MOVEMENT PREDICTION AND ALERT GENERATION IN SLACK USING MOTION SENSORS INTEGRATED WITH MOBILE ADHOC NETWORKS

R. GOPAL1, M. KUMARESAN2*, S. ANNAMALAI3, S. VIJAYAKUMAR4, M. MATHIVANAN5

1 Assistant Professor, Information and Communication Engineering, College of Engineering, University of Buraimi, Oman.
2 Associate Professor, School of Computer Science and Engineering, Galgotias University, India
3 Assistant Professor, School of Computer Science and Engineering, Galgotias University, India
4 Professor, Department of ECE, Paavai Engineering College, Namakkal, India.
5 Associate Professor, Dept. of ECE, ACS College of Engineering, Bangalore, India

*Corresponding author : phdkumaresan@gmail.com

ABSTRACT

Applications of Mobile Ad-Hoc Networks under Wireless Sensor Networks are drastically growing for various purposes in recent days. One of the major and important real-time applications is monitoring and predicting human and objects' abnormal activities. Children missing, older people participating, and unknown people involving in a family or private party should be monitored and identified to take care of all. Some of the applications like strange people, children, and old age people need to be watched to generate alert messages to save them. In this paper, motion sensors interconnected into concentric's IoT sensor network is considered as the background network and surveillance application is deployed. Then mobile nodes are deployed and connected to the network to receive the alert message to know the abnormal activity and its location. It helps to provide immediate prevention to save the people and avoid dangers. New IoT gateway products are launched with battery-powered sensors and wireless suites. All the motion sensors are connected with Node.js software development kit for broadcasting alerts whenever an abnormal activity happens. The experimental results are verified and evaluated through Twilio API, where it interconnects anyone from anywhere. The experimental results show that this kind of application is very much useful in real-time.

Keywords: Wireless Sensor Networks, IoT Sensors, Motion Sensors, Movement Prediction, Abnormal Identification.

I. INTRODUCTION

In recent days surveillance monitoring becomes more important to watching and monitoring any remote applications or environment. Monitoring applications become more effective in detecting the abnormal activity to save the people and avoid dangerous loss. Various kind of applications like children, old age people, forest, agriculture, horticulture and etc, are drastically growing and highly demanding nowadays. While playing the children may enter into prohibited areas, old age people may fall down or getting illness suddenly, animals in the forest may be affected by violence activity and/or fire. Wireless sensor networks are a group of sensors that are either arranged randomly or arranged in a pattern for recording any physical activity in a given environment. Each sensor node contains a microcontroller, a memory unit and a trans-receiving unit. Microcontrollers are used for executing the allotted task and processing the collected data. Memory unit acts as a storage vessel. Trans-receiver is used for both transmitting and receiving data. Monitoring is essential in almost all sorts of places such as indoor monitoring [1], wildlife surveillance, traffic monitoring etc. Implementation of Wireless Sensor Networks in wide area network such as malls or any public places is mainly for security reasons [2]. Public places need continuous monitoring and as well as security guards, this is the most challenging part in surveillance operation. Continuous video surveillance by an officer will gradually decrease the officer’s efficiency in less than an hour [3]. In such cases automatic surveillance and detection is essential for any occurrence of malicious activities. In modern video surveillance systems, automatic detection of any malicious activities is identified by a computer vision analytics. It reduces the actual risk in live monitoring. It also increases the efficiency of
monitoring systems. Detecting anomalies in videos is the main goal in this paper. Anomalies include any suspicious activities or any unusual activities. Frame level detection is carried out by a computer vision analytics. Spatial localization process is the challenging issue in frame level detection. It is because of the identification of pixel which corresponds to anomaly detection. This is also referred to as pixel-level detection. Main job includes in detecting an object by video surveillance mode. Wireless networks are used for transferring the information regarding to the surveillance data and this is data is further analyzed for any anomalies.

