# FOUNDATION FOR ADVANCEMENT OF EDUCATION AND RESEARCH

# PANIMALAR INSTITUTE OF TECHNOLOGY

## DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

# UWB RADAR FOR SOIL QUALITY TESTING

## PROJECT REPORT

## FOR

## PROJECT PROPOSAL FOR
## FAER –McAfee SCHOLAR PROGRAMME
## SCHOLAR AWARDS - 2017 - 2018

From

Date: 14-05-2018

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Sub: Submission of Project Report Proposal – FAER –McAfee Scholar Programme – Awards – 2017-2018- reg

We are hereby submitting a Project Report for **project proposal for FAER- McAfee Scholar Programme 2017-2018- Awards** under the title **UWB RADAR for Soil Quality Testing.** The following are the list of students of B.E-Electronics and Communication Engineering doing the project.
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Kindly consider our Project Report for **project proposal for FAER- McAfee Scholar Programme 2017-2018- Awards**

Thanking you,

Yours faithfully,

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# UWB RADAR FOR SOIL QUALITY


## ABSTRACT

This project proposal presents soil quality testing for its nutrient content such as nitrogen, potassium and other minerals through an UltraWideBand (UWB) RADAR. A monostatic UWB radar module is applied to collect the reflected signals from subsurface of bare soil and sand with different volume water contents (VWCs). The statistical information lacks the ability to disclose the direct relation between the waveform and soil moisture. In this work, we try to model the problem as a time-series forecasting problem. The reflected signals are divided into training data and testing data. In agriculture, a soil test commonly refers to the analysis of a soil sample to determine nutrient content, composition, and other characteristics such as the acidity or pH level. A soil test can determine fertility, or the expected growth potential of the soil which indicates nutrient deficiencies, potential toxicities from excessive fertility and inhibitions from the presence of non-essential trace minerals. Agriculture being an important source of living for human mankind can be greatly benefited from this research paper whereby it uses a signal processing technique such as Dyadic Wavelet Transformation (DYWT) to process the digital image acquired through UWB RADAR where it sends an electromagnetic signal and captures the image from the signal. Through processing of the digital image the dyadic wavelet transform produces a resultant signal which is evaluated in terms of root mean square error (RMSE) analysis for a particular nutrient content such as nitrogen, potassium and other nutrients. The outcomes presented in this project proposal can be significantly used to plan cultivation of agricultural fields thereby preserving resources such as fertilizers, water and increase agricultural productivity for farmers. Issues of Problem of soil quality testing for assesment and analysis of nutrient content in the soil will be helpful for ploughing, sowing of seeds and cultivation of plants for Agriculture for our Indian farmers. Being a significant task the cost involved in soil testing through existing methods can be overcome by using low cost UWB RADAR which will be beneficial for farmers in planning and forecasting their agricultural fields. The problem surfacing plight and woes of farmers can be overcome using our proposed project.

# CHAPTER 1

# INTRODUCTION

## 1.1 SOIL GENERAL CHARACTERISTICS

Soil is a vital part of the natural environment. It is just as important as plants, animals, rocks, landforms, lochs and rivers. It influences the distribution of plant species and provides a habitat for a wide range of organisms.Nutrient cycling, water regulation, and other soil functions are normal processes occurring in all ecosystems. From these functions come many benefits to humans, such as food production, water quality, and flood control, which have value economically or in improved quality of life. Soil lets plants grow, allows gas exchanges to happen between the land and air, provides habitat for most of the organisms on Earth, holds and cleans water, recycles nutrients, and is used for constructing structures like buildings and roadbeds. Soil is recognized as one of the most valuable natural resource. Soils are considered as the integral part of the landscape and their characteristics are largely governed by the landforms on which they have developed Systematic study of soils provides in (P) and potassium (K). Most nutrients that plants need are readily available when the nutrient of the soil solution ranges from 6.0 to 7.5. Below a nutrient of 6.0 (acid): Some nutrients such as nitrogen, nutrients nutrientorus, and potassium are less available. Above a nutrient of 7.5 (very alkaline), Iron, manganese, and nutrients nutrientorus are less available. Wide range of soil colour; gray, black, white, red, brown and yellow is influenced by the content of organic matter, and due to the presence of water and oxidation state of iron and magnesium. Yellow or red soil indicates the presence of iron oxides. Dark brown or black colour in soil indicates that the soil has high organic matter content. Wet soil will appear darker than dry soil. Red and brown colours caused by oxidation. The presence of specific minerals can also affect soil colour. Manganese oxide causes a black colour, glauconitic makes the soil green, and calcite can make soil regions appear white.

