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Target Detection and Classification Using Seismic and PIR Sensors for border security system

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ABSTRACT

Underground sensor are used to monitor footstep recognition and motion of intruders in a secure region. Disadvantage of UNDERGROUND SENSOR systems is high false alarm rates due to insufficient underlying algorithms and conditions of on board calculation. This project presents a wavelet-based process for target detection and classification. The given process has been validated on information sets of seismic and passive infrared sensors for target recognition and classification, as well as for payload and movement variety identification of the targets. The main merit is fast execution time and low memory necessities. It is potentially well-suited for real-time implementation with on board UNDERGROUND SENSOR systems. Seismic sensors(ADXL278) are used for recognition of moving targets in the ground sensor area. Because of the difficult environmental conditions and the non-stationary nature of the seismic signals, footstep detection and classification is a very challenging problem. This difficulty can be cracked by applications such as border security, surveillance and intruder detection. Previous works in the domain of seismic recognition of human vs animal. quadruped have relied on the condense frequency-based models. However, cadence-based detection only results in high false alarms. In this project, we define a seismic footstep information base and present classification outputs based on support vector machine (SVM). We observed that in addition to put on a good classification algorithm, finding robust features are very important for seismic discrimination.

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I. INTRODUCTION

Underground sensors are mainly used in industrial monitoring and military operations. Commercially available Underground sensors systems make use of many sensing modalities like seismic sensor(ADXL278), passive infrared, electrostatic, and video. Capacity of Underground sensor systems is frequently limited through high false alarm rates because the on board information processing algorithms may not be able to correctly categorize different types of objects or targets like humans from animals .Energy consumption is a essential consideration in Underground sensor systems. Therefore, energy-efficient sensing models, less-energy signal processing algorithms, and efficient methods for exchanging information between the Underground sensor nodes are needed.

In case of detection and categorization difficulty , the objects or targets generally include human, vehicles and animals like selective human footstep signals from other objects or targets and noise sources is a difficult task, because the signal-to-noise ratio of footsteps decreases rapidly with the distance between the sensor and the walker. The footstep signals can vary considerably for different people and environment conditions. Often the frail and noise infected signatures of humans and vehicles may not be visibly different from each other, in compare to heavy vehicles that emit loud signature. Seismic sensors are used for personnel detection, because they are smaller amount sensitive to Doppler effects and environment conditions, as compare to acoustic sensors. Current detection methods are grouping into three categories like time domain, frequency domain and time-frequency domain. Generally, time-domain analysis is not able to detect objects or targets correctly because of the noise, complex signal waveforms, and variations of the ground. The exactness of frequency domain methods may be tainted due to underlying non-stationary in the detected signal. Therefore, recent research has based one time-frequency domain methods because of their denoising and localization properties.

Passive Infrared sensors have been extensively used in motion detectors, where the PIRs signals are usually quantized into two conditions, i.e."on" and "off". PIRs signals contain Discriminative information in the time-frequency domain and are compatible for Underground sensor systems due to low energy consumption.

Once location is detected through PIRs sensor then Radio frequency identification reader read the ID of that human. ID is checked through controller if ID matched then no any action taken through the controller, however if ID is mismatched then GSM sends message to headquarter.

II. LITERATURE SURVEY

Iyengar, S.G (2007):Acoustic and Seismic Sensing

In this work, we present a copula-based framework for integrating signals of different but statistically correlated modalities for binary hypothesis testing problems. Specifically, we consider the problem of detecting the presence of a human using footstep signals from seismic and acoustic sensors. An approach based on canonical correlation analysis and copula theory is employed to establish a likelihood ratio test. Experimental results based on real data are presented.

Dibazar, A.A.(2007):The Application of Dynamic Synapse Neural Networks on Footstep and Vehicle Recognition.

In this paper we report application of biologically based dynamic synapse neural network (DSNN) on perimeter protection. More specifically, the purpose is to protect a fence line from approaching human being and vehicles. We have used geophones to detect seismic signals generated by footsteps and vehicles. While acoustic sensors can be fooled by artificial sounds, fooling geophones by artificial seismic waves is a complicated task. Moreover detecting human footsteps -weak signal to noise ratio -by acoustic waveform is subject to the distance between the sensor and human. Therefore detecting a human's footsteps by employing acoustic information will not be possible unless he/she walks close to the acoustic sensors. Geophones are resonant devices; therefore any vibration in the substrate can generate seismic waveforms which could be very similar to the signature generated by footstep or vehicle. In addition, geophone response is completely substrate dependent, rendering recognition of footsteps or vehicle vs. other vibrations to be a very difficult task. Therefore, in order to have robust and high-confidence classification/detection of a human/ vehicle threats, we have employed the DSNN. The network is trained to extract intrinsic characteristics of the waveform, frame by frame. Then parameters of the network are analyzed by Gaussian mixture models. The results of our study show 88.8% and 86% correct classification rate for the detection of human footsteps and vehicle respectively.

