IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Volume 11, PP 47-49

An RF Based Intruder Detection Using Radar System

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Abstract: *In Recent Years, Peoples Are Using Electromagnetic Theory For Exchanging Information In Free Space For Various Home & Defense Applications. From Mobiles To Health Monitoring Systems. Intruder Detection System Is A Type Of Security System & Object Detection System Using Radar System. Intruder Detection System Development Attracted The Researchers Mind Towards Radar System. As We Know The Nature Of Rf Of Deep Penetration The Vital Sign Detection System Includes Various Domain Of Application, Viz. Medical, Security, Etc. This Paper Presents Review Of Rf Based Intruder Detection Using Radar. In This Paper, Vital Sign Detection Techniques Are Presented.*
Keywords – *Radar System, Heartbeat, Intruder, Radar Receivers, Respiration Rate.*

I. Introduction

As We Know That In Today's Life There Are So Many Types Of Security Systems Are Available Depending On Our Needs. In Intruder Detection Systems We Are Using Various Types Of Alarms Having Advantage Of Easy Availability & Cost Effective Etc. These Systems Have Some Disadvantages, Such As Weather, Animal, Air, Machinery, Change In Physical Parameters Etc. The Discovery Of Radiation In Electromagnetic Waves In 1886, By Heinrich Hertz While Their Propagation, Which Was Used As Radar System During World War –II. Now A Days The Use Of Radar System Increases Rapidly, Now The Recent Area Of Research Is Human Vital Sign Detection System. By Using So The Drawback Of Different Physical Parameters & Weather Conditions Can Be Removed. This May Become Possible Only Due To The Deep Penetrating Nature Of RF Signals. We Can Use This Type Of System For Continuous Assessment Or Monitoring. This Paper Gives An Overview Of Human Vital Sign Detection System.Radar Detectors Have Been Around A Long Time, Nearly 40 Years, And For Much Of That Time The Best Radar Detector Was Considered To Be One That Was The Most Sensitive And Alerted To Police Radar From The Farthest Distance. A Lot Has Changed In Both The Radar Detector And Traffic Enforcement Industries And Today In 2017, The RF Landscape Has Significantly Deteriorated And Become Far More Challenging For A Radar Detector To Function Well. A Radar System Is Best If It Can Successfully Balance Two Opposing Dynamics: Filtering (Signal Rejection) And Sensitivity.

II. Radar Theory For Security System

As We Know That When Source & Observer Moves Relative To Each Other Then There Is A Change In Frequency. There Is An Inverse Relation Between Distance & Frequency, So As Distance Increases Frequency Decreases & Vice-Versa. This Inverse Relation Is Known As Doppler Effect Or Doppler Shift. Mike Valentine Used To Work With Cincinnati Microwave And Had A Hand In The Design Of Their Original Radar Detector, But Eventually Left The Company To Start His Own Radar Detector Manufacturing Business To Build The Most Uncompromising Radar Detectors. The V1 Radar Detector First Appeared In The Early 90s And His Small Cadre Of Highly Dedicated Engineers Produces Their First Radar Detector In The Early 90s And Their V1 Radar Detector Was Way Ahead Of Its Time. His Radar Detectors Were The Only Ones That Offered Both A Front And Rear Facing Radar Antennas, Provided Directional Arrows That Would Point To The Source Of The Radar Threat.

Valentine's Philosophy Then And Now Is That His Radar Detectors Will Be The Only Ones You Will Ever Have To Buy. He Does This By Offering A Continuous Upgrade Path, Both In Hardware When Needed And Firmware, For A Nominal Fee That Can Vary Based Upon The Amount Of Changes That Have Occurred Between Upgrades. One Notable Thing About The Valentine 1 Radar Detector Is That Valentine Research Has Retained The Same Pricing Over Its 27 Year Life-Span.

III. Requirement Of Intruder Detection System

Following Are Some Requirement Of Intruder Systems-
1 .Probability Of Detection Should Not Be Less Than 0.95 For Level A & 0.90 For Level B
2. Detect The Motion Of Human Intruder When Platform Is Stationary.
3. Nuisance & False Alarm Rate Should Not Be More Than One Per Platform Per Shift.

