Thermal/Video Integration with UGS System

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CERTIFICATE OF CORRECTIONS & APPROVAL

Certified that work contained in this thesis titled "**Thermal/Video Integration with UGS System**", carried out by GC Muhammad Tayyab, GC Aanosh Ahmed Khan Mughal, GC Muhammad Omer Javaid and GC Muslim Khan Tareen under the supervision of Dr. Fahim Arif for partial fulfillment of Degree of Bachelors of Electrical Engineering, in Military College of Signals, National University of Sciences and Technology, Islamabad during the academic year 2019-2020 is correct and approved. The material that has been used from other sources it has been properly acknowledged / referred.

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Dedicated to my exceptional parents and adored siblings whose tremendous support and cooperation led me to this wonderful accomplishment.

ABSTRACT

THERMAL/VIDEO INTEGRATION WITH UGS SYSTEM

For security, early warning of an attack or intrusion can help save many lives and result in success without losing any single resource. For a Unit or a specific Base to know of a raid being conducted on them before the commencement of the attack, the soldiers can be mentally and physically prepared for the counter attack. In this situation, the counter attack will be a surprise on the intruders or enemy where they will lose their focus and will be forced to retreat. A failed raid of an enemy will result in their defeat and hence defense will be held strong.

For the purpose of defense, Pakistan Army is using Unattended Ground Sensor System (UGS System). Unattended Ground Sensor (UGS) System is an early warning system which is used for the purpose of surveillance and intrusion detection in unattended areas/gasps in defense, border access conflicts and 24/7 perimeter security of designated area.

Currently the system is facing limitations with regard to uncertainty of data collected through different sensors. This is causing wastage of resources, time, budget and manpower. To counter these issues, this updated system integrates live video transmission from different sensors during normal operations to the user at Command, Control and Intelligence (C2I) Station. It will helps user to identify targets, number of intruders, enemy's weaponry and even the enemy's plan. Hence the user will be able to enhance security by take action accordingly and defeating the enemy or eliminating risk of intruders.

When an intrusion is detected by a specific sensor, it broadcasts an alarm to the user at Command, Control and Intelligence (C2I) Station, the system provides the interface at the Command, Control and Intelligence (C2I) Station to check the live transmission of

that particular area transmitted by video camera installed. The transmission will provide us distinction between different objects, their behavior and appearance. This distinction will help the user to take timely action, thus saving the precious lives of soldiers and civilians.

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CHAPTER: 1

INTRODUCTION

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1. INTRODUCTION

1.1 OVERVIEW

The research work presented in this dissertation outlines the importance of early warning system with target identification and the prime focus of its importance in military setups for the purpose of security and defense. It discusses complete project details and design.

1.2 BACKGROUND

For security, early warning of an attack or intrusion can help save many lives and result in success without losing any single resource. In early times, the employment of messengers and runners were the only means of communication and early warnings. In case of an attack, check points were designated at different positions and soldiers were deployed in case an enemy would approach that way. The soldier would then send a message through a soldier or pigeon. All the time would be wasted in informing the main unit. With the advancement of technology, communication advanced to audible signals and then audible signals were sent for informing the Unit.

Nowadays, Electronic equipment is being used in tactical communication. Such an electronic equipment system is being used by Pakistan Army, The Unattended Ground Sensor System (UGS System). UGS System is an early warning system which is used for the purpose of surveillance and intrusion detection in unattended areas/gasps in defense, border access conflicts and perimeter security.

Currently the system is facing limitations with regard to uncertainty of data collected through different sensors. This is causing wastage of resources, time, budget and manpower. Whenever there is an intrusion in a particular area where the system is deployed, the warning has to be ground checked by the deployed platoon or company. Most of the times, the warnings are declared as false alarms because it is caused by

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mostly nearby wild animals, passing travelers and sometimes high wind. To counter these issues this updated system integrates live video transmission from different sensors during normal operations. It will helps user to identify targets, number of intruders, enemy's weaponry and even the enemy's plan. Hence the user will be able to enhance security by take action accordingly and defeating the enemy or eliminating risk of an attack by any intruder or enemy.

1.3 PROBLEM STATEMENT

Unattended Ground Sensor (UGS) System is facing limitations of creating false alarms with regard to intended targets. This results into user lack of confidence on the data collected through different sensors, wastage of time and resources and mismanagement of incidents/situations.

Whenever there is an intrusion detected by the UGS System, that particular area has to be ground checked by the deployed platoon or company. Most of the times, the warning is caused by wild animals or even high wind. Once the platoon goes for the ground check, they are wasting time and resources. If the above incident is repeated again and again, the user loses the confidence on the System. This also leads to mismanagement of incidents as sometimes when the warning is real and the user ignores it keeping in mind the previous experiences. This mismanagement of incidents leads to loss of precious lives and property.

1.4 PROJECT OBJECTIVES

All time video integration with Unattended Ground Sensor (UGS) System, thereby providing live transmission to C2I Station which can be used for:

a. Unattended surveillance

b. Intrusion detection in unattended areas

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c. Resolution of border access conflicts

d. Ensuring 24/7 perimeter security

e. Correct identification of targets

1.5 PROJECT SCOPE

The system is already deployed by Pakistan Army at operational and tactical areas. The UGS System's technical efficiency and operation capability are now improved with the additional feature of visibility.

1.6 APPLICATIONS

The UGS System can be deployed at:

a. Unattended Border Areas

b. Sensitive Installations of Armed Forces

c. Field Exercises at Tactical and Operational Level

1.7 CONTRIBUTIONS

Following contributions were made while completing this project:-

a. Integration of video stream to the UGS System

b. Updating of previous system

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c. Movement of camera to the scene where activity occurs

1.8 ORGANIZATION

The first section of thesis is the abstract, which describes the main details of our project, followed by the introduction section, which specifies the background, problem statement, objectives and scope. The literature review section states the research done on the project. The design and development section of thesis illustrates the work done on the integration of live video transmission with the Unattended Ground Sensor (UGS) System. The analysis and evaluation part provides with the details of the results of the work done on the project. The future work gives further improvements and point out further developments and research work that can be carried out to enhance the scope of the project.

