Wireless Intrusion Detection System Using Wireless Sensor Network: A Conceptual Framework

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Abstract—**Intrusion Detection System, as the name suggests is such an arrangement whereby any unauthorised access to private premises can be monitored closely. This paper suggests the development of a system which ameliorates the traditional way of fencing to avoid in filtration. The system comprises of Infra Red (IR) transceiver for continuous surveillance of the enclosure. An intrusion subsequently disturbs the IR beams and generates a signal which triggers the camera and associated entities like hooter and spotlight. The camera captures still sand records a video as soon as the intrusion occurs. These images and video along with the location of the intrusion are sent to the central control station through the dual-radio board for the authorities to take actions efficiently. Area of application mainly include large storage premises or agricultural land where safety of the goods is a major concern and this system can be deployed as the primary hurdle for intruders besides the traditional way of fencing with bar bed wires.**

Index Terms—**intrusion detection, infra-red, transreceiver, central control unit**

I. INTRODUCTION

This is the era of information technology and everyone has access to information. Lives of human beings are all deviated and they can access the benefits of cutting edge technologies. Wireless Intrusion Detection System is used as a second level protection for protecting the perimeter of a sensitive area already guarded by an existing boundary wall. It can generate immediate alert on detection of unwanted intrusion through jumping over the wall [1], [2].

The proposed wireless intrusion detection system will detect intrusion automatically, through multi-level detection mechanism (IR sensor & camera) and will generate multi-level alert (buzzer, images, segment illumination, SMS) to notify security officers, owners and also illuminate the particular segment where the intrusion

happened. This system will enable the authority to quickly handle the emergency through identification of the area of incident at once and to take action quickly.

II. LONG RANGE PASSIVE IR SENSORS

Passive IR sensors are used in object detection due to their specific properties. Passive IR sensor can operate both during the day and night. These sensors operating within visible and infrared radiation they can operate properly in the conditions of limited visibility (e.g.in a fog or smoke area). Passive sensors are undetectable devices different from active systems. They are safe for service personnel, for eyes and environment.

A. Operating Principle

The collecting optics of passive sensor is decisive for quality of device operation as well as effects quantity and spectral composition of the radiation focused on a detector. The detector integrates optical signal over its surface and time and next converts it into electrical signal. However it is simultaneously a source of noise. Electrical systems for signal conversion amplify and filter the signal that is next analysed by automated decisive system. Frequency and noise characteristics of electronics system influence on correctness of final analysis of the signal, the result of which is decision about object detection. For the objects smaller than the field of the view of the optical sensor system, signal to noise ratio decreases with square of the distance between object and sensor.

Passive radiation sensors used for detection of people crossing optical barrier have optimal range of operation in long wavelength detection band (8-12micro-meter). Long wavelength detection band is chosen also due to significantly lower intensity of reflected solar radiation in this spectral window comparing to the 3-5micro-meter spectral band. Because of low temperature contrast of the object and high probability of false alarms, resulting from fluctuation from background radiation, it is necessary to use two element pyroelectric detectors operating in a

differential system. Application of optical filters cutting of radiation of wavelength shorter than 8 micro-meters significantly decreases the level of false alarms.
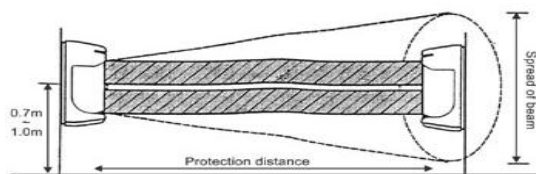

Figure 1.   Deploying procedure

Fig. 1 shows Infrared sensors are available invarious forms it can be an emitter and detector by itself operating at the same wavelength, a emitter and detector housed in the same unit or a like a photoelectric sensor which works with reflective surfaces. The major categories of infrared sensor are retro-reflective sensors, diffuse reflection sensor and through beam sensors. Each of these sensors has its own advantage based on the application it is being used for. A through beam works great in assembly lines and in close ranges. A retro-reflective is really durable and works well where there are harsh environment. A diffuse reflective is useful where only partial light is reflected back. [3]

B.   Applications

Possible uses of the ABE-250 infrared access control/security system are many, ranging from notifying store operators that a customer has entered the store, home or commercial security system detector, to manufacturing process control.

