areas and find potential hazards quickly before any disaster could be expected. In this work, we propose an original way to deal with make a decentralized engineering to oversee watching robots and cameras taking advantage of lightweight conventions utilizing space of Internet of things (IoT). To expedite the affirmation and assessment processes, that is feasible for incorporate in all target of wise climate psychological information through the gathering of the haze figuring viewpoint. Dispersing the knowledge among every target of the observation biological system permits a quicker acknowledgment and response to conceivable advance notice circumstances. The acknowledgment of strange items in specific regions, e.g., air terminals, Railway stations and other transport area, has been made utilizing PC visual calculations. With broad reception of Internet of Thing conventions in various leveled engineering gives high versatility permitting a simple and effortless join of other shrewd items. Likewise a concentrate on the delicate continuous practicality has been directed and is thus introduced.

Keywords: Internet of Thing, Surveillance System, Protocol, Computer Vision

Introduction

Somewhat recently we saw an extraordinary exertion of the examination local area within reconnaissance along with security areas. Such requirements enforced the review along with advancement of solution for quicker identify and respond to advance notice circumstances and threats. The observation in broad daylight places like air terminals, transport stations and Rail route stations have been significantly expanded uniquely inside nations with high dangers of psychological warfare.

The innovation improvement in implanted gadgets permitted the advancement of all the more impressive registering gadgets with little sizes that can bear to run fundamental examination and acknowledgment errands all alone without depending on a cloud design. Then again, web of things (IoT) convention enhancements prompted the likelihood to impeccably oversee net group with a colossal point of hubs, little defer response along with high dependability. These combination standards brought forth a transitional layer among cloud and a "mist". It over-burden cloud layer with every assignments. In our work, we highlighted a portion of elaboration errands on shrewd gadgets like savvy cameras for pre-elaborate gathered information. Along these lines, it ensures feasible for decrease time to elaborate and lessen computing burden nervous/haze hubs. This is conceivable on account of the greater computational assets we can track down on inserted gadgets.

As a result, we made the decision to employ these resources to equip smart cameras with a computer vision (CV) module in order to conduct research [8-10]. A similar rule may be seen in the fog registering, wherein few calculating sub-module continued through centrally managed module for to minimizing idleness because of separation among devices with algorithmic sub-modules [1]. Besides, decentralizing a portion of the capabilities framework brings about additional versatile frameworks. This edges layer is in charge for compiling data from the distributed center to describe events. It additionally answers for cautions with collaboration to public layer. We defined a framework in light of a decentralized design for expanding the versatility, the dependability and in general exhibitions as far as framework reaction duration. This engineering architecture is capable of supporting a range of purposes, including unmanned aerial vehicle operations and fifth - generation customer hardware (User equipment) plans [2]. The authors give a summary of UAV-aided distant correspondences through describing essential fundamental systems administration engineering and primary performance parameters, stressing its crucial design concerns in addition to the brand-new wonderful prospects to be taken advantage of [3]. In order that seamlessly integrate a variety of conventional UAVs in cutting-edge distant communication groups, the authors offer a variety of tiered engineering of UAVs with multifaceted and communicated parts [4].

In [4-5]the creators first direct a top to bottom examination of current mechanical patterns of 5G from client hardware (UE), plan point of view, and afterward present a savvy cell Wi-Fi plan philosophy in light of the new conveyed staged cluster design especially to fifth-Generation gadgets for instance. In [6] the creators present a cross breed Unmanned Aerial Vehicle encompass with the Wireless Sensor networks which are designed for working on securing ecological information through enormous regions. The main focus is on improving the direction configuration to avoid forbidden regions, transit through established manner at guaranteed correspondence duration, and to reduce the overall duration of the route. The authors provide an experimental units for a cross Internet of Things environment that is supported through built-in barriers and collision avoidance using a variety of intelligent Drones. They propose a clever methodology to tackle the characterized issue [7].

Work Objective

• We proposed a successful shared convention premised on the widely used device to device standard known as messaging queuing telemetry transport; we outlined three tiers, describing the functions of every layer's components.

• Each element of framework, including the automated wheeled vehicle as well as the intelligent camera, was developed and implemented. Also, through specifying key human-to-machine interfaces, we carried out an implementation for integrating humans with the framework and understood the test platform in the context of a real-world situation.