Surveillance monitoring will be well suited in healthcare platform. Early detection in patient’s illness and it will alert for rapid response. Majority of death rates in hospitals are occurred due to unmonitored conditions. In such conditions, surveillance system in wireless networks is highly useful. The ViSi mobile Patient Monitoring System is the first approved body worn multi sensor wireless surveillance monitoring system. As a part of wireless networks, all worn devices are capable of transmitting the collected data with the help of in-build sensors. These sensors will typically monitors the patient’s condition and alert if any value drops from an actual value. Though wireless sensor networks are inexpensive in implementing and maintaining, installing a rugged area is a tedious process. Wireless sensor networks are becoming an unavoidable source in both commercial and in business or industrial purposes. They are used in various real time applications such as smart agricultural and animal tracking system, environmental monitoring system, transportation and logistics monitoring systems, security and urban terrain tracking and civil structure monitoring. The overall functionalities of the paper are illustrated in Figure 1.

![Image of Figure 1](https://example.com/image.png)

**Figure 1. Overall Functionality of the Paper**

**II. CONTRIBUTION OF THE PAPER**

This paper presents the information about the way of deploying various motion sensors in the network. Interconnect motion sensors with the various IoT devices for recording and analysing the sensed data. Finally, creates and broadcasts an alert message whenever it meets the abnormal events in the data. Data analysing involves the pre-processing, normalization, learning and predicting the abnormal class.

**Literature Review**

In this literature paper, systems are categorized into three generations such as CCTV, digital cameras and multi-view intelligent surveillance system. Recent works are started in developing vision algorithm for latest surveillance systems [4]. Queue monitoring or any anomaly detection in crowd functioning has less attention in research now-a-days [5, 6]. A perfect surveillance system will ensure the utmost security in surveillance and in detecting anomalies. Still current researches are more prone to false allegations and missed detections [7-9]. Past studies revealed that the objects are tracked by extracting the CNN features from any region of an image. This method has an disadvantage, that this model requires a full forward network inference and it is not well suitable for real time applications. This can be overcome by computing a single fully conventional feature and the rescaled windows are classified [10, 11]. Yolo detector is the best in surveillance architecture because of its speed and accuracy [12]. Earlier work is purely based on novelty detection, where all the novels in the video are considered as an anomaly [13]. Most common method for representing normal and anomaly frames is to identify the frames with higher reconstruction loss such as sparse coding, auto-encoder etc [14, 15]. Due to the lack in computation speed, this representation is done only in smaller datasets which is not sufficient in anomaly detection[16].

Considering all the novelties as anomalies in novelty detection is not possible. For example considering a campus, where riding a bike is novel, because this model is trained only for people with walking. But riding a bike is not a security threat. But this model shows very helpful in some scenarios such as actual crime scenes and helps in correct anomaly detection by recognizing various patterns [17, 18][22][23]. Supervised methods are considered for detecting anomalies in surveillance system. By using weak supervised methods older version of anomaly detection is increased slightly. In highway, any accident occurs; the foreground and background patterns are analysed and the anomalies are detected. Manual detection techniques are employed by using geometric prior
knowledge and physics principles. Some works are depends on object identification for detecting anomaly events [19], [20][21].

Limitations and Motivation

A detailed study has been carried out over various existing research works related to the surveillance monitoring. In most of the related works, the authors have focused on using static sensors for surveillance process. But the static sensors are fixed in a place and it monitors or sense the data from any one direction. In most of the surveillance monitoring system, the monitored data will be stored in a server for analysing it later. Thus, if any intrusion or abnormal activity happens, it will be identified after sometime, where it leads to poor prevention and curing. For overcoming these kinds of issues, this paper motivated to provide a surveillance monitoring system based alert system using conetric based IoT gateways. It analyses the data and broadcasts alert messages immediately to avoid dangerous and losses. The performance of the conetric based IoT incorporated surveillance system is experimented and tested with MATLAB software.

III. PROPOSED ENVIRONMENT

Most of the sensors are completely wireless and they are smaller in size. They are very easy to attach on any devices. The setup process of a sensor is very easy. It does not require any tedious process like drilling holes in the walls. Motion sensors are used for detecting any movements in the given area. The main advantage of the motion sensor is that it could be able to communicate with other security devices. If you need to install the motion sensor, the instructions should be read before mounting. The setup process is too simple, so that the user could do it themselves. There might be chances, that there may be chances of false alarm. It is not error-proof. False alarms are triggered due to the power surges, damaged sensor, user error etc. Small insects or animals could also trigger the motion sensor.