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CHAPTER: 2

LITERATURE REVIEW

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2. LITERATURE REVIEW

2.1 UGS SYSTEM ARCHITECTURE

The Unattended Ground Sensor (UGS) System comprises of three basic components including Sensor Node, Media Exchange Gateway (MEG), Command, Control and Intelligence (C2I) Station (Laptop), and where necessary a router/relay node is used to enhance communication range of the system. Each sensor node is equipped with multiple active and passive motion detection sensors including Passive Infrared (PIR) Sensor, Microwave (MW) Sensor, and Seismic Sensor, a radio communication device (Zigbee) and a navigation module housed in a fiberglass stone.

Whenever a sensor node detects some intrusion, the information is passed wirelessly to Media Exchange Gateway (MEG) which transport it on Ethernet Cable to Command, Control and Intelligence (C2I) Station (Laptop) where warning is displayed on satellite imagery/map. The UGS System works in real time and is powered by batteries and hybrid solar power arrangements.

Pictorial view of a deployed UGS System is shown in Figure 2.1.

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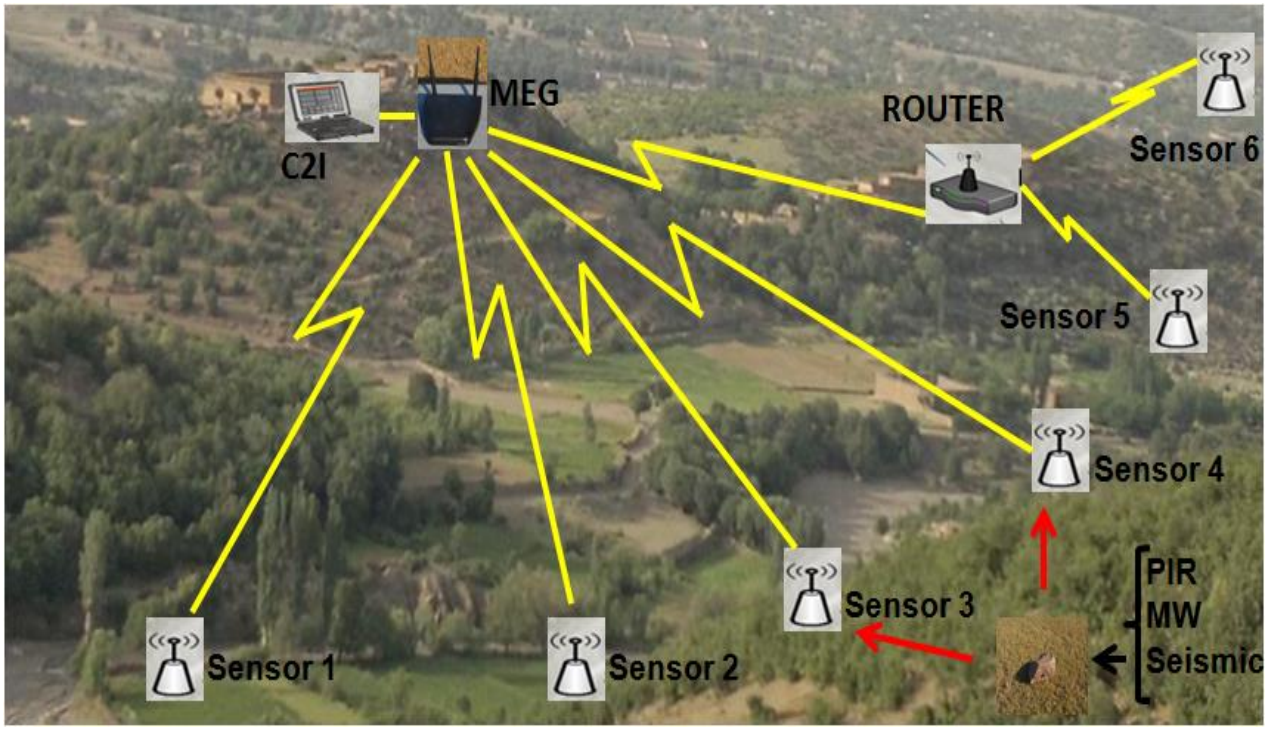

Figure 2.1: Deployed UGS System

The components of UGS System are described as follows:

2.1.1 SENSOR NODES

Main components of a sensor node are sensors, signal processing electronics circuit board, navigation module and a battery housed in waterproof fiberglass stone. A sensor node has three different types of sensors including Passive Infrared (PIR) Sensor, Microwave (MW) Sensor and Seismic Sensor. Passive Infrared (PIR) Sensor and Seismic Sensor are passive while Microwave (MW) is an active sensor.