Thus due to concentration of organic matters, presence of water and oxidation are influenced factors of nutrient and colour association. Colour is the byproduct of the spectrum of light, as it is reflected or absorbed, as received by the human eye and processed by the human brain. When light hits objects i.e. soil, water, vegetation some of the wavelengths are absorbed and some are reflected, depending on the materials characteristics. However, digital camera receives the light in the terms of blue green and red bands. Red, green and blue are fundamental colours which is arranged in bands 321 (RGB), denote the wave lengths of electromagnetic radiation in spectrum band 3 (0.63 - 0.69 μm), band 2 (0.52-0.60μm) and band 1 (0.45-0.52 μm) are distinctly represented by different wavelengths. Reflected energy (Blue, green and red) from the various materials which was captured by digital cameras is responsible for signature capture of the object. Soil colours charts were derived though digital camera is the part of visual perceptual property where digital values of red, green 9 and blue (RGB) provide a clue for spectral signature capture of nutrient in soil. Keeping above in view, the present investigation was conducted to determine the soil nutrient by using Dyadic wavelet transformation technique.

## 1.2 TYPES OF SOIL

### 1.2.1 LOAMY SOIL

Loamy soil is one of the riches soil types because of its composition. Loamy soil is composed of a mixture of clay, sand, silt, and decaying organic materials (humus). The soil has a pH level of 6 with high calcium content and the potential of retaining water and nutrients for relatively longer periods. This is what makes it one of the riches soils for crop production. The distinguishable composition of loamy soil may vary, but it can be made perfect with the right balance of additives. For instance, compost manure is usually added to loamy soil to improve the desired qualities which may be lacking. Loamy soil is dark in color and has a dry, soft, and crumby feel on the hands. It has good nutrient and water holding capacity. It also drains well and has pore spaces which enable air to freely move in between the soil particles down to the plant roots. Essentially, this is the characteristic making loamy soil the most ideal for plant growth and for that reason, the most preferred soil by gardeners.

### 1.2.2 CLAY SOIL

Clay is one of the many unique soil types due to its composition of a very fine-grains and plasticity when moist but hard when fired. The clay soil particles are tightly compressed together with no or very little air space.Because of this feature, clay persists as the heaviest and densest type of soil. Also, it is this characteristic that makes it to hold and retain large quantities of nutrients and water, and still making it very difficult for air and moisture to penetrate through it. So, to achieve successful gardening, one has to know the correct state and conditions of the soil.Wet clay is ordinarily difficult to garden with since it’s heavy but dry clay is smooth and soft and as such, easier to manage. Knowing these characteristics can surely help for gardeners especially in spring and autumn seasons when clay soil is dry. Compost or mulch can be added to the top soil every autumn season to avoid the freezing of the soil in winters. Compost or mulch makes the soil more ideal for planting by ensuring it has better drainage and air flow.

### 1.2.3 SILTY SOIL

Silty soil is composed of clay, mud, or small rocks deposited by a lake or river. It is made up of much smaller particles compared to sandy soil and when moistened it forms a soapy slick. For this reason, silty soil is extremely smooth and since it retains a lot of water, it is fairly fertile. Regardless of its good characteristics, silty soil is deficient of nutrients in comparison to other soil types.Because of the characteristic of silty soil, it can be easily compacted by the weight of heavy overlying materials. For this reason, if it is in your garden you should avoid walking on it which can lead to its compaction, which may require aeration. Silty soil is perfect for crop farming as the particles in silty soil are miniscule.

### 1.2.4 PEATY SOIL

Peaty soil is under normal circumstances dark brown but it can as well be black in color. Peaty soil has large quantities of organic material and is rich is water, which makes it one of the best soil types for plant growth. However, the soil needs to be drained first due to its high nutrient and water content.Because of its characteristic of high nutrient and water content, peaty soil is able to keep plants healthy even in dry weather and shields the plants from harm during rainy periods. The water content in peaty soil is to a small degree acidic but is ideal for controlling plant diseases and can be utilized to balance the pH level of other soil types.

### 1.2.5 SANDY SOIL

Sandy soils are pale yellowish to yellowish brown in color and are one of the poorest types of soil.Sandy soil is composed of loose coral or rock grain materials and has a dry and gritty touch. Sandy soil is also grouped as one of the soils composed of the largest particles which prevent it from retaining water. As such, sandy soils loose water content very fast which makes it very difficult for plant roots to establish. Thus, plants do not get the opportunity of using the nutrients and water in sandy soil more efficiently as they are speedily carried away by runoff. This is what makes sandy soil the poorest for supporting any kind of plant growth.

### 1.2.6 CHALKY SOIL

These are the types of soils found in limestone beds with deeply rooted chalk deposits. Chalky soils are extremely dry and are known to impede the germination of plants. They are composed of or containing or resembling calcium carbonate or calcite and characteristically have the color of chalk. Accordingly, chalky soil is entirely imperfect for crop farming or plant growth as it presents a lot of difficulties to work with. It has high lime content but low water content, which gives it a pH level of 7.5.This means the chalky soil is basic and it normally leads to yellow and stuntedplants.