The associated manner of coordination is used for the work. Segment 2 discusses related works; herein, we highlight the key differences among our proposal and those previously given there in writing; the framework concept has been laid out in Part 3. Every design elements were given a clear explanation of their main responsibilities; Section 4 explained the convention used to enable communication between layers and structural elements. The convention depends on a notable M2M convention called MQTT [22], which depends on the distributer/endorser component. In Segment 5 we revealed the outcomes we got by assessing the proposed arrangement in a very much determined setting. We have included "proposition correlation" with a cloud edge structure and also the "testing ground." The completion of the research is shown in Segment 6. In this, we talk about the findings obtained and briefly touch on potential future work.

Related Work

Researchers have recently concentrated their study on the IoT ecosystem [22], including algorithms, protocols for providing communication among several devices. There are numerous literatures that discuss communication among different combination of Human and Machine focusing on their potential future capabilities and uses.

Studies have been done on the IoT strategy in technical advancements. The Internet of Things (IoT), which is generating a lot of interest from a number of different industries, is one of the most important areas of future technology. The article [23-24] is aimed at IoT application categories for businesses to leverage them to boost consumer value and highlights wireless technologies require for rollout of services and graphic products having potential. The authors give a decent introduction of IoT technologies, applications, and upcoming advances [25]. The security aspects of present protocol and network stack for the Internet of All Things are the subject of investigations.

The authors of this study highlighted on wireless technologies needed for designing integrated system focusing on its specific features in the context of embedded systems [26]. They look into the fundamental technology, current patterns, and distinctive characteristics of IoT systems. In their approach Whisper, a software defined network (SDN) enabler for lossy and low-power networks. A network's central whisper controller remotely manages the forwarding and cell distribution of nodes. The controller and all network nodes have the finest possible in-band connectivity thanks to this method.

The authors [11-12] address the wireless (IoT) concept for identifying networked things that have sensing, processing, and communication capabilities, utilizing mobile capabilities for supporting various machine and Human communication. The author [13] discusses a number of theories related to interactions among human and machine with focus on their relation to how lane departure warning systems can explain driver behavior (LDWS).

A distributed algorithm based on concepts from evolutionary computation and epidemic models is proposed by the authors [14-15] to address the issue of data availability and dissemination in this setting.

Architecture Proposed

To achieve a scalable architecture, we prepared distributed model utilizing edges & mist computing. An edge layer, which makes up the system's fundamental core, is in charge of embellishing data via sensors or dispersed smart gadgets like cameras, tone equipment, and un-manned aerial vehicles. Also, edges must command or assign tasks onto mobility devices in order to govern them. Instead, in order to acquire data about the gadget they need to query or instruct, the application layers can interact with one another and work together. Lastly,

stationary or mobile devices are used to implement the device layer.
Devices that implement a computational module are regarded as intelligent, while those utilized merely for signal conditioning are not. In our approach, we made an effort to into creating an intelligence which can leverage our given environment of devices to understand its environment on its own. An architecture employed in this research is illustrated in Figure 1.

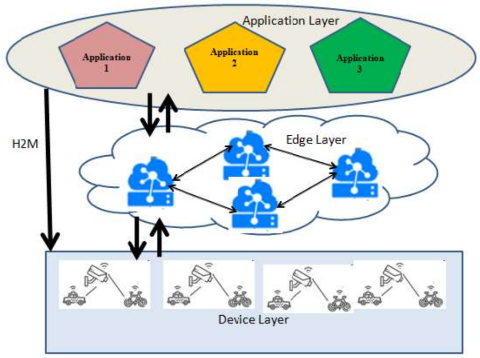

Figure.1. Proposed Architecture Model showing all the three layers.

The arrangement of layers is illustrated in Figure 2.

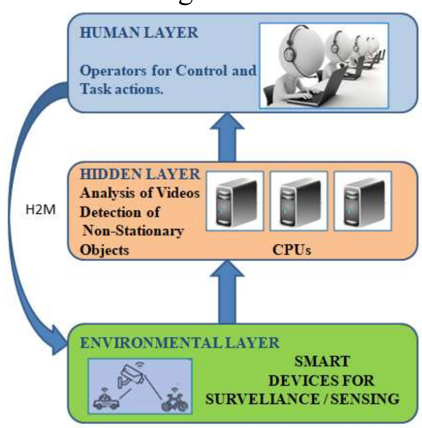

Figure.2. Architecture with three layers

The environmental layer, which is at the bottom, transmits information to the edge layer, which is at the concealed layer. Once information has been gathered and expanded, the hidden layer passes it along to the human layer. People can participate in the process by engaging with gadgets found within environment layer using mobile or desktop devices. Humans have two options for interacting with machines: they could imply interfaces by taking advantage of human and machine connections, or utilizing hidden layer through altering certain system characteristics.