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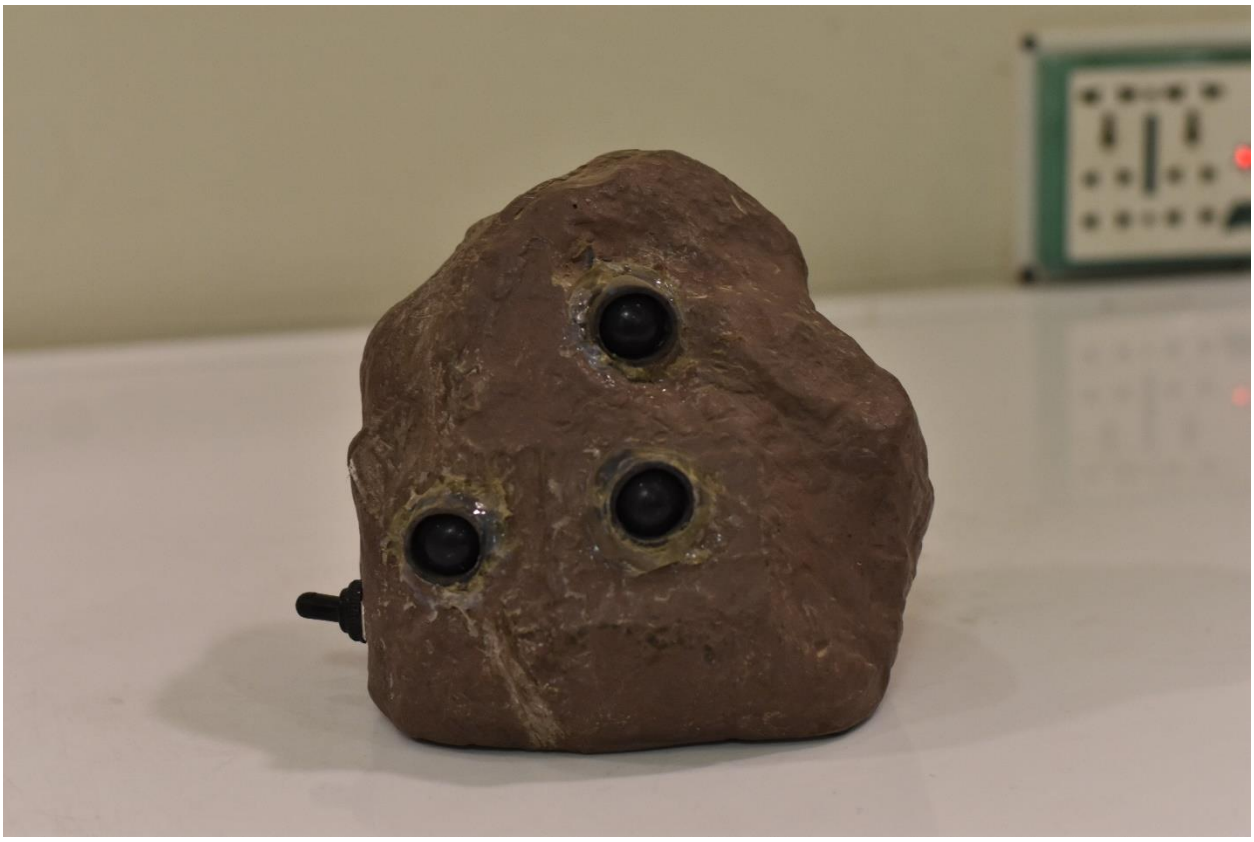

Figure 2.2: Fiberglass Stone

Passive Sensors acquire intelligence from its surrounding due to change in environment or vibrations without generating energy while active sensors generate energy from detection. Working principle of sensors and its communication is described under:

a. Passive Infrared (PIR) Sensor:

Passive Infrared (PIR) Sensor detects Infrared (IR) frequencies ranging from 0.300-430 THz emitted usually from humans. PIR sensor has a detection range of 25-30 ft and field of view of 100 degrees. The sensor node can have more than one PIR sensor to enhance the FOV as shown in Figure 2.2.

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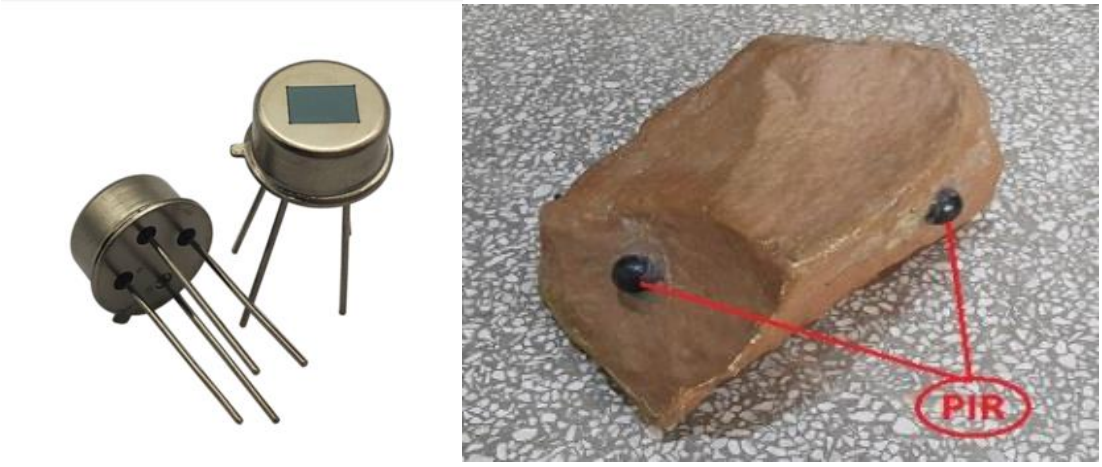

Figure 2.3: Passive Infrared (PIR) Sensor (Left) and PIR Sensor installed in a fiberglass stone (Right)

b. Microwave (MW) Sensor:

It is an active sensor which works on the principle of RADAR in X-Band (10.525 GHz) frequency. The detection is caused by a change in receive frequency shift caused by moving body in sensor Field of View. The detection range is 20-25 ft and field of view is 60 degrees. Microwave Sensor is installed alongside Passive Infrared (PIR) sensor to enhance detection capability. Dual sensor installed in a senor node is shown in Figure 2.3.

Figure 2.4: MW Sensor installed with a PIR in fiberglass stone (Left) and Microwave Sensor (Right)

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c. Seismic Sensor:

The Seismic Sensor detects low frequency (0-120 Hz) generated by footsteps, light vehicles, heavy vehicles and flying objects. Seismic sensor has a detection range of 150 ft all-around. Figure 2.4 shows a Seismic Sensor.

Figure 2.5: Seismic Sensor (Left) and Seismic Sensor installed with a fiberglass stone (Right)

2.1.2 COMMUNICATION SYSTEM OF UGS

Unattended Ground Sensor (UGS) System sensor nodes communicate with Media Exchange Gateway (MEG) using Zigbee communication module. The device works around 900 MHz frequency band with inbuilt transmission and communication security features to avoid interception or decryption of messages by unintended users. The basic communication network design used by Unattended Ground Sensor (UGS) System is star` topology in which Media Exchange Gateway serves as central hub to which all sensor nodes are connected. The communication range is 3000-400m extendible by another 300-400m using a router/relay node. Whenever, there is a larger distance to be covered than the usual, a router/relay node is used which extends the

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range of the device.