# CHAPTER 2

**[1] UWB Radar for human being detection**

*AUTHORS*: **A.G.Yarovoy, L. P. Lightart, J. Matuzas, B. Levitaset**

This paper presents the UWB radar for detection and positioning of human beings in complex environment has been developed.UWB radar for detection and positioning of human beings in complex environment has been developed and manufactured. Novelty of the radar lies in its large operational bandwidth (11.7 GHz at -10 dB level) combined with high time stability.Detection of respiratory movement of a person in laboratory conditions has been demonstrated. Based on experimental results human being radar return has been analyzed in the frequency band from 1 GHz till 12 GHz. Novel principle of human being detection is considered and verified experimentally.

**[2] Through-wall imaging with UWB radar systems**

*AUTHOR:**I.M.***Aftanas**

This paper presents the through wall imaging is new, but very promising field for rescue and security applications. The signal processing techniques are required for future improvements. It is to obtain the target shape imaging and track it synchronously using triangle localization method and the difference of time delay in the application of through wall imaging (TWI). The proposed algorithm based on a system model built in the near field can effectively estimate the velocity and track of moving target with the imaging result. Simulation results show that the effect of the wall can be removed visibly and the purpose of the imaging and tracking of moving target can be realized well.

**[3]Micro-Doppler character analysis of moving objects using through Radar based on improved EEMD**

*AUTHORS:* **H.R.Wang, R. Narayanan, Z. O. Zhou, T. J. Li, L. J. Kong**

This paper presents the micro Doppler signals of human's heartbeat, breathe and arm moving using through wall radar are non linear and non stationary which can be analyzed. In homeland security and law enforcement situations, it is often required to remotely detect human targets obscured by walls and barriers. In particular, it can specifically interested in scenarios that involve a human whose torso is stationary. In proposed system a technique to detect and characterize activity associated with a stationary human in through-the –wall scenarios using a Doppler radar system. The presence of stationary humans is identified by detecting Doppler signatures resulting from breathing, and movement of the human arm and wrist. The irregular, transient, non-uniform, and non-stationary nature of human activity presents a number of challenges in extracting and classifying Doppler signatures from the signal. These are addressed using bio-mechanical human arm movement models and the empirical mode decomposition (EMD) algorithm for Doppler feature extraction. Experimental results demonstrate the effectiveness of our approach to extract Doppler signatures corresponding to human activity through walls using a 750-MHz Doppler radar system.

**[4] Reconstruction of GPR signals by spectral analysis of the SVD Components of the data matrix.**

*AUTHORS:* **F.Y Nan, S.Y. Zhou, Y. N. Wang, F. H. Li, W. F .Wang**

This paper presents the problem of reconstructing total-time responses from noisy data collected by ground-penetrating radar (GPR). The well-known singularity expansion method (SEM) - a theory - for late-time response representation is generalized to establish a matrix model (data matrix) representing total-time responses of radar scattering waveforms. Using singular value decomposition of the data matrix - an intermediate processing technique, it present an approach to model-order determination and successfully reconstruct the total-time responses. The model order is quantitatively selected by spectral analysis of left singular vectors of the data matrix and of the emitted waveform. The most important discoveries in this letter are as follows: (1) the GPR upper frequency can be used as a criterion for the selection of left singular vectors of the data matrix, and (2) the left singular vectors of the data matrix, which should not be neglected, tend to be predominantly low-pass functions and also provide valuable information for model-order determination.

**[5] Through wall detection of human being's movement by UWB radar.** *AUTHOR:* **J.Li, Z. F. Zeng, J. G. Sun, F. S. Liu**

This paper presents the Ultra wideband (UWB) radar technology has emerged as one of the preferred choices for through-wall detection due to its high range resolution and good penetration. The resolution is a result of high bandwidth of UWB radar and helpful for better separation of multiple targets in complex environment. Detection of human targets through a wall is interesting in many applications. One significant characteristic of human is the periodic motion, such as breathing and limb movement. In this letter, applying the UWB radar system in through-wall human detection and present the methods based on fast Fourier transform and S transform to detect and identify the human's life characteristic. In particular, it can extract the center frequencies of life signals and locate the position of human targets from experimental data with high accuracy. Compared with other research studies in through-wall detection, this letter is concentrated in the processing and identifying of the life signal under strong clutter It has a high signal-to-noise ratio and simpler to implement in complex environment detection. It can use the method to search and locate the survivor trapped under the building debris during earthquake, explosure or fire.