Advantages of Motion Sensors

Motion detecting sensors are not only for house levels, it is also used in industrial levels for tracking their manufactured products to keep track of all the products. Other uses of motion sensors are listed below:

- To open and close automatic doors.
- To turn on and off automatic water faucets and toilets.
- To turn on lights when a person enters a room.
- To control ATM displays.
- At automatic ticket gates.
- For some parking meters.

Conetric is an agile development partnership and they recently launched a new IoT gateway. It comes with wireless sensors powered by battery. In this proposed paper, we’ll discuss about the usage of motion sensor and node.js SDK. The overall environment comprises of hardware and software. Where in the hardware system, it includes the following type of sensors along with a USB router.

- Motion sensor
- Switch (door) sensor
- Temperature/humidity sensor

In order to deploy motion sensors for monitoring and managing a remote environment the proposed approach deploys the USB router along with motion sensor in the modelling.
USB Router

USB router is used mainly as a gateway for receiving messages from the sensors for connecting the Conectric mesh network. It is for working with the open source Node.js SDK. This Node.js is used for translating the open source into JavaScript objects. This coding will reflect in application code. USB router does not need any external sources for inserting this drive; it only requires the normal USB port present in the computer. For extending mesh network’s range, extra USB ports are used and these extra ports are charged by regular connectors.

Motion Sensor

Motion sensor used for detecting any movements in the surroundings and they automatically sends ‘motion’ message. Motion sensor can be mounted in any places such as walls or ceilings. Working of this sensor is confirmed by frequent LED flashes. Single motion sensor is used and each of the sensor reports with their own ID and this ID’s are shows which sensor detects movements. The fitting of the sensor is too easy. The initial setup includes fitting battery into the sensor and they are fitted in any ceiling or wall.

Software

The software used in designing motion sensor is called as “Slack”. Using Incoming Webhooks, the external messages will post messages regarding movements. Incoming Webhooks are HTTP POST requests. This Post requests contains formatted JSON bodies for displaying message content along with the broadcasting channel name with the content. In Slack, an incoming webhook is initialized and the URL is copied for generating a portal for messages and the copied URL will be retrieved in Node.js call-back function.

Conectric network comprises of various wired, wireless and battery powered sensors with IoT gateway. USB routers, temperature and humidity sensors are some of the sensors interconnected to Conectric network.

Location Investigation

This paper focused on analysing a surveillance data using motion sensors. Reason for using motion sensors is, the fixed sensors can monitor only certain portion of the surveillance area and it cannot do surveillance all the area. Each motion sensors are the extra eyes of the surveillance area where it monitors the entire area and make sure that all the sensors have strong line of sight. The motion sensors are mainly used in various security related environment; where some of them are Passive Infra-Red (PIR) sensors. These sensors will pass rays to detect the heat. The rays from the PIR sensors cannot identify heat from furniture or walls. Thus, it is important to deploy the sensors from where it can detect the obstacles.

Deploying right sensors at right locations enables people to cover any (large size) area with a smaller number of sensors. It reduces the cost and time. The best way to avoid false alarms is to read the user manual more carefully and this will increase the sensor’s effectiveness. The below placement tips will help to use the sensor more precise.

1. Keep PIR sensors 10-15 feet away from the heat sources: the motion sensors should be kept away from the heat sources such as radiators, heaters etc. A slight change in temperature may trigger the sensor and it will cause an alarm.
2. Place Motion Sensor at “Choke Points”: the placement of sensor should be in the choked areas such as staircases or main hallway. These are the areas where an intruder will trigger the alarm without knowing the placement of the sensor. Theoretically an intruder will go to the master bedroom. It is wise to mount a sensor in those areas with valuable things.

3. Access where intruders are most likely to enter: most of the intruders’ breaks into the others house through back doors or through patio door. So it is advisable for mounting in such places.