Iyengar, S.G (2007):Acoustic and Seismic Sensing

In this work, we present a copula-based framework for integrating signals of different but statistically correlated modalities for binary hypothesis testing problems. Specifically, we consider the problem of detecting the presence of a human using footstep signals from seismic and acoustic sensors. An approach based on canonical correlation analysis and copula theory is employed to establish a likelihood ratio test. Experimental results based on real data are presented.

AsifMehmood, Vishal M. Pateland Thyagaraju Damarla (2007) :Discrimination of bipeds from quadrupeds using seismic footstep signatures.

Seismic sensors are widely used to detect moving targets in the ground sensor network, and can be easily employed to discriminate human and quadruped based on their footstep signatures. Because of the complex environmental conditions and the non-stationary nature of the seismic signals, footstep detection and classification is a very challenging problem. The solution to this problem has various applications such as border security, surveillance, and perimeter protection and intruder detection. Previous works in the domain of seismic detection of human vs. quadruped have relied on the cadence frequency-based models. However, cadence-based detection alone results in high false alarms. In this paper, we describe a seismic footstep database and present classification results based on support vector machine (SVM). We demonstrate that in addition to applying a good classification algorithm, finding robust features are very important for seismic discrimination.

Park, H.O. (2009):Cadence analysis of temporal gait patterns for seismic discrimination between human and quadruped footsteps

This paper reports on a method of cadence analysis for the discrimination between human and quadruped using a cheap seismic sensor. Previous works in the domain of seismic detection of human vs. quadruped have relied on the fundamental gait frequency. Slow movement of quadrupeds can generate the same fundamental gait frequency as human footsteps therefore causing the recognizer to be confused when quadruped are ambling around the sensor. Here we propose utilizing the cadence analysis of temporal gait pattern which provides information on temporal distribution of the gait beats. We also propose a robust method of extracting temporal gait patterns. Features extracted from gait patterns are modelled with optimum number of Gaussian Mixture Models (GMMs). The performance of the system during the test for discriminating between horse, dog, multiple people walk, and single human walk/run was over 95%.

MehmoodA.(2012):Discrimination of bipeds from quadrupeds using seismic footstep signatures.

Seismic sensors are widely used to detect moving targets in the ground sensor network, and can be easily employed to discriminate human and quadruped based on their footstep signatures. Because of the complex environmental conditions and the non-stationary nature of the seismic signals, footstep detection and classification is a very challenging problem. The solution to this problem has various applications such as border security, surveillance, and perimeter protection and intruder detection. Previous works in the domain of seismic detection of human vs. quadruped have relied on the cadence frequency-based models. However, cadence-based detection alone results in high false alarms. In this paper, we describe a seismic footstep database and present classification results based on support vector machine (SVM). We demonstrate that in addition to applying a good classification algorithm, finding robust features are very important for seismic discrimination.

III. PROPOSED SYSTEM

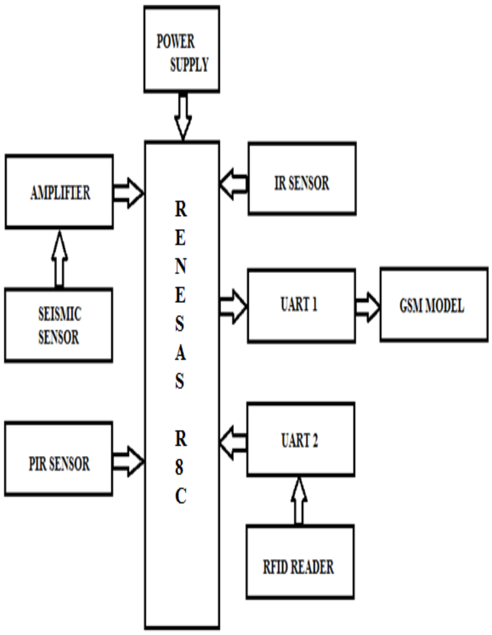

Fig 1. Block Diagram

PIRs sensor is piezoelectric passive infrared and seismic sensor(ADXL278) sensor(ADXL278) are used for detection of human movements. When humans or animals walk, their footsteps create spontaneous seismic sensor(ADXL278) signals that propagate through the earth. Seismic sensor(ADXL278) signals propagate via body waves (compression)and surface waves. We recorded the seismic sensor(ADXL278) information created through the footprints of the walking subjects using seismic sensor(ADXL278) sensor(ADXL278). The design of the sensors deployed and the path of the walking subject is shown in Figure. 2

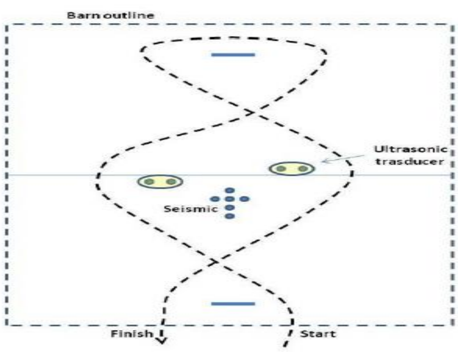

Fig 2. Walking path and sensors layout in the barn for data collection

In the above fig, other sensors such as ultrasonic and microphones were also used to collect the information simultaneously. However we only study the seismic sensor(ADXL278) information. The walking subjects selected were humans.