# CHAPTER 3

# EXISTING SYSTEM

Traditional method of estimating the soil quality with the traditional biochemical methods, and more specifically estimating those elements that are essential components for the soil fertility,[6] is a difficult, time-consuming, and expensive process, which is however, necessary for selecting and applying any management practice to land ecosystems [7]. Properties of the soil surface can also be done by using field measurements as presented in the literature of [8]. Ground Penetration Radar (GPR) based imaging analysis can provide very good results for a specific region of coverage which can aid in agricultural cultivation[9]. Hydrogeology is another allied area of research which provides investigations relating to geological areas and also the amount of water content available in the specific area and for this Ground Penetrating Radar(GPR) can be very much helpful [10]. 3D architecture of soil analysis is given in literature work of [11]. In the research work of [12] Ground Penetration Radar is generally based on the operating principles of refraction where an electromagnetic signal or a wave travels from one medium and gets refracted from the surface and the refracted wave can provide significant results for nutrient content of the soil [13]. GPR can provide 3D analysis of specific data acquired from the RADAR which are target specific attributes [14]and this can provide application oriented development for archaeology in a concrete structure. GPR prospects can also provide data analysis in a region for remote geographical analysis relating to soil[15].A number of research work s presented from [6]-[15] have dealt with soil analysis using ground penetrating radar.

Generally three experiments are conducted to measure the ability of ground-penetrating radar (GPR) to non-invasively determine water content while simultaneously resolving depth to wetting fronts, buried objects, and stratigranutrientic boundaries during dynamic hydrologic conditions. This is particularly appealing as GPR can provide dense spatial coverage for vadose zone characterization where traditional invasive measurements are costly, destructive, and time-consuming. The vadose zone was replicated using a tank filled with 1) homogeneous river sand, 2) homogeneous river sand with an embedded land mine surrogate, and 3) homogeneous river sand with an embedded layer of silica flour. These systems were subjected to controlled irrigation events and monitored with GPR using automated time-lapse wide-angle reflection refraction (WARR) surveying. The unique form of data collection allowed the data to be conceptualized into a 3D data cube, providing multi-offset projections to extract wave velocities for depth and average water content measurements and transient common-offset projections to observe changes in amplitude and travel time of arrivals over time associated with the fluctuations in average water content of the tank. Average water content estimates from ground-penetrating radar were similar to in-situ capacitance probe measurements for the homogeneous tank experiment. Radar estimates of depth to wetting front and bottom of the tank, however, were found to have some issues associated with wave interference, causing errors in the range of 1-25%, with the largest errors occurring at times of infiltration. It was concluded that GPR has potential, through transient multi-offset imaging of the subsurface, to greatly improve vadose zone characterization by imaging the subsurface, quantifying water content, and tracking wetting fronts as they move through the media.The layered experiment revealed that the silica flour greatly inhibits vertical flow of water causing significant changes in the GPR response through time when compared to a similar homogeneous experiment. At initial conditions, the radar data resembled that of a single layer system; however, as the water content increased, reflections and multiples from the upper layer dominated the image, degrading the interpretation of the system and clearly illustrating that interpretation of GPR data can be affected by the hydrologic state of the subsurface. The land mine experiment showed that the unsaturated flow of water was not affected by the land mine and closely resembled the hydrologic response of the homogeneous tank. While the land mine signal was unclear on the GPR data, differences in amplitude vs. offset relationships between groundwave arrivals for the land mine and homogeneous tank indicate that significant changes in amplitude occur which may assist present methods for landmine identification. The data also showed that high water content values, such as after a rainfall event, provide a more favorable environment for landmine identification, as the groundwave is highly attenuated, reducing wave interference. While valuable data was collected, WARR surveying of the land mine may be secondary to common offset or common mid-point surveying as the land mine was not clearly visible on the WARR data, however, more robust signal processing of WARR data may also improve data interpretation. In conclusion, these experiments have illustrated that more reliable images, water content estimates, and overall characterization of the subsurface will be attained by the transient monitoring of the subsurface with surface based GPR for variable hydrologic conditions.

### 3.1 DRAWBACKS OF THE EXISTING SYSTEM

- In the medical field, for many situations, it is essential that a subject’s respiration and heartbeat be monitored.

- The primary tool used for monitoring heartbeat is the voltage-derivedelectrocardiogram (ECG). Electrical signals cause the heart muscle to contract. These signals pass through the body and can be measured by electrodes (electrical contacts) attached to the skin.

# CHAPTER 4

# PROPOSED SYSTEM

Ultrawideband refers to transmitting and receiving information signal as impulse signals of the order of nanoseconds where its operating frequency ranges is from 3.1 GHz to 10.6 GHz [1] and [2]. These ultrawideband pulses/signals are robust to interference and hence mitigates multipath fading when sent in as pulse signals or signals transmitted using multiband orthogonal frequency division multiplexing (OFDM) [3] signals. Ultrawideband [4] communication due to is aforementioned advantages when applied to Radio Detection and Ranging (RADAR) can provide good improvements in any application field. Application of RADAR signals penetrating into the ground for detection on and above the earth contents has become attention for earthing studies [5] and [6].