The Unattended Ground Sensor (UGS) System works on the basics of star topology, the network design is shown in Figure 2.5.

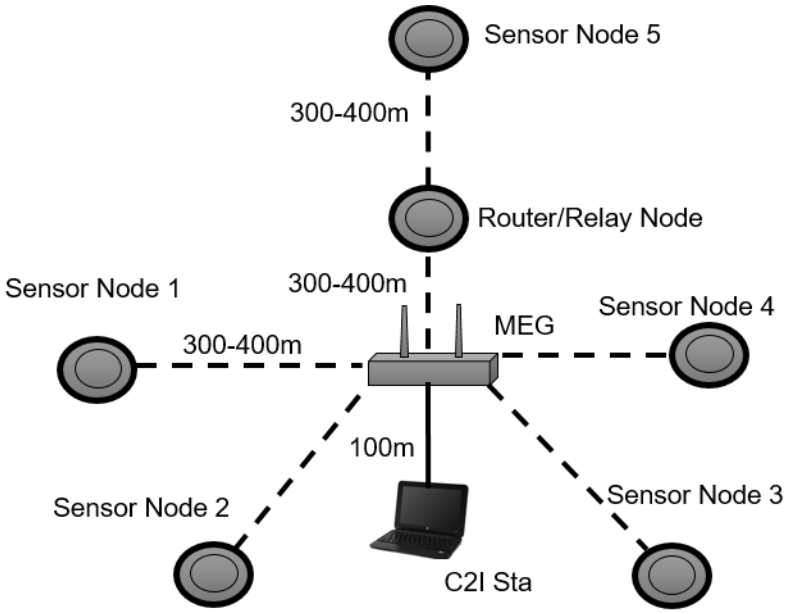

Figure 2.6: UGS System Architecture

In the above Figure 2.5, Unattended Ground Sensor (UGS) System has 5 x sensor nodes and 1 x relay/router node. Dotted lines depict Zigbee wireless communication and straight line for Ethernet cable connection

2.1.3 STAR TOPOLOGY

A star topology is used in LAN (Local Area Network). In star topology, all the nodes are connected individually to a central point, which is mostly a hub or a switch. The benefits of star topology is that if one link fails, the system does not fails and it is easy to identify fault. In this situation only the connection to that particular node is lost, while all other nodes are still intact and connected. Star Topology is expensive due to cabling cost. In case the central device fails, the whole system fails. Each device has a dedicated point-to-point link only to a central device (Hub or Switch). The devices are not directly linked

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to one another, a star topology does not allow direct traffic between devices. All the traffic has to be routed through the central device.

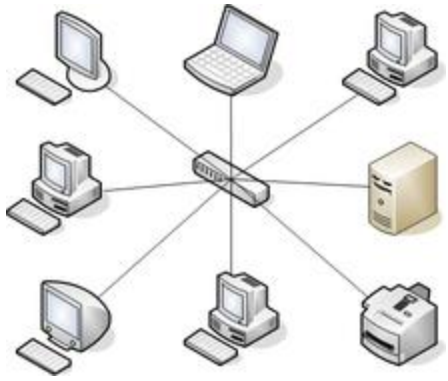

Figure 2.7: Star Topology

Star topology is considered to be the best topology but theoretically the best topology should be mesh topology. In mesh topology, each device is directly connected to all the other devices in the system by cables without the use of central device. Mesh topology is considered to be the most expensive one due to a lot of cabling cost.

Star Topology is also considered to be the most secured and stable as each node is independently connected to the central device. In case one node goes down, the rest of the network will be unaffected and will still be functional.

2.1.4 MEDIA EXCHANGE GATEWAY (MEG)

Media Exchange Gateway is an intelligent media exchange module equipped with Zigbee radio to process data received from sensor nodes and transport it to Command, Control and Intelligence (C2I) Station over wired media (Ethernet Cable). Media Exchange Gateway (MEG) performs data collection, filtration and transfer to Command, Control and Intelligence (C2I) Station in real time. Sensor data includes initialization messages which are generated by sensor node as soon it is switched on, battery status and alert messages on an event of intrusion detection. MEG is shown in Figure 2.7.

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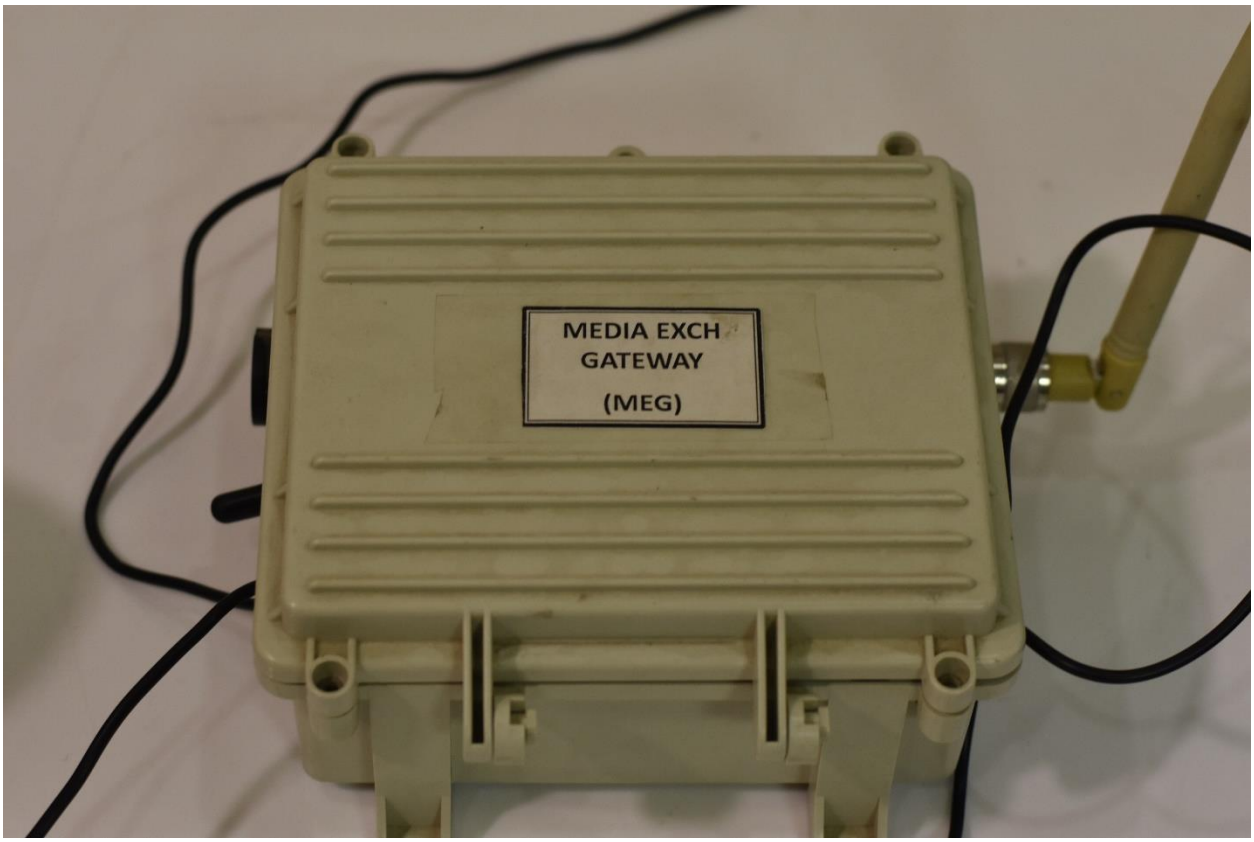