Elements of Architecture

In this section, we discussed the various components of the architecture used in this paper. To better assess the system's capabilities, we specifically examined its behavior in a specific application. We used the following configuration, following the earlier basic modules. The following devices make up the lowest layer:

• Intelligent IP cameras: These devices have the ability to deconstruct captured data and, upon request, can stream video or images to a higher layer. Most of the time, IP cameras are capable of analyzing result, pertaining to detection, location and alarm parameters.

• Devices for unmanned ground vehicles: These are sufficient for environment-based pathrolling as well as location-specific focused research. They independently navigate environment utilizing a predetermined path. Using H2M interfaces; they can activate free movement or pass under human control in the event of a need;

• Gadgets that sense: They are installed on areas that need to be tracked and monitored to have specific parameters info to be gathered.

Edge/fog nodes make up the middle layer, which is also known as the hidden layer. These nodes ensure communication with the lower physical layer, using various protocols. Utilizing an Internet connection, the edge and fog nodes are linked to one another [16-18]. In addition, application layer can make use of this layer. We talked about each part of the architecture in the rest of the section.

Communication Problem

In this section, we talk about problems with communication. Particularly, a number of the actors who interact with their surroundings are described. The main architecture core representations are the edge nodes. Data are used to gain knowledge in this situation. Considering data snatched by that information, edge hubs choose to either order a robot to move in a particular region or to begin another movement, for example, watching or so on. The manner in which the involved nodes communicate with one another is a drawback of this organization. We have decided to use the protocol MQTT to communicate between nodes. The three components of the MQTT protocol are the broker, subscriber, and publisher.

• The agent: Its primary objective is to manage publisher messages and inform subscribers of newly received content. The broker can manage the messages using a number of policies. Each network node in this work has access to the edge layer broker, which is situated there [18]. We made use of the free, open-source MQTT Paho broker, which is available 24/7.

• Subscribers/Publishers: In this work, each entity on each layer is both a publisher and a subscriber to a particular topic. The following messages and topics are outlined in order to provide a more accurate representation of the system as a whole:

- Position: All of the environment's devices transmit status messages. It includes the device's current state, time-to-live, and operations.
- Updating data: devices that are Utilize sensor activities send data messages;
- Drone commands: Three types of topics are covered in messages sent to a specific drone: surveillance, camera alert, and remote control topics. Regarding the topic of remote control, only messages from a remote user that instruct the drone to move are sent. After that, these are packaged using SCP and forwarded tp controller for controlling the drone's motion. Table 2 provides a description of the messages. A mandatory id, along with other critical parameters like instructions, command, and discretional make up each message. The type of command determines whether the direction and options fields are present.

Table.1 Instruction of Movement received from Controller

Identification	Instruction	Guidance	Choices
Gadget	a. Motion b. Halt c. Limit Speed d. Shift e. Revolve	a. Push-Forward b. Push-Backward c. Turn left d. Turn right e. Move up	a. Throttle b. Digital Value for Speed

	f. Monitor g. Alarm Detected h. Remote Control	f. Move down	

- Camera Instructions: A camera use commands for concentrating to specific zones where some abnormal behavior is seen. Such Instructions allow the camera to move if it is not fixed, change the resolution of streaming if detailed analysis is required, allowing to capture images for further broad analysis. Similar to the drone, these messages are received on the subject of camera control. The same function is adopted using controller of Raspberry connected to installed cameras. Table 3 depicts the camera-executable commands, which are comparable to the drone-executable commands.

Table 2: Instructions received by Controller of Camera

Identification	Instruction	Guidance	Choices
Gadget	Move Capture Image Resolution modify Focus	Turn Left Turn Right Move Up Move Down	a decimal figure that may be used to indicate the resolution, zoom factor, or angulation

- A communication about anomaly detection is sent to the hidden layer whenever a camera or drone picks up something strange. The hidden layer begins changing other devices to focus on the target area as soon as it receives the communication, which cuts down on the duration it takes to react to an alert situation. These reports provide the device ID that discovered the anomaly as well as the location and current time of region of interest. Hidden layers need a position in order to communicate with other devices correctly. For instance, the location is required to send the correct adjustment commands to the cameras so that they can focus exactly on the anomalies when two sets of camera in the area are capable of changing their angle. By considering the architectural layers, each message can be assigned to a different source layer. Specifically, we set up three shifts with different roles. The various devices that make up each layer are responsible for a specific set of tasks.

Performance Evaluation

A number of tests were carried out to verify the system as a whole. In our laboratory, we constructed medium for conducting test accomplishment. Primary objective aim was assessing response time and scalability of a decentralized system. In addition, we compared the system's performance to that of a cloud-edge system by moving few functions, like Computer vision along with management tasks into upper management and computer vision tasks, into higher layers. We chose to move system management functions to the cloud layer and computer vision and data filtering, aggregation, and analysis tasks to the edge layer.