The proposed system for assessing soil minerals is shown in block diagram in Fig.4.1. The soil under test is considered and the UWB RADAR sends out electromagnetic signal in the form of Ultrawideband signal and it reaches back the RADAR where by its image is captured using the camera housed on it. The UWB RADAR operates by ultrawideband principles which detects objects exhibiting motion using Doppler principles. The RADAR does not contact the object under test for analysis which is insensitive to changes in temperature, humidity, noise, airflow, smog and sunlight. The UWB RADAR operates at a frequency of 10.5 GHz, output power namely effective isotropic radiated power (EIRP) of 13dBm(1 decibel with respect to 1 milliWatt) and voltage of 5V.

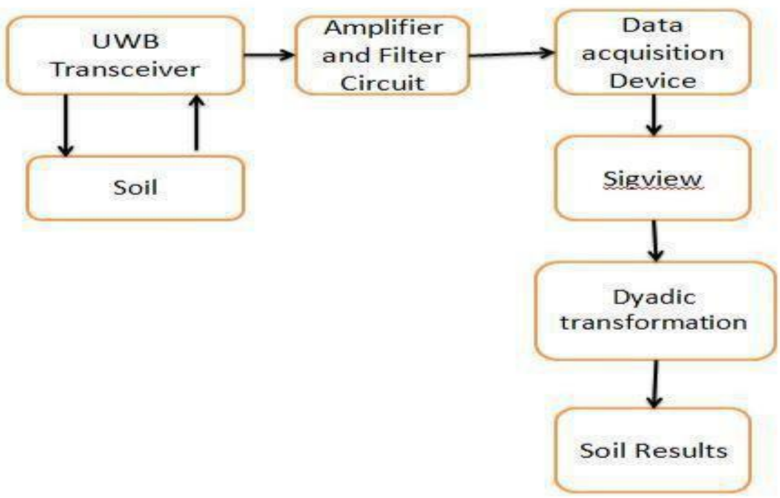


Fig.4.1 Proposed System UWB RADAR

The RADAR received signal is processed for noise, through a low pass filter and passed into the amplifier circuitry for maintaining proper resolution of the RGB signal content. Fig.4.2 shows a low pass RC filter used for filtering unwanted noise components which is embedded in board of the UWB RADAR and it is capable of filtering high frequency range signals.

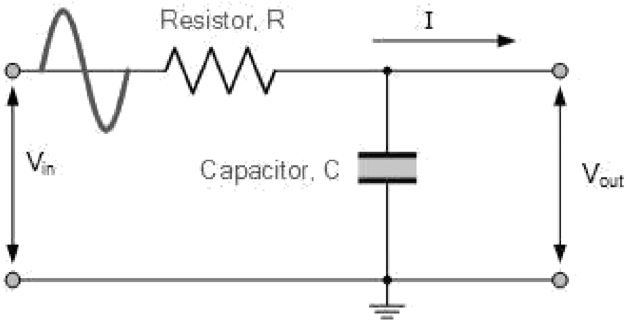


Fig.4.2 Low Pass Filter

The image signal is passed into a data acquisition device where image signal is maintained for its resolution and sent into sigview software processing where it provides a wide range of spectral analysis for 2D and 3D analysis as shown. in the block diagram of Fig.4.1, The resultant signals are passed into Dyadic Wavelet Transformation (DYWT) for obtaining the mineral content of the soil such as nitrogen, potassium, urea and contents relevant in the soil. Artificial Neural Networks though not presented in the block schematic of the proposed system is used to train the network for soil types for example sandy soil and it can be tested for recovering the mineral content as an additional segment for enhancing the research value of the paper. Finally from the obtained results the mineral contents can be assessed. On the whole, the proposed system will determine the characteristics relevant to the soil quality by processing of soil section of RADAR signals[15] and perform extraction of suitable visual features using Dyadic Wavelet Transformation (DYWT). DYWT when applied on the recorded signal the selective features of the soil can be extracted which can then be used to deduce the minerals present in it. Table 1 shows the minearals content level in the soil

**Table 1. Minerals content level in soil**

| **Minerals** | **Low(kg/ha)** | **Medium(kg/ha)** | **High(kg/ha)** |
|---|---|---|---|
| Nitrogen | lower than 280 | 280-560 | above 560 |
| Phosphorus | lower than 10 | 10-24.6 | above 24.6 |
| Potassium (K) | lower than 108 | 108-280 | above 280 |

**DYADIC WAVELET TRANSFORMATION**

This section presents the procedure to mathematically determine the dyadic wavelet transformation for obtaining the mineral contents of the soil. Dyadic wavelet transformation is a method which is used for soil feature detection. Dyadic transformation has multi-resolution capability which refers to that it can dilate (or) squeeze (or) expand and translate the basis function. Mother wavelet used in DYWT is different and can provide better results when cubic spine function is used. Better results can be provided when compared to functions such as Haar, Gaussian and minimum phase functions.