Figure 2.8: Media Exchange Gateway (MEG)

2.1.5 COMMAND, CONTROL AND INTELLIGENCE (C2I) STATION

Command, Control and Intelligence (C2I) Station is a laptop ported with a C2I software application to provide a real time common operation picture of all sensor nodes deployed in an area. It performs geo tagging of all sensor nodes on a satellite imagery/maps. The C2I software is based on a Client-Server architecture which enables multiple users to have a view of sensor nodes network. C2I application displays sensor node ID, geographical location with Latitude and Longitude. C2I application displays an alert message/ warning whenever there a motion or intrusion along the sensor.

After the warning is displayed on C2I Station, the user can see the live transmission of that particular area. After seeing the area though the camera, it will be up to the user to decide whether to take an action and alert further platoon/company to go to that particular area for ground-check. If the warning is true and the platoon/company takes

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action, they will be saving the precious lives of so many innocent people. If the warning is due to some other reasons which is considered to be false alarm, the user will not take action and it will save resources, time and manpower.

Figure 2.9: Command, Control and Intelligence C2I Station

2.1.6 POWER SYSTEM

Sensor node is powered by 3.7VDC, 10400mAHC Li-Ion battery which provides 60 x days of continuous operation, Media Exchange Gateway (MEG) and Command, Control and Intelligence Station are powered by hybrid power arrangements (solar/main AC)/DC batteries with 4 x solar panels (150W each) and 12VDC, 150 AHC battery which provides uninterrupted power backup and charge sensor node, MEG and laptop batteries.

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CHAPTER: 3

DESIGN AND DEVELOPMENT

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3. DESIGN AND DEVELOPMENT

3.1 OVERVIEW

This project highlights the importance of early warning along with target identification. The prime focus of this project is in military setups for the purpose of security and defense. It discusses complete project development and design.

3.2 PROJECT GOALS

The main purpose of this project is to enhance the security by updating the Unattended Ground Sensor (UGS) System. This can be achieved by integrating a camera by the UGS System. The camera will provide all time live video transmission of the particular area which will ensure unattended surveillance, intrusion detection in unattended areas, resolution of border access conflicts and ensuring 24/7 perimeter security. The main goal of this particular project is the correct identification of targets meaning differentiating among different objects.

3.3 PROJECT DESIGN

The Thermal/Video Integration with Unattended Ground Sensor (UGS) System has been designed in a way, where a single camera can cover at least 2 sensor nodes areas. The purpose of this project is to identify targets and ensuring security. A Pan-Tilt-Zoom (PTZ) camera will be able to cover 2 possible sensor nodes. Whenever a movement is detected by a sensor node, the user can access the camera of that particular node and will be able to view the complete area.

The distance of a sensor node from the Media Exchange Gateway (MEG) is 300-400m and it is connected through Zigbee technology and module. The Media Exchange Gateway (MEG) is then connected to Command, Control and Intelligence (C2I) Station through an Ethernet Cable at a distance of 100m. Pan-Tilt-Zoom (PTZ) camera is situated at a distance of 100-200m from Media Exchange Gateway (MEG) at such a

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point where it can cover at least two sensor nodes and any movement detected there by the sensors. Pan-Tilt-Zoom Camera is connected with Media Exchange Gateway (MEG) through an Ethernet Cable and Media Exchange Gateway (MEG) is connected to Command, Control and Intelligence (C2I) Station through a 100m long Ethernet cable proving user with data from sensor nodes as well as from the camera. The design has been described in Figure 3.1.