For detection of objects, count people passing through an entry gate, or objects moving over a conveyor etc. [4]

C.   Features

- Infra red system AES-250 is pre-assembled and easy to install.
- Provision for external power supply with battery backup.
- Multiple mounting options.
- High cover detecting distance outdoor 250m and indoor 750m.
- Three photoelectric beam transmitter & receiver units.
- Beams blocked detection mode.
- Very high response time approx 50-70msec.
- Power and voltage DC12~24V, AC11~18V.

D.   Specifications

- Detection type: through beam (long–range)
- Power supply: 10Vto30VDC
- Beam sensing range:
    800ft (250m) outdoors
    2300ft (750m) indoors
- Detection method: simultaneous breaking of three IR beams.
- Response time: 50ms to 700ms
- Alarm out put relay: NC/NO 1A, 120Vac
- Tamper relay: NC1A, 120Vac

- Power transmit indicator.
- Level: Indicators turns on when the beam align presents. Specific alignment accuracy refers to signal strength receiving indicator.
- Alarm: The indicator turns on when the alarm presents.
- Good: the green indicator turns on when the beam aligns with the receiver.
- If fails to align, the indicator will be off.
- Alignment laser wavelength: visible 650nm.
- Laser output power: 5mw max.
- IP rating: IP55
- Photoelectric beam alignment range:
  Horizontal: ±90 °
  Vertical: ±15 °
- Operating temperature:- 13 ℉ to +131 ℉ (-25 ℃to+55 ℃)
- Duration audio signal: about 1sec. For chime, 30sec. For alarm.
- Timer adjustable: 3-30sec. Before alarm activation.

E.   Technical Parameters

Following Table I shows technical parameters of infrared sensor required in proposed application.

TABLE I.   TECHNICAL PARAMETERS

Model		50	100	150	200	250
Alert distance	Outdoor	50m	100m	150m	200m	250m
	Indoor	150m	300m	450m	600m	750m
No.Ofbeams		3beams				
Detection mode		3beamsblockedsimultaneous				
Optical source		Infrared digital pulse beam				
Response speed		50~700mmsecadjustable				
Alarm output		Relay contact output:NO,NC contactrating:AC/DC30V0.5Amax				
Power supply		DC 13.8 ~ 24 V AC11~18VP≥15W				
Power consumption		70mAmax.	80mAmax.	90mAmax.	100mAmax.	
Operation temperature and humidity		-25 ℃~55 ℃ 5%RH(Relative humidity)				
Tamper output		Contactoutput:NCcontactratingDC24V0.5mAmax				
Optical axis adjustment(H)		±180 ʾ(±90 ʾ)				
Optical axis adjustment(V)		20 ʾ(±10 ʾ)				
Viewfinder		Detachable				
Protection against dew, frost		Calefaction housing(optional)				
Material		PCresin				
Gross		2000g				

F.   Beam Alignment

Voltage test method:

- Remove the cover and connect power.
- Adjust the beam frequency of transmitter and receiver to the same channel.
- Observe the collimation effect at a distance of 5cm from the viewfinder. Adjust the upper/lower angle regulation screw and horizontal adjustment wheel inorder that the image of opposite detector falls into the central part of viewing hole.

- Adjust the vertical adjusting wheel, the signal strength indicator will light up step by step, adjust until level 5 or higher indicator lights up if not adjust it again.
- Insert the test pen in to the test hole (please note the+,-polarity).
- First adjust the horizontal angle until the test hole voltage output maximize. Then adjust the until the test hole voltage output maximize. Then adjust the vertical angle by the same way.

G. Wiring Connections

Table II, III, IV, V & VI show detail connections required for transmitters and receivers used in application development.

TABLE II.   TRANSMITTER WIRING CONNECTIONS.

Transmitter

Terminalnos.	Connectiondetails
1.	12VSupply
2.	Gnd
3 & 4	Noconnection

TABLE III.   RECEIVER I FOR ALARM GENERATING HOOTER CONNECTIONS

Receiver I(For alarm generating by hooter)

Terminalnos.	Connectiondetails
1.	12Vsupply
2,3	Gnd
5.	Trigger of Timercircuit
4,6 & 7	No.connection

TABLE IV.   RECEIVER II FOR ALARM GENERATING HOOTER CONNECTIONS

Receiver II(For alarm generating by hooter)

Terminalnos.	Connectiondetails
1.	12Vsupply
2&3	Gnd
4,6&7	Noconnection
5.	Connectedto5thterminalofReceiverI

Receiver I (RFID) A tag will be connected in place of hooter and timer circuit.