Initially consider a mother wavelet and then dilate by a factor of 2 which refers to lowering the values. Afterwards convolve the mother wavelet in addition with the dyadic dilated versions to produce a sequence of functions which represents the Dyadic Wavelet Transformation (DTWT).

Let $\psi$ denote the mother wavelet which is a function with zero mean. The dyadic dilation at level $j$ is given by

$$\psi_{2^j}(x)=\frac{1}{2^j}\psi\left(\frac{x}{2^j}\right). \tag{1}$$

The wavelet transform of $f(x)$ at the dyadic scale $j$ and at the location $x$ is defined to be

$$W_{2^j} f(x)= f * \psi_{2^j}(x)=\int f(t)\cdot \psi_{2^j}(x-t)dt. \tag{2}$$

The Dyadic wavelet transformation is then the sequence of functions $\mathbf{W}_f = \left(W_{2^j} f(x)\right)_{j\in Z}$ and $\mathbf{w}$ is the dyadic wavelet transformation operator. Further, the Fourier transform of $W_{2^j} f(x)$ is denoted as $\hat{W}_{2^j} f(x)$. Then, its estimated value is $\hat{W}_{2^j} f(x)=\hat{f}(\omega)\hat{\psi}\left(2^j\omega\right)$.

Also, if there exist positive constants $A_1$ and $B_1$ such that for all values of $\forall\omega\in\mathbf{R}$

$$A_1 \le \sum_{j=-\infty}^{+\infty}\left|\hat{\psi}\left(2^j\omega\right)\right|^2 \le B_1 \tag{3}$$

then the whole frequency axis is covered by dilations of $\hat{\psi}(\omega)$ by $\left(2^j\right)_{j\in Z}$ so that $f(x)$ can be recovered from its dyadic wavelet transformation. The reconstruction wavelet is a function $\chi(x)$ whose Fourier transform satisfies the property mathematically expressed by

$$\sum_{j=-\infty}^{+\infty}\hat{\psi}\left(2^j\omega\right)\hat{\chi}\left(2^j\omega\right)=1 \tag{4}$$

The function $f(x)$ is recovered from its dyadic wavelet transform with the infinite summation which is given as

$$f(x)=\sum_{j=-\infty}^{+\infty} W_{2^j} f * \chi_{2^j}(\omega) \tag{5}$$

Similarly the reconstruction formula can also be represented for any sequence as $\left(g_j(x)\right)_{j\in Z}$ with $g_j(x)\in L^2(R)$ is not necessarily the dyadic wavelet transform of some function in $L^2(R)$. The inverse dyadic wavelet transform operator is denoted by $\mathbf{W}^{-1}$ and it is defined as

$$\mathbf{W}^{-1}\left(g_j(x)\right)_{j\in Z}=\sum_{j=-\infty}^{+\infty} g_j * \chi_{2^j}(\omega). \tag{6}$$

The reconstruction formula given in (6) implies that $\left(g_j(x)\right)_{j\in Z}$ is the dyadic wavelet transform of some function in $L^2(R)$ if and only if it satisfies the condition

$$\mathbf{W}\left(\mathbf{W}^{-1}(g_l(x))_{l\in Z}\right)=\left(g_j(x)\right)_{j\in Z}. \tag{7}$$

whereas the condition for sequence of $L^2(R)$ functions is found to be dyadic wavelet transformation of $L^2(R)$ function. The output of the dyadic wavelet transformation can be given as input the Artificial Neural Networks (ANN) which is presented in the simulation section of this work for proper minerals assessment.

### 4.1 ADVANTAGES OF PROPOSED SYSTEM

- Using Data Mining the data's are stored in the data bases for future use.
- Time can be consumed using UWB radar technology.

# CHAPTER 5

## 5.1 MODELING AND IMPLEMENTATION

The block diagram portrays a UWB RADAR which takes signal information from the soil under test and passes it into a amplifier circuit and Instrumentation Amplifier along with its accessories. The DATA Acquisition device takes the signal and sends RGB multispectra image into sigview with Dyadic Wavelet Transformation (DWT) and provides the results from which the nutrient contents of the soil are proposed to be assesed. The modeling part in the project proposal involves interfacing a UWB RADAR with an Instrumentation Amplifier and Data Acquisition System. The captured signal in the system intends to capture the digital image and processing is done by signal processing technique using Dyadic Wavelet Transformation (DWT).

**T**he prototype involves very less hardware components and does not require time consuming process to take digital images and process the digital images for obtaining the mineral content prevalent in the soil. Testing will be done for different types of soil, and programming part will be done in Matrix Laboratory (MATLAB) using Dyadic Wavelet Transformation. The soil types can be sandy soil, Alluvial soil, Brackish soil and does not incur large budget. Fig. 5.1, Implementation scenario of UWB RADAR for Soil Quality Testing.