Description of the Test Bench

This section described the test environment used for the performance evaluation campaign. The test bench consisted of intelligent IP cameras, each equipped with a Raspberry Pi 3 board capable of using the designed protocol interface and CV algorithm [20-21]. We also installed OpenCV framework for embedded devices and his Raspbian operating system on each

Raspberry device. We used a mobile drone specifically designed for indoor trail rollers.
Our laboratories and office spaces define each area. Cameras for communication with edge layer and other gadgets were installed in 3 rooms. Campaign testing platform we developed is depicted in Figure 3. We used two applications to control and monitor the system: one on a desktop computer and one on a mobile device.

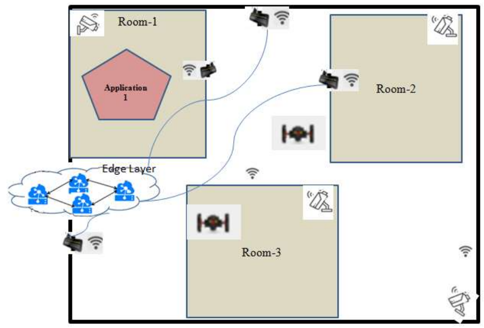

Figure.3. Campaign testing platform in controlled Environment with 3 Rooms

The first campaign was used for measuring frames for object detection and system's ability to recognize them. Three tests were carried out using 50, 100 and 150 frames and observed respectively. The time required to identify the three primary colors was extremely high with 150 frames, whereas for identifying white and black objects was lower. With decreasing frames detection time also reduces. The detection times of colored and black-and-white objects are identical when a small number of frames are used consecutively. This occurred due to the stream's short duration, which reduces the likelihood of chromatic or brightness variations.
We focused on the detection algorithm's working load in the second campaign. While looking for various colors within the frame, we tested the amount of time required to identify an object. We used the detectable red color in this test because it has a wider color spectrum. We observed that the object detection times are very similar, but the time to add additional colors to the search algorithm is shorter.
Detecting shape with the features of filtering and the ways in which it improves recognition quality were the primary themes of the third campaign. The shape recognition feature reduced the number of false positives caused by changes in stream brightness and color, resulting in variability in the number of detected objects in successive frames. Detecting color reduced the number of detected objects by half, and detecting black and white reduced the number of detected objects by a third. There was a noticeable jump in the brightness of the video stream thanks to the artificial lighting. Shape detection takes into account the estimated surface area and number of vertices of the object.

Comparison of System

In this section, we discuss our findings regarding system scalability. In order to verify these findings, we conducted a number of tests. The primary objective of this scenario is to contrast the proposed system's goodness with that of a cloud-based system. We compared the system to a hybrid solution to verify its performance even in this scenario. Here, we divide tasks between the cloud and the edge by moving computational modules to edge nodes. In order to evaluate the systems' performance, we measured latency in the configuration of edge and cloud systems. Particularly, we look at how the configuration of the edge can boost system performance with increasing number of devices. Figure.4. depicts the dip in latency. The

lambda value also increases with devices. As a result, more service requests reach cloud nodes and edges. Also, the measured average latency increases, but the service rate decreases.
Latency is illustrated in Figure.4. The performance of the system's cloud, edge, and modules of management is depicted in Figure.5. Modules of management were moved to the cloud platform and the detection modules to the edge nodes in particular. Because of this, the system must wait for the computation performed by edge nodes before implementing a strategy to solve found treatments. In this scenario, the edge node performs detection algorithms after receiving the camera-captured image. We need to keep in mind that the edge node is running these last algorithms simultaneously. To get the same results, more time was devoted. A decision procedure is conducted once data is transmitted to the cloud and an edge node recognizes a treat represented by a known risky object.