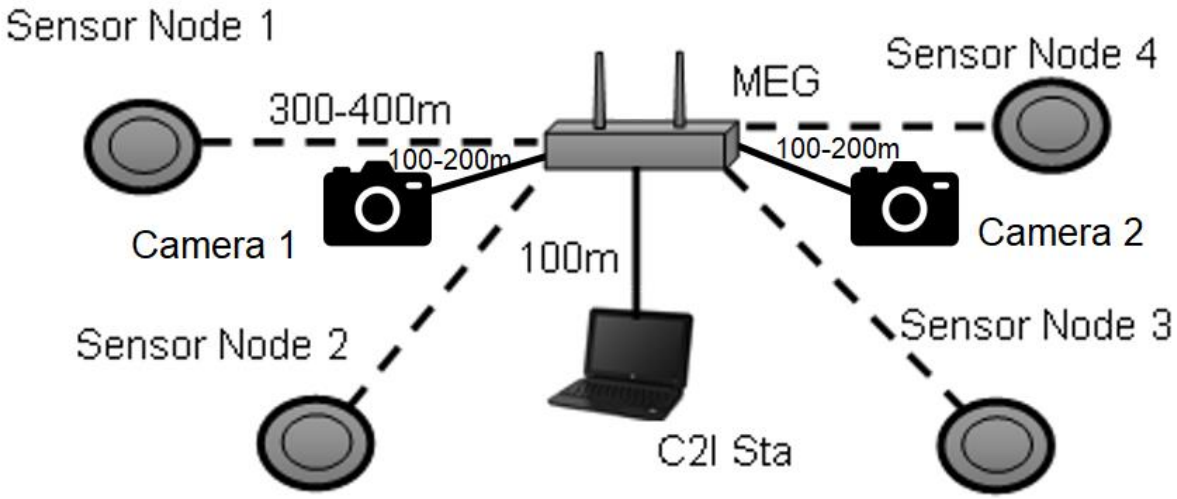

Figure 3.1: Design of Camera integrated UGS System

3.4 PROJECT DEPLOYMENT

Deployment of Unattended Ground Sensor (UGS) System is very important and should be quite tricky. With limited number of sensor we need to cover the maximum vulnerable area. So for the deployments, always choose the most threaten area. Placement of sensors is another aspect and very important. Passive Infrared (PIR) dots on top of the sensor should point towards the vulnerable path and zone.

All sensors are equipped with GPS module. Whenever you want to deploy the sensor simply turn-off your sensor and take it to the required location and turn-on the power button. Sensor will automatically detect the current GPS location and send GPS

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coordinates to the Command, Control and Intelligence (C2I) Station. Command, Control and Intelligence (C2I) System will automatically place the sensor on actual location on map by using GPS coordinates.

Deployment of camera should be in a way that it should cover at least two sensor nodes. As the Pan-Tilt-Zoom (PTZ) camera can move around and get a 360 degrees view so it is easy for the camera to cover two sensor nodes.

3.4.1 PIR NODE DEPLOYMENT

Normally we have 3 Passive Infrared (PIR) with each sensor node. Each Passive Infrared (PIR) node covers a specific area and we need to point out this node towards vulnerable areas.

3.4.2 MW NODE DEPLOYMENT

MW is combination of Passive Infrared (PIR) and Microwave. MW and PIR both should face towards the vulnerable area.

3.4.3 SEISMIC NODE DEPLOYMENT

Seismic sensor covers more area than other sensors. It works on vibrations in ground and it should be deployed on vulnerable area not on path but on one side of the path.

3.5 PRECAUTIONS

Command, Control and Intelligence Station (Laptop) and all other components are sensitive and breakable components. Keep all components very secure and safe from any kind of shock or dust/water. Do not pug anything other than UGS items into power system.

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Sensor node can be placed in sunlight but PIR sensor node should not face the sun directly. Power station is purely designed for UGS system only. It is dependent on sun light and get the power from light. For long time rainy season, it may power down as well. Keep the power station dry and keep it secure from any kind of water or rain.

Command, Control and Intelligence (C2I) Station or Laptop is for indoor use only and no USB/CD/DVD is allowed to plug-in with C2I Laptop.

3.6 USER GUIDE FOR UGS SYSTEM

A small user manual is listed to help user handle the equipment more efficiently:-

3.6.1 STARTING THE SYSTEM

- Turn on Media Exchange Gateway (MEG).
- Connect the MEG via/through Ethernet port to C2I Station.
- Turn on the C2I Station (Laptop).
- Login using username and password.
- Open Firefox and click on “UGS Application” on Firefox toolbar or enter the following URL:

  Localhost:8080/cnc/login
- Login to application with the specified username and password.
- Click on configuration Tab and select MEG connection.
- MEG default IP is already entered in the field. Simply click on Check button to verify the communication between MEG and C2I Station.
- If “**MEG is not connected. Please check the MEG is powered ON, or the cable connection with MEG is OK or entered IP address is valid IP address of MEG.**” Message appears then it means MEG is not connected properly or not powered on. Check the cable connection and power supply to MEG.

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- If message appears “**MEG is connected**” then it means communication with MEG is established.
- Turn on the sensor to check the communication.
- Turn on the camera to check the connection.

3.6.2 RECHARGING BATTERIES

- Recharging connector is already there on the sensor. Simply connect the sensor with Charger. Charging light on charger will show the indication that sensor is being charged.
- In case charging connector is not working then open the screws of sensor node.
- Open the white box.
- Unplug the battery.
- Plug-in the charged spare battery to sensor so that there should not be any down time.
- Bring back the battery with you on post and plug it into charger with power solution.
- Red light should indicate to make sure that charging is in progress.
- When green light is on, it means charging is complete and unplug the battery from charger.
- Now your battery is ready to replace with any sensor.

3.6.3 TROUBLESHOOT

- If alert is not being received, refresh the Firefox by F5 button on keyboard of C2I or click the refresh icon of Firefox.
- Check that MEG device is powered on or not.
- If MEG is already powered on then check the Ethernet cable is connected or not.

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- To verify the communication between C2I and MEG, go to “Configuration” tab on UGS Application and click on “MEG Connection”. Default IP Address of MEG is already entered.
- If “**MEG is not connected. Please check the MEG is powered ON, or the cable connection with MEG is OK or entered IP address is valid IP address of MEG.**” Message appears then it means MEG is not connected properly or not powered on. Check the cable connection and power supply to MEG.
- If message appears “**MEG is connected**” then it means communication with MEG is established.
- Now check the python service is running on C2I System with the following command in terminal.

Ps –x I grep python

- If main.py is displaying as one entry in result of above command then it means service is running. If main.py is not being displayed then restart the C2I laptop.
- Python service should run in background to receive alerts.
- If project URL is not working or showing error message on Firefox then you need to check the Tomcat (Server) is running or not. To run the Tomcat server open the terminal and enter the following command in terminal:

cd/opt/apache-tomcat-7.0.57/bin

./startup.sh

- The above command will start the tomcat and now check again in Firefox that application is working or not.
- Just in case of any problem simply restart the whole system. First unplug the power cable to MEG and plug it again. Then restart the C2I laptop and follow the instructions to start the application.