4. Find Walls that an Intruder would walk: sensors could be placed on the narrow wall that will lead to the hallway. The best way to trigger the sensor is to walk parallel but now towards it. For example, in a hallway the intruder tends to walk parallel to the walls, not directly toward them.

IV. INSTALLATION OF A MOTION SENSOR

Installation of Motion Sensor is easier because wireless sensor is becoming more common. It is as simple as inserting a screw. Only considered thing about sensor installation is checking for optimal coverage of area.

Un-box your Motion Detector

A typical motion sensor kit will have its own instruction manual along with its hardware. Motion sensor will have separate batteries and this will give the necessary energy for sensor operations. Motion sensors are smaller in size and it is handier so that the installation is easier.

Decide on a location

Before mounting a motion sensor, the placement should be chose more carefully for its efficient performance.

- Corners are an ideal location: before positioning sensor, infrared sensors have the capability to cover the entire area. Motion sensors could be possibly fit in any place or any corner of the room. Even the sensors could be mounted on the edges, since mounting is easier.

- Mount your Motion Detector high on the Wall: the motion sensor should be mounted on the higher place in the wall so that it will cover wider area. Placing should be avoided between any shelves or any furniture, because it will limit the infrared coverage range.

- Mount your Sensor opposite to a Main Entrance: mount the sensor exactly opposite to any room entrance. This is the place where any movements could be easily triggered. It could detect the intruder’s movement more precisely.

Mount the Sensor

Drywall anchors or studs will not be a problem in mounting a sensor, since motion sensors are light weighted. The mounting time varies from the normal screwdriver to the electrically powered screwdriver. A mounting bracket which comes separately and it comes with the screwing hole. It will attach to the wall first and the motion sensor will attach to the mounting bracket. Replacing sensor does not require changing the mounting bracket every time. Only the sensor will be removed and replaced. The infrared sensors are removed before mounting.

V. CONNECTING SENSOR TO THE SYSTEM

Mounting the sensor will be easier while following the user manual. Most of the tutorial videos give complete information about installation process and this will help us to connect the sensor to any devices such as mobile or any system. This will enable the user to monitor the sensor’s performance in any place. Some motion sensor such as Z-Wave which is powered by Aeotec TriSensor which enables the user to connect the sensor with smart applications. This will turn on the lights when a motion detected. These settings could be altered whereas any motion detected, it could alert the mobile device which is registered.

Adjusting the Motion Detection Settings

Motion sensor detector has three main settings,

1. Instant Mode: in this mode, the alarm will get triggered in case of all movements.
2. Entry Delay Mode: In an entry delay mode, the sensor will be triggered in a delayed manner. In case of sensor detects any movements, the user has a minute for disarming the alarm or canceling.

3. Inferior Follow-up Mode: In this mode, the sensor works with an entry delay mode. In this the door contacts the trigger. It detects motion in the home without a door contact triggering.

Maintaining the Motion Detector
Cleaning the motion sensor should be done periodically. Because in overtime, dust and debris from the outside will intervene the infrared signals and it will lower the sensor performance in motion detecting. By using microfiber cloth, the sensor should be cleaned, but it should be cleaned carefully without damaging the infrared sensor. If any chances of painting the wall, the device should be removed first. If any damages to the device occur, then the motion sensor should be replaced.

Additional Steps for Installing the Motion Sensor
For improving the efficacy of the motion sensor application, it is also essential to consider the pet size. Pet immune motion sensors are the type of sensors, that are specifically programmed for only immune to the movement of pets. Pets have the capability to trigger false alarms. Many pet immune systems are more related to animal’s weight. But in many cases, small pets might trigger the alarm vertically. If the user’s pet jumped high, it could trigger false alarm. If any active sensor is mounted near a stairwell, then this sensor will trigger alarm if any rats or an animal pass.

Do not block the infrared
Infrared waves are a beam of light that will detect any motion if any object passes through the infrared light. The density of the infrared varies, as the light is denser near the device and the dense gets shorter when the light is farther from the device. Infrared waves from the motion sensor could not penetrate hard objects such as walls etc. It only is placed in light walls, so that it will cover more area. If any object creates a shadow, then this will block the infrared light.