## 5.2 REQUIREMENTS

### HARDWARE REQUIREMENTS:

1. UWB RADAR
2. INSTRUMENTATION AMPLIFIER
3. SIGNAL CONDITIONER
4. POWER SUPPLY
5. TRANSFORMER

### SOFTWARE REQUIREMENTS:

1. SIGVIEW
2. MATLAB 2017

## 5.3 UWB RADAR

Description: This is a Microwave moving object detector which is designed by Doppler Radar principle.The features of the UWB RADAR are such as non-contact detection

- Independent of temperature, humidity, noise, airflow, dust, light, etc., suitable for the harsh environment; Strong resistance to RF interference.
- The output power is small, and did not constitute a hazard to the human body;

Long-distance: the detection range of more than 20 meters .
A transmitting frequency: 10.525 GHz
Frequency setting accuracy: 3MHz
Output power (minimum): 13dBm EIRP

Operating voltage: 5V 0.25V
Operating Current (CW): 60mA max., 37mA typical
Harmonic emission: <-10dBm Pulse
operating modes:
Pulse width (Min.): 5uSec
Duty cycle (Min.): 1% Receive:
Sensitivity (10dB S / N ratio) 3Hz to 80Hz bandwidth: -86dBm 3Hz to 80Hz bandwidth clutter 10uV Antenna Gain: 8dBi

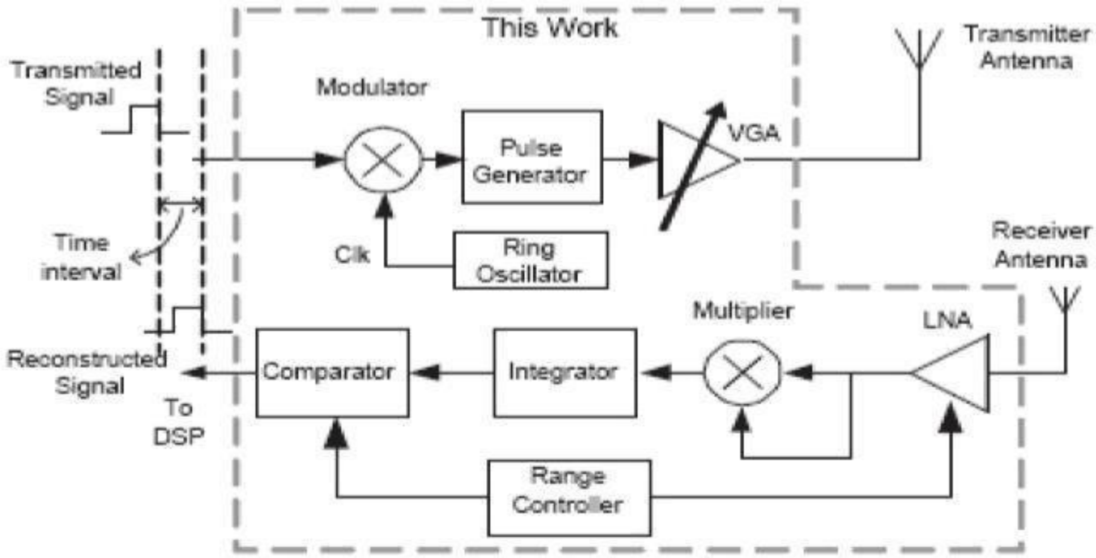


Fig 5.2 Architecture of the UWB radar transceiver

When designing a UWB radar transceiver system, two design aspects need to be considered: architecture and implementation. Different architecture set the fundamental performance capabilities of the design, and good implementation choices improves radar performances. Impulse radar detection range depends on radiated energy, transmitter and receiver design, target size, and signal processing. Among various UWB transceiver architectures, the impulse-based energy detection UWB transceiver architecture is discussed here.

An example of the impulse-based energy detection transceiver architecture. In this architecture, the transmitter sends a pulse train toward the target. The interface between two medias produces a partial reflection. Then the receiver detects and samples this particular type of reflected pulse train, and the decision circuit makes The final decision pulses are diffracted and scattered by different tissue layers and organs in human body.Channel distortion and power loss easily destructs the reflected pulses and make them undistinguishable. The rang-gate is designed to look for the destined reflected pulse rather than wait and receive every reflected pulse from every location and try to identify the expected return pulse, which in many cases are very week and tangled with other return pulses. The receiver samples only the pulses arriving at the receiver during a very narrow time window after pulse transmission. By estimating the distance of the expected target, a delay time is chosen.This proposed transceiver architecture enormously reduces the circuitry complexity and power consumption. The transmitter consists of a modulator, a pulse generator, and a variable gain amplifier (VGA) driver. An on-off keying (OOK) modulation scheme is used to modulate the pulse. The VGA and driver are used to amplify output and match output impedance. The receiver consists of a low noise amplifier (LNA), a correlator, an integrator, a clocked voltage comparator, and a delay controller. The input clock train and control signal are modulated to a sequence of clock pulse, which then enters the pulse generator to produce a pulse train. This pulse train is passed onto a driver amplifier and then to an UWB antenna. The reflected pulse is caught by the antenna in the non-coherent receiver and amplified by a LNA. The signal then is squared by a multiplier at the asynchronous receiver. The squared output is then fed into an integrator and clocked comparator to boost up the voltage and reconstruct the signals. The range controller uses logic gates to switch on/off the LNA and disable the sampling operation of the comparator for range finding.