In the categorization stage, there are multiple groups like humans, animals, and vehicles and the signature of the vehicles is different from those of the other two groups. thus, this difficulty is formulated in a two-layer categorization process. A binary categorization is to detect the presence of a target and then to identify whether the target is a vehicle or a human. Upon recognizing the target as a human/vehicles/animal, other binary categorization is done to determine its definite group.

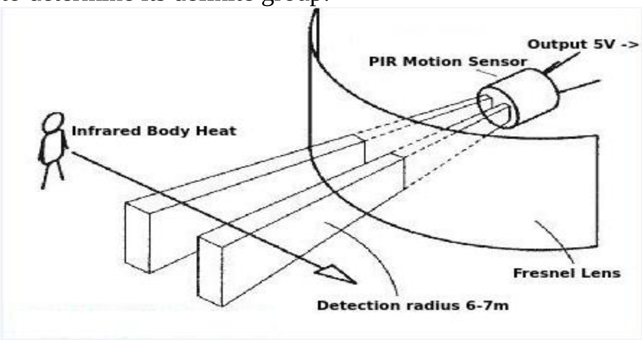

Fig 3. Target classification using PIR sensor

PIRs sensors which is broadly used in motion detectors. PIRs signals are usually quantized into two states, i.e., “on” and “off”. PIRs signals contain information in the time-frequency domain and are suitable for Underground sensor systems due to less energy consumption.

This report addresses the difficulty of target detection and categorization through using seismic sensor(ADXL278) and PIRs sensors that monitor the penetration of humans, light vehicles and domestic animals for border security. Once human is detected through using PIRs sensor and seismic sensor(ADXL278) sensor(ADXL278) ,thenRadio frequency identification reader read the ID of that person. ID is checked through controller if ID matched then no any action taken through controller, however if ID is mismatched then GSM sends message to control room.

IV. ADVANTAGES AND APPLICATION

ADVANTAGES

1. Indian government to manage a huge standing army with border security forces is entirely reduced by this system.
2. This system is reliable and efficient.
3. Low cost as compared to other systems.
4. System is more secured.

APPLICTION

1. Border security system.
2. As a security system in various companies.

IV. CONCLUSION

The differences of footsteps can be known by the power spectral density of sound and vibration generated by footsteps. Every footstep of the human has a certain density of frequency, of generated sounds or vibrations. The difference between one's footstep and others' will be more accurately distinguishable by detecting footsteps simultaneously, that is by using geophone and PIR. Geophone and PIR sensor have sensing with each characteristics, so that by doing the simultaneous detection, the accuracy of foot step identification can be more believable obtained.

REFERENCE

[1] Y. Shoji, A. Itai and H. Yasukawa "A study on footstep detection for personal recognition."Nonlinear Signal and Image Processing, 2005.NSIP 2005.Abstracts. IEEE-Eurasip Digital Object Identifier:10.1109/NSIP.2005. 1502271. Publication Year: 2005.

[2] S.G. Iyengar, P.K. Varshney and T. Damarla, "On the Detection of Footsteps Based on Acoustic and Seismic Sensing."Signals, Systems and Computers, 2007.ACSSC 2007. Conference Record of the Forty-First AsilomarConference on Digital Object Identifier: 10.1109/ ACSSC.2007.4487641. Publication Year: 2007, Page(s): 2248 –2252.

[3] A. Itai, H. Yasukawa, "Footstep Recognition with Psyco-acoustics Parameter."Circuits and Systems, 2006.APCCAS 2006. IEEE Asia Pacific Conference on Digital Object Identifier: 10.1109/APCCAS.2006.342254. Publication Year: 2006, Page(s): 992 – 995.

[4] Y. Guo and M. Hazas, "Localising speech, footsteps and other sounds using resource-constrained devices." Information Processing in Sensor Networks (IPSN), 2011 10th International Conference on Publication Year: 2011, Page(s): 330 – 341.

[5] S. Schumer, "Analysis of human footsteps utilizing multi-axial seismic fusion". Acoustics, Speech and Signal Processing (ICASSP), 2011 IEEE International Conference on Digital Object Identifier: 10.1109/ICASSP. 2011. 5946499 Publication Year: 2011, Page(s): 697- 700