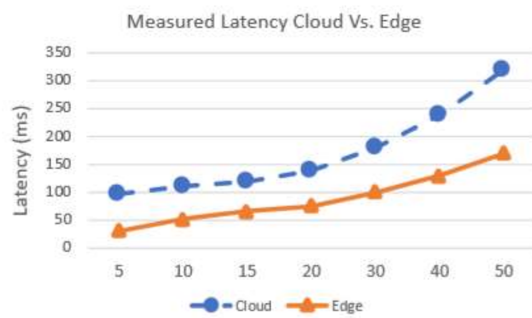

Figure.4. Highlighting the measured and Dip in Latency

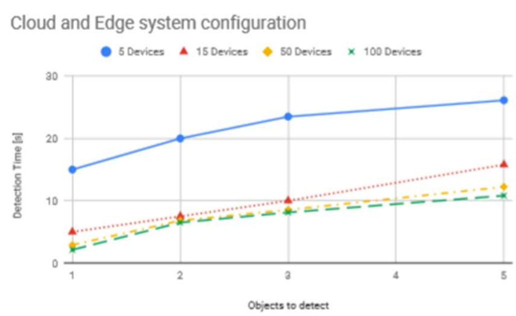

Figure.5. Performance of the System

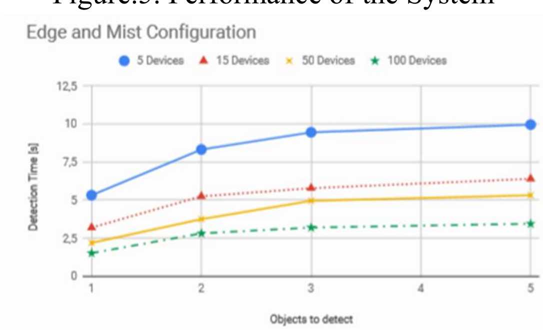

Figure.6. Time Detected with IP cameras installed

By implementing an M2M interface based on the MQTT protocol to communicate a position of the alarm source to the mobile drone, cloud will play a part in assisting operations on the ground. Figure.6 illustrates how the system functions when smart IP cameras are used. In this instance, IP cameras do CV analysis on their own and relay the analysis' findings to already-installed edge nodes. The detection time is quicker than the configuration of a edge/cloud system in Figure 6. Also, compared to the patterns shown in Figure 7, the slope of detection trend becomes significantly smoother as the number of items to be identified rises. We measured the system's performance in both of the previously mentioned configurations in Figure.7. We paid close attention towards the index, that's the sum of the log bytes transmitted through active devices to the hidden layer divided by the total bytes transferred. To figure out the overall number of bytes, add both data and log bytes.

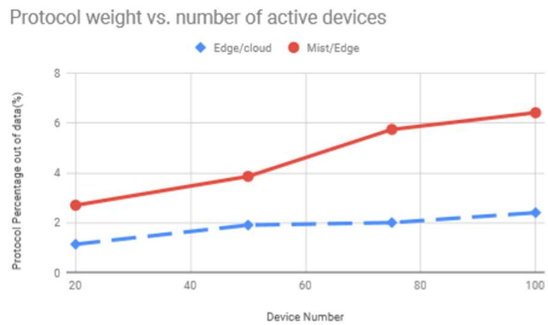

Figure.7. Test Based showing Protocol weight with active number of devices for total bytes calculation.

As the Figure Shows, in reference to the control messages sent the Edge/Cloud configuration outperforms the Mist/Edge configuration. It shows relationship among total number of messages sent and the number of control log messages. As a result, the percentage shown in below equation is obtained.

$$pp = \frac{T_{ptr}}{T_{ptr} + T_{data}} \times 100$$

The vertical axis of the Figure.7 shows the *pp* term, which is the percentage of the logarithm. Additionally, the term T_{ptr} refers to the total number of control protocol messages sent by compute nodes and intelligent devices on the network. This is similar to the term T_{data} indicating the total number of data messages sent by an intelligent device. This can be seen in comparison with the edge/cloud configuration. Mist/Edge configurations use more data bytes for logging purposes. This is due to the use of camera streaming with edge/cloud configuration. In effect, devices with this configuration send data to the edge layer for further analysis.

Conclusion:

We presented a specific application-specific decentralized edge and mist computation-based solution in this work. We have shown that distributed computing architectures outperform centralized architectures in terms of scalability, allocation of resource and response time. In addition, this work showed that Mist Computing can be used to support edge computing and improve the overall performance of the system. Several test conducted for demonstrating the scalability and computation time required to achieve the proposed results. The proposed system was compared with a strategy based on edge and cloud computing. When network parameters were evaluated, it scored well. In our analysis, a comparison between a distributed system architecture scenario and a scenario that only provides cloud services in terms of system latency was shown. Reports show that the system performs better in a distributed configuration, with a best-case scenario of 30% and a worst-case scenario of 5% improvement when user demand overwhelms edge nodes.

Prospective Scope:

We are considering our focus on developing embedded hardware. It is compatible with Linux ARM-based operating systems and plans to deploy an ARM based solution. Improve the fog calculation engine through extensive data analysis for the data collected. We are working on aggregating data along with modules (ANN) to make them aware of the device.

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