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CHAPTER: 4

ANALYSIS AND EVALUATION

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4. ANALYSIS AND EVALUATION

4.1 FINAL PROJECT OUTPUT

The Command, Control and Intelligence (C2I) Station is ported with a C2I software which provides a real time operational picture of all sensor nodes along with cameras deployed in unattended area. All the sensors deployed are shown on the satellite maps.

The Command, Control and Intelligence (C2I) application displays all the sensor nodes available on the system as shown in Figure 4.1. While no alert messages are being displayed, all the sensors are active and the live transmission can be seen anytime from the Command, Control and Intelligence (C2I) application as shown in Figure 4.2.

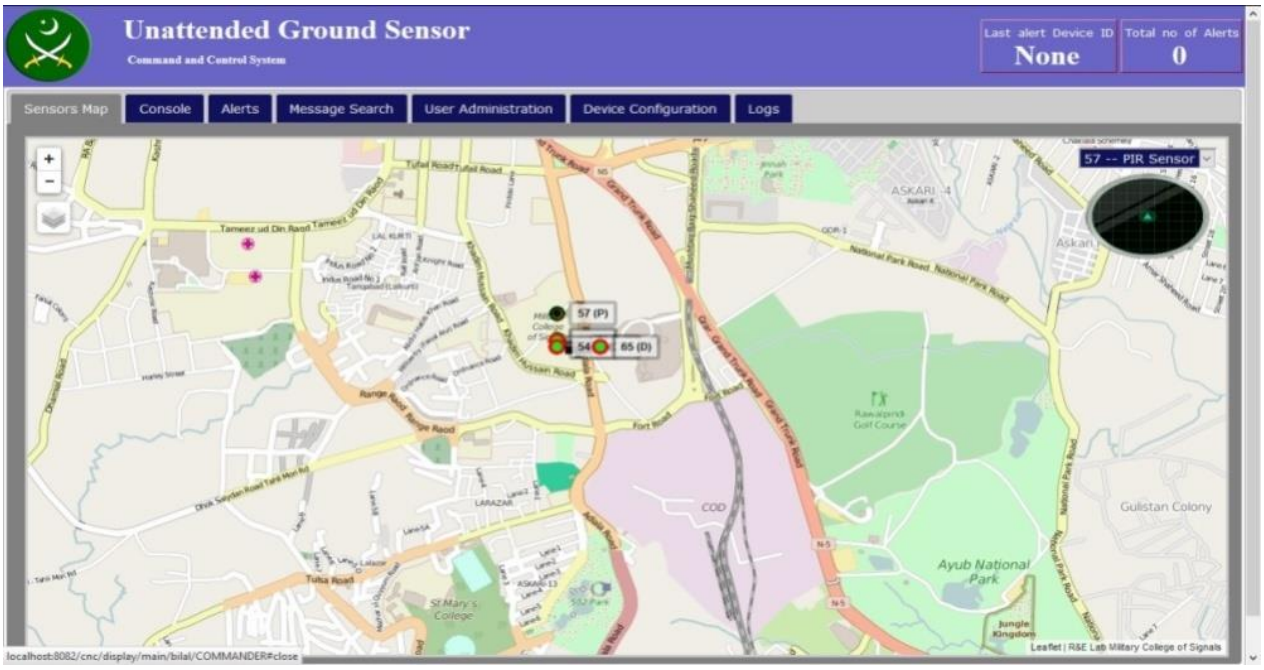

Figure 4.1: Map of sensor nodes on C2I display, active sensor node is shown as green disc with a red circular boundary.

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Figure 4.2: Live video transmission from the sensor node when there is no movement at all.

An alert message from sensor node is displayed whenever there is any movement along the sensor ID and its longitude and latitude position as shown in Figure 4.3. After the alert message has been viewed, the user can then switch to the live video transmission in order to classify the warning as true or false alarm as shown in Figure 4.4.

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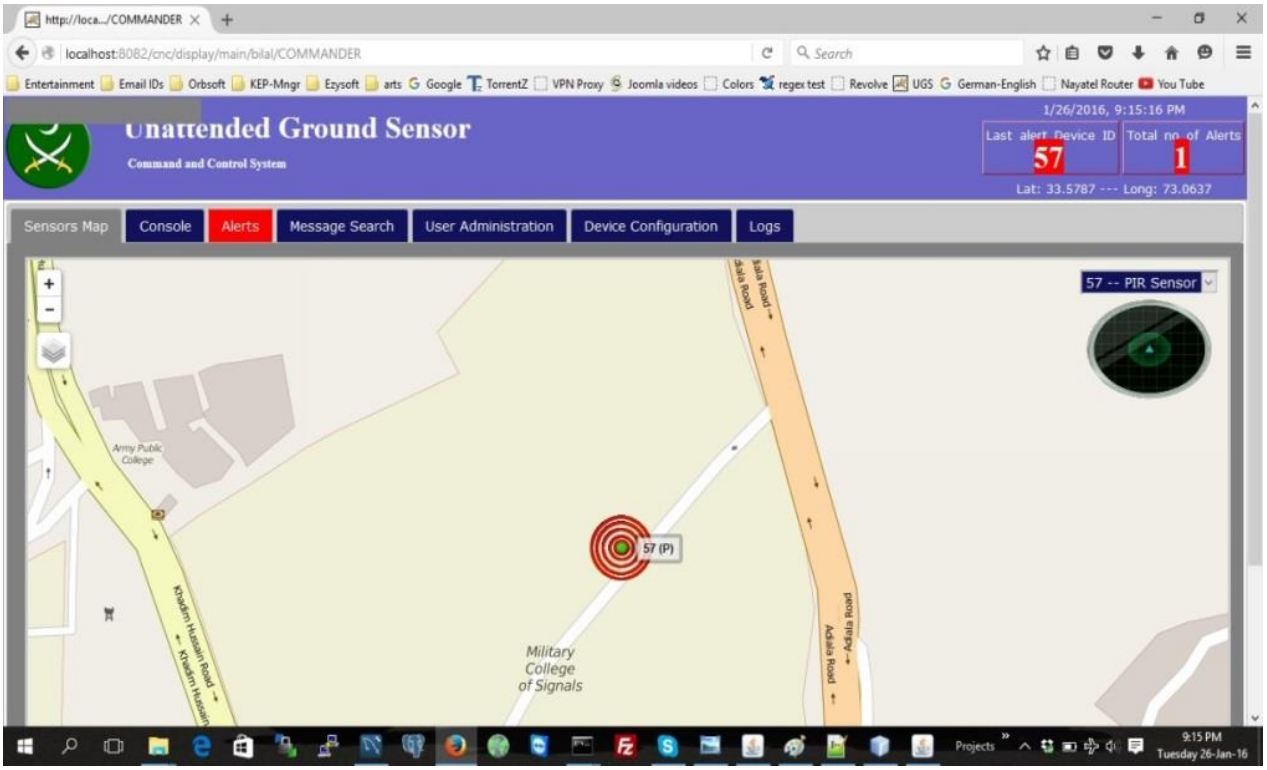