4. Capable Of Penetrating Smoke, Fog, Dust Etc.

IV. Intruder Detection System

The Primary Purpose Of Intruder Detection System Is To Detect The Presence Of Object & Also To Minimize The Nuisance & False Alarm Rate. When A Vehicle Is Patrolling In An Area The Intruder Regularly Stops & Detects The Presence Of Intruder. If Any Motion Is Detected Then A Track File Is Started That Describe The Threat If Any. The Vision & Radar System Sensor Are Bore-Sited Such That The Potential Threat Can Be Classified As Human Or Non- Human.

V. User Interface

The Distributed Processing Of MRHA Control Console Is Useful For Synchronizing The Operation Of Multiple Interior And Exterior Remote Platforms (I.E., Semi-Autonomous Robots). The System Is Designed To Run Automatically With Minimal Human Oversight. The Supervisor Display Provides High-Level Status Information For All The Platforms To The User With A "Big Picture" Of The Patrolling Platforms And The Secured Areas As Shown In Figure 4. User Intervention Is Required Only When A Platform Encounters An Exceptional Condition Such As A Security Breach. Site-Specific Prioritization Scheme Is Used To Rank Any Reported Exceptional Conditions. Operation Station Display Is Then Assigned The Proper Order & Then User Is Appraise To Situation & Appropriate Response Order. The One To One Human Control Of Associated Robotic Platform Is Provided By This Interface. It Also Provides Operational & Diagnostic Information Of The Relevant To The Situation.

VI. Radar For Intruder Detection

A Conventional Radar Systems Use Electromagnetic Energy Of 3-100 Gigahertz (Ghz) Range For A Variety Of Applications. High-Power Military And Commercial Radar Sensors Are Typically Combined With Sophisticated Signal Processing, Making Them Capable Of Excellent Range Accuracy And Target Discrimination. Microwave And Millimeter-Wave Radar Have The Ability To Sense Through Smoke, Dust, Fog, And Haze For An Intrusion Detection System In Surrounding Environments. Microwave Energy, Widely Used In Military Surveillance Radar, Navigational Equipment, And Tracking Systems, Nominally Spans The 3-30 Ghz Range, Ideal For Long-Distance Sensing Due To Longer Wavelengths. This Is Also Useful To Minimize Atmospheric Attenuation And Blocking By Precipitation And Other Adverse Weather Conditions. Disadvantages Of Microwave Systems Include Susceptibility To Specular Reflection, Backscatter, And Multipath Problems, Reduced Resolution When Compared To Millimeter Wave Radar, And Longer Wavelengths That Lead To Bulky Components And Large Antenna Sizes5. The Range Of Millimeter Wave Radar Is 30-300ghz. These Shorter Wavelengths Have Greater Atmospheric Attenuation And This Has Lesser Range Than Microwave –Based Systems. However, The Shorter Wavelengths Lead To More Accurate Range And Doppler Measurements, Lower Power Requirements, Smaller System Components, And Reduced Multipath And Backscattering Effects. In Addition, At Higher Frequencies The Effective Beam Widths Is Narrower. This Results In More Accurate Information About The Nature Of The Surrounding Targets.

VII. Microwave System

The Walking, Moving, Running Intruders Radar, RF Or Doppler Sensors Which Are Microwave Sensors, Are Useful In An Outdoor Environment. This Type Of Solution Provides High Probability Of Detection, Low Nuisance Alarm Rates And Resistance To Rain, Fog, Wind, Dust, Falling Snow And Temperature Extremes. Microwave Security

Systems Are Based On Volumetric Designs. The Microwave Sensor Provides A Semi-Conical Detection Area, Referred To As A Barrier Curtain, And Is Defined By The Volume Of The Area Protected. Microwave Security Systems Tend To Be Self-Contained Solutions That Stand Alone Or Can Be Integrated With Existing Facility And Perimeter Security Systems. Integration With Other Technologies Requires An Analysis Of Desired Alarm Response Criteria, And Security Testing And Monitoring Procedures Should Be A Part Of Designing The Solution. For Example, A Microwave System Reduces The Threat Of Trespass Into Long-Range, Open Field Areas. Microwave Technology Is Used To Complement Fence Perimeter Security Such As A Fiber Sensor Mounted To The Fence Or Buried In Gravel Inside Or Outside The Perimeter. Microwave Relays Can Be Tied Into New Or Pre-Existing Alarm Annunciation Equipment To Initiate Audible Alarms, Activation Of Flood Lights And Other Incident Response Measures. Microwave Integrated Solutions Can Also Support Local Guard And Patrol Services That Can Be Notified Through An Auto-Dialer Enabled By The Alarm Output Technology.