TABLE V.   RECEIVER I FOR RFID CONNECTION.

Terminalnos.	Connectiondetails
1.	12VSupply
2,3&4	Gnd
5,6 & 7	Noconnection

Receiver II (RFID) A tag will be connected in place of hooter and timer circuit.

TABLE VI.   RECEIVER II FOR RFID CONNECTION.

Terminalnos.	Connectiondetails
1.	12VSupply
2.	Gnd
3.	ToTag
4.	Connectedto4thterminalofReceiverI
5,6 & 7	Noconnection

H. Connectors Used for RFID:

Figure 2.   Fivepin, three pin&two pin round connector.

TABLE VII. CONNECTORS USED FOR RFID

Pinno.	Fortag	ForDCoutput	ForACinput
1	Gnd	Gnd	Neutral
2	Supply	No connection	Phase
3	No connection	Supply	
4	Receiver terminal		
5	Receiver terminal		

1) For alarm sound emitter by hooter:

Figure 3.   Fourpin, three pin &two pin connector.

TABLE VIII.   TIMER CIRCUIT CONNECTIONS

For timer circuit

Pinno.	Fortimercircuit	ForDCpowersupply	ForACinput
1	Gnd	Gnd	Phase
2	Supplyfortimer	Noconnection	Neutral
3	Noconnection	Supplyforrelay	
4	Connectedto5thterminalofIR		

III.   WIRELESS CAMERA

This is a great Wireless and Wired IP monitoring system and it works with both PC by simply connecting with LAN cable or through network router. The camera also process span (270 ⁹) and tilt (120 ⁹) remote rotation through browser. The web interface has 9 squares (3x3screen), 4squares (2x2screen) and single system so that you can connect up to 9 IP cameras for system monitoring.

This IP camera has motion detection, alarm function. Moreover, the camera has built-in infra-red LED with night vision function at night. You can view and record the video or picture into PC and the file can be viewed by standard window media player. You can even do remote monitoring on Internet or Mobile Phone (can connect Internet) with provided software.

A. Some of the Camera Features

- Day/night vision mode.
- 480Kpixels colour digital CMOS sensor, 0.3Lux low lux illumination.
- Wired/Wireless Operation–Simply wired with LAN cable or wireless via Wi-Fi router for easy

installation and operation Remote control pan & tilt camera–PAN:270 ° and Tilt:120 °.

- Two way audio monitoring.
- Nine squares system/Quadra system/single system screen monitor-Connecting up to 9 IP cameras for system monitoring.
- Motion detection–Automatically captures moving objects, and send captured video or snapshot file to your assigned email address or FTP.
- Alarmfunction– Motiondetectionalarm,andexternalinput/outputalarm ssuchasPIRmotiondetector,smokedetector,gasdetect oretc.
- Viewing/Recording-Clear user interface to view real-time pictures. Even when you leave for a while, IP camera will record the pictures and transfer files to your PC. Files will be saved in the form of standard windows media, suitable for extensive application program.
- Easy installation-IP CAMERA is an independent system, with built-in CPU and picture decoder. Just one power adapter and LAN connection can make it work.
- Multi form protocols-TCP/IP network protocol, SMTP protocol, HTTP protocol and other protocols related to internet.
- Simple configuration-With standard web browser in administrator interface.
- Administrator can control and manage IP Camera by LAN or Internet.
- Dynamic Monitoring–Capturing any tiny pictures and sends to your mailbox. IP camera will automatically compare the two continuous pictures and find out the changes caused by moving.

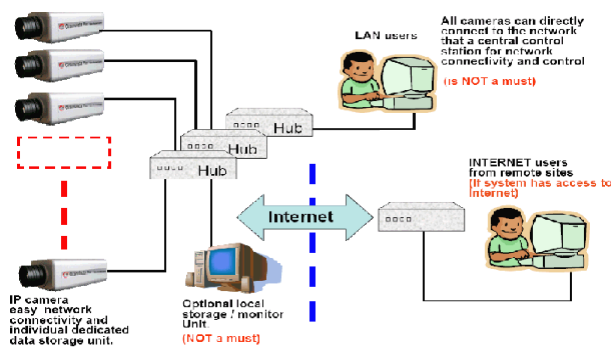Following Fig. 4 shows camera can also take part in a multi camera network application.