Figure 4.3: Alert message of sensor node on C2I Station with red circles.

Figure 4.4: Live video transmission from the sensor where a movement has been detected by the sensors.

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CHAPTER: 5

FUTURE WORK

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5. FUTURE WORK

5.1 RECOMMENDATIONS FOR FUTURE WORK

Although the Thermal/Video Integration with Unattended Ground Sensor (UGS) System proposed in this project presented after integrating techniques are set after a lot of deliberations and detailed work, still following recommendations can be taken into consideration as enhancements in this project to bring more positive outcomes:-

5.1.1 DIGITAL IMAGE PROCESSING

Digital Image Processing (DIP) is used to process digital images through an algorithm by a digital computer. Digital image processing has many advantages over Analog Image Processing as it allows a wide range of algorithms to be applied on the image, it helps in the processing by eliminating factors such as noise and distortion and enhancing brightness and contrast.

Digital Image Processing is generally used for:-

1. Checking for presence
2. Object detection and localization
3. Measurement
4. Identification and Verification

Matching is involved in Digital Image Processing, this means looking for regions that are similar or the same as a predefined template. This template can either be an image or a geometric pattern which contains information regarding edges and geometric features. These methods area called correlation pattern matching and geometric pattern

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matching respectively. A predefined template of animals, weapons, cars and human being is given to the computer and when the camera detects any object, it matches it to pre-defined template and once it matches it, the user can easily identify any object detected by the system at that unattended area.

5.1.2 INTRODUCTION OF MICROPHONE ALONG WITH SENSORS

This project can be enhanced by adding an additional microphone along with each sensor, the addition of microphone will help the user. Once a warning is displayed on Command, Control and Intelligence (C2I) Station, for the classification of warning, the user opens the live transmission. The user is getting a live transmission of the particular area where the signal has triggered and there is a risk of an intruder. The user is only able to see through the eye of the camera and might be able to see intruders.

The intruder might be hiding as to avoid being seen by any check post, but keeping in the mind the distance of the intruders from the check post, the intruders will be of the thought that they won't be heard by anyone if they talk with each other. If there is a microphone along with that sensor, the user will be able to hear the intruders and might be able to learn about the plans of the intruders.

The addition of microphone will help the user to further eliminate the chance of any doubts in any decision he takes.

5.1.3 THERMAL CAMERA INTEGRATION WITH UGS SYSTEM

Due to current COVID-19 Pandemic situation all around the world and especially in Pakistan, our syndicate was unable to arrange a thermal camera as the country has been under lockdown since a while.

Hence it is recommended that if further work is to be done on this project, Thermal camera should be integrated with the Unattended Ground Sensor (UGS) System.

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Thermal camera will increase the efficiency of this system during the night time. When there will be movement at night and sensors senses it, the user will be able to distinguish between different objects including human beings, wild animals or vehicles. Thermal camera will improve the system’s technical efficiency and operational capability.

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CHAPTER: 6

CONCLUSION

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6. CONCLUSION

6.1 CONCLUSION

In this project integration of thermal/video camera with Unattended Ground Sensor (UGS) System is proposed which is achieved by integrating a camera with Media Exchange Gateway (MEG) along with a sensor. The sensor, once senses any movement along the unattended area, sends a signal to Command, Control and Intelligence (C2I) Station through Media Exchange Gateway (MEG), the user at Command, Control and Intelligence (C2I) Station then views the live video transmission through the same Media Exchange Gateway (MEG). Once the user views the live transmission, he can then take action according as he classifies the warning as true or false alarm. If the warning is true and there is some intruder, he can call for ground forces such as a platoon or a company deployed there for the security. The platoon or the company can then clear the area knowing there is risk ahead and they will be prepared for it mentally. If the warning is declared as a false alarm, as it can be triggered by any wild animal or even high wind. It will save the time of the platoon/company, manpower involved for the ground check of the area and resources used for clearing the area.

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CHAPTER: 7

BIBLIOGRAPHY

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7. BIBLIOGRAPHY

1. https://en.wikipedia.org/wiki/Star_network

2. https://www.researchgate.net/publication/237696511_Unattended_Ground_Sensor_UGS_Systems_for_Homeland_Defense

3. https://www.researchgate.net/publication/241222845_A_roadmap_to_truly_disposable_unattended_ground_sensor_UGS_systems

4. https://www.semanticscholar.org/paper/The-Application-of-Unattended-Ground-Sensors-to-Agassounon-Steadman/4389fb4a5b7c415b8267fcfff2a76da47995dfbe

5. https://www.researchgate.net/publication/251569505_Seismic_Target_Classification_Using_a_Wavelet_Packet_Manifold_in_Unattended_Ground_Sensors_Systems

6. https://www.researchgate.net/publication/2904810_Target_Detection_and_Classification_Using_Seismic_Signal_Processing_in_Unattended_Ground_Sensor_Systems

7. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.113.1431&rep=rep1&type=pdf

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