VIII. Monostatic Vs. Bi-Static Microwave Sensors

The Two Most Prevalent Volumetric Microwave Security System Designs Can Be Classified Into

Monostatic And Bi-Static System Designs, Where The Name Is Descriptive Of The Number Of Sensors Required For Operation. Mono-Static Designs Require A Single Transceiver Unit That Includes Both Transmitter (Tx) And Receiver (Rx) Elements. Mono-Static Units Typically Offer A Short Barrier Curtain, Less Than 50 M, Where Security Is Enhanced With A Wide The Area Of Coverage. These Units Are Ideal For Short Ranges Or Downward Looking Applications And Are Frequently Used To Monitor Unauthorized Access To Doors & Windows. Systems Can Be Expanded With Multiple Units To Add Protection Coverage To Several Areas. 7 Figure 1: Mono-Static Sensors Offer A Low-Cost Solution For Close-In, Microwave Barrier Curtains Less Than 50 M. Bi-Static Microwave Detection Systems Require Two Units, A Transmitter (Tx) And A Receiver (Rx) To Protect An Area. Bi-Static Systems Provide Long-Range "Invisible Fence" Coverage Where The Volumetric Barrier Is A Focused, Narrow Beam, Curtain For Open Area Intrusion Detection. The Bi-Static Designs Provide Asset Protection At Distances Ranging From 50 M To 500 M. Figure 2: Volumetric Microwave Barrier Curtains. Bi-Static Microwave Models Range From 50 M To 500 M. Modern Volumetric Microwave Detection Sensors Offer Leading-Edge Digital Technology For Accurate & Effective Wireless Intrusion Detection. Units Combine "Fuzzy" Digital Logic Technology That Provides Enhanced Detection Reliability By Analyzing The Received Microwave Signals. The Microwave Detection Sensor Offers Bi-State Operation, In Either X- Band Or K-Band Frequencies. K-Band Operation Offers Optimal Performance At Military Bases Or Commercial Airports With High Levels Of Background (RF) Radiation With Enhanced Immunity To RF Interference (RFI) That X- Band Cannot. 8 The Microprocessor Based Design Uses "Fuzzy" Logic To Create Behavior Models Based On Received Signals That Are Compared With Those Generated By A Potential Intruder. Some Digital Microwave Designs Also Provide Multi-Frequency Crystal Designs With Anti-Masking Capability To Prevent Tampering. These Advanced Units Are Immune To Temperature Changes With Microprocessor Controlled Environmental Adjustments. Figure 3: Examples Of Increasing Effective Coverage Using Multiple Bi-Static Barrier Zones

IX. Conclusion

The Concept Of Detecting Human Vital Signs Is Successfully Implemented By Reviewing RF Based Vital Sign Detection Using CW Doppler Radar. It Can Be Stated As Quadratuer Doppler Receiver Gives More Accurate Results Than Direct Conversion Receiver. The Drawbacks In Direct Conversion Receiver Such As, DC Offset Can Be Reduced By The Use Of Quadratuer Doppler Receiver. It Has The Scope Of Future Advancements In Various Domains For Industrial Approach Such As, Clutter Cancellation Techniques, Antenna Design With Frequency And Power Constraints, Effect On The Signal W.R.T. Body Movement, More Than One Human Are Present Etc.

Initial IDS Tests Conducted By Both RST, SPAWAR, And The Army Test Center, Aberdeen, MD, Have Been Quite Promising, With The System Able To Detect, Track, And Validate Human Intruders Out To 100 Meters With An Nearly Zero Nuisance Alarm Rate. The Radar System Has Performed Well In Measuring The Velocity And Distance To Targets And Detecting Target Motion, Both Radial And Tangential To The Radar Antenna. With This Demonstrated Sensitivity, It Is Possible Even To Detect Human Crawling In Tangential Fashion.

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