Figure 4.   Multi camera network application.

IV.   FUNCTIONING OF SOFTWARE INVOLVED

Let us look at the proto type of the software that has to be developed for integration of the components and efficient working of the system. The central server is always highly secured and the administrator can access it with a user-id and password which has to be entered in the login page. After logging in a map of the entire premises guarded with the IR sensors is displayed in a console and the beacons indicate the intrusion. Each beacon represents a unique position, which is equipped with the entire arrangement. Red indicates intrusion and Green indicates no intrusion. The current or real time view of the position scan be monitored by clicking on the irrespective positions in the interactive map. [5]

In case of intrusion, the beacon turns red and on clicking on the position, the exact details like date and time of intrusion, the related videos and snapshots of the intrusion can be obtained. After the intrusion, the dual radio sends the SMS and MMS to the central server. Upon receiving the information, a separate window pops-up with the provision of sending the MMS to the user/owner of the premises manually. A SMS is also sent to the owner besides the central server.

In case of malfunctioning or failure of any of the components, a pop up is automatically generated from the respective positions with the details of the faults and a reminder is set until their repair or replacement is accomplished. [6]

V.   PROPOSED SYSTEM WORKING PRINCIPLE

The perimeter of the boundary wall is segmented into multiple straight-line segments of length <=200 meters. The following Fig. 5 illustrates ten-segment intrusion detection system. Then, each segment is protected against intrusion using a pair of Wireless Intrusion Detection units. There is no limit to the number of segments that can be used to protect a long boundary wall.

Suppose there is a ten-segment intrusion detection system as shown in Fig. 1 it includes ten Wireless Intrusion Detection units, wireless routers for data communication to a remote computer (central security office) and software at central security office for visualization, report generation and data analysis.[7]
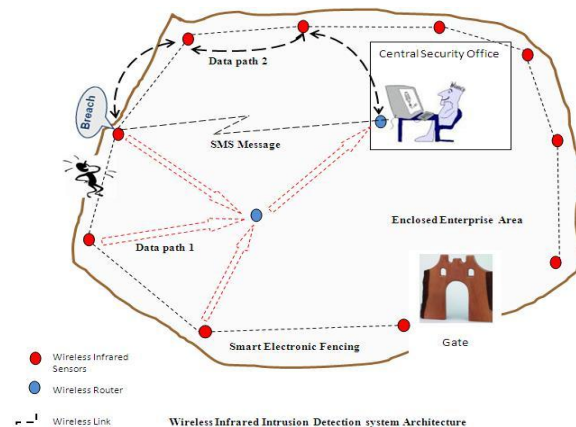

Figure 5.   Wireless infrared intrusion detection systemschematic

One segment of Wireless Intrusion Detection system consists of infra-red receiver and infra-red transmitter one infra-red sensor unit in separate mounting stands. Each mounting stand also includes a halogen light and a buzzer

for alert generation. Additionally, an outdoor camera may be used for each segment to capture snapshots of the event as soon as any intrusion is detected. Each segment can realize a straight-line fencing of length <=200 meters. Each mounting unit (Tx and Rx for IR) will also include a wireless tag to send the intrusion signal wirelessly to control station and hooter, spot light and (an optional) camera for alert generation. [8]

Figure 6.   Proposed wireless intrusion detection system.

Central security office is nothing but remote control station with wireless receiver for getting intrusion location information from wireless tag attached to the intrusion detection unit. GSM/GPRS modem is used to send automatic SMS to preset mobile numbers and software to capture snap-shots of affected area. [9]

VI.   CONCLUSION AND FUTURE WORK

This proposal has resulted in the development of an effective, low-cost wireless intrusion detection system. The device and the RFID tags used to instrument the environment are inconspicuous and low cost. As soon as the routing and the communication between control station and user works, new opportunities may arise to make the system viable for people with special requirements. Future work will be solving problem of false alarm. [10]

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