Overhangs decrease range
If the LED motion sensor is installed under an overhang will lower the coverage range. Because this will block the infrared light and the coverage area will decrease. For example, if the actual coverage area of a motion sensor is about 180 degree, installing the device under an overhang, it will turn the coverage angle into 90-degree angle. All the motion sensor detector does not work exactly like other. The light intensity in the motion sensor detector varies from indoor to outdoor.

Occupancy Sensor: this sensor will automatically turn on when someone enters into the room. It will again go off if the person left.

Vacancy sensor: this sensor will turn the lights off when the room is empty. But the light does not turn on automatically. It has to be done manually.

Dimmer Sensors: These sensors are used for maintaining the brightness level. It can be used for adjusting the brightness of the bulbs.

Lutron is a special type of sensor brand which contains all the three types of sensor types.

Record and transmit the sensed data
Each sensor $S_i$ from $S$ where $S = (S_1, S_2, ..., S_i, ..., S_n)$ located at $Loc_i$, and can be moved within the area $A$. It is assumed that the sensors can move at a speed $t$, and any direction $D$. Thus, all the sensors are interconnected with $K$ number of IoT devices to collect the sensed data for processing. During the time $T$, the sensed data from sensor $S_i$ immediately passed to the corresponding connected IoT device and there the data will be analysed.

Analyse the sensed data and send alert message if any abnormality occurs
The data is analysed using the Convolution Neural Network algorithm for finding the abnormality. Each data obtained from the IoT device is directly feed into the CNN architecture. The convolution layers in the CNN learn
the data and extract the features. To learn the data effectively it uses windows or stride method and obtain all the features from the data. Once the set of all features are extracted the pooling layer shrink the feature size and send it to SoftMax layer. There the features are classified as normal or abnormal. All the data are learned and the ODD data is extracted by each convolution and pooling layer. Finally the ODD data is classified as abnormal data.

VI. EXPERIMENTAL RESULTS AND DISCUSSION

The data sensed from the motion sensors are analysed using CNN model using Node.js software development kit software. From the simulation, a greater number of times the execution is carried out over the various number of nodes deployed in the network, and different QoS parameter values are calculated. The simulation is repeatedly executed for 50 to 200 times (rounds). Initially, the total number of data packets transmitted and the packet delivery ratio is calculated, and the corresponding result is shown in Figure 4 and Figure 5, respectively. From the result, it is noticed that proposed model performs a little higher than PSO, but the delay is more.

![Figure 4. Number of Packets received](image)

The total number of packets reached the destination is calculated and shown in Figure-4. It is identified from the result; the number of packets reached is directly proportional to the number of rounds and number of nodes. The proposed model and PSO algorithms perform merely equal. Based on the packets delivered at the source node, the amount of packet received at the destination node is calculated as PDR, and it is shown in Figure 5. From the figure-5, it is clear and noticed that the PDR obtained using PSO is higher than the proposed model. The end-to-end delay is calculated from the simulation and given in Figure-6. From the simulation, it is identified that the delay has taken by proposed model little high than PSO since proposed model uses a greater number of comparisons dynamically than PSO.

![Figure 5. Packet delivery ratio](image)
Figure 7 shows the throughput obtained for proposed model and compared with the PSO. Throughput is the amount of data transmission within a time interval where it is directly proportional to the number of rounds, number nodes. The throughput comparison between proposed model and PSO is given in Figure 7. Comparing with PSO, proposed model obtained better throughput. Figure 8 shows the packet dropping ratio, where the proposed model drops only a few numbers of packets reaching with PSO. From the above discussion and results, it is obvious that the PSO algorithm provides a better outcome for WSN in terms of various QoS parameters. Still, the proposed model performs better in data transmission without data loss.
VII. CONCLUSION

Motion sensors are not just an extra feature for a security system. Motion sensors are the security system. Without these motion sensors, there will not be any possible methods for detecting intruders. Motion sensors are highly useful in detecting intruders. Installing motion sensors are easy and it will cover the entire region. Motion sensors are not much expensive and the installation is easy. Also, from the simulation the set of all QoS parameters are verified. From the results it is concluded that the motions sensors performs better than the normal sensors.

REFERENCE