**BUDGET/MODULE FOR UWB RADAR FOR SOIL QUALITY TESTING**

| | |
|---|---|
| UWB RADAR | – Rs. 7,500 |
| INSTRUMENTATION AMPLIFIER | – Rs. 1,000 |
| POWER SUPPLIES | – RS. 3,500 |
| TOTAL BUDGET | – RS.12,000 |

**SIMULATION RESULTS**

In this section, Mean Square Error (MSE) performance of detecting the nutrient content in the signal is observed after dyadic wavelet transformation. The signal values from the image are given as input to the Artificial Neural Networks (ANN) and the target is set and it is tested to get the accuracy of the mean square error for the tested soil type which is presented in the first plot of Fig.5.3. In Fig 5.3, in the second plot for sample index values ranging from 0 to 300 the peak value arises at sample index starting at 50 and above which refers that 50 represents the nitrogen content level in the soil under test which is a sandy soil. The corresponding mean square value, normalized mean square value, standard deviation are also given for nitrogen nutrient content. In the third plot for Fig.5.3, the amount of nitrogen content level in the soil and here it exceeds above 100 which is absolute value taken from the value signal level of the image. The soil under test confirms the presence of nitrogen content in the soil.

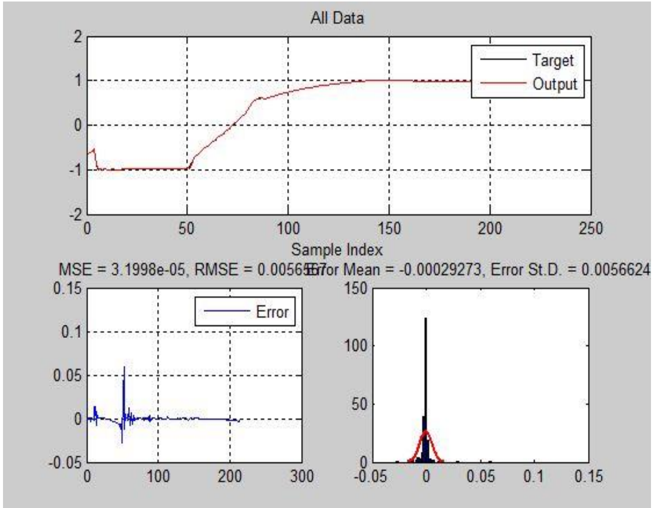


**Fig.5.3, Soil Minerals Assesment of Nitrogent content**

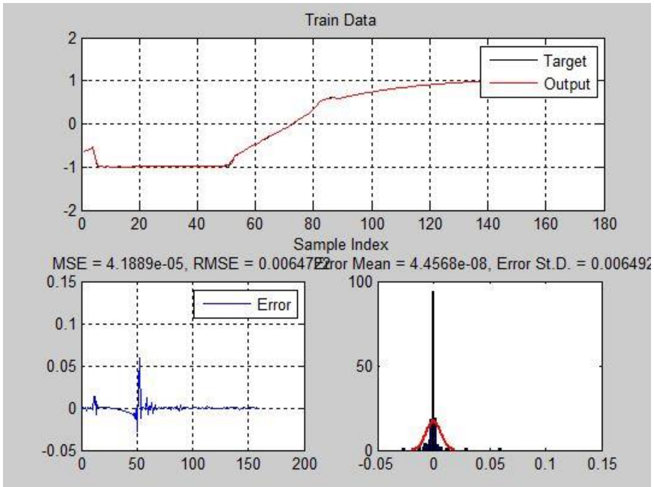


**Fig.5.4, Soil Minerals Assesment of Pottasium content**

In Fig.5.3, Mean Square Error (MSE) performance of detecting the nutrient content in the signal is observed after dyadic wavelet transformation. Similar to Fig.5.3, Fig 5.4 is analyzed in the same manner where the target output is also met for the sandy soil as the trained data. The sample index at 50 the error goes to a peak value which indicates the presence of a nutrient content in the soil presented in the second plot of Fig.5.3. In the third plot of Fig.5.4 it shows the amount of nutrient content in the soil which exceeds a value above 90 which indicates the presence of potassium content in the soil. Thus amount of soil minerals assessment is given in this section for nitrogen and potassium.

## CONCLUSION

This project proposal is that it determines the nutrient content level in the soil under test using UWB RADAR. Signal processing technique of dyadic wavelet transformation is applied to the captured image from the RADAR and it is tested using Artificial Neural Networks for the trained image and tested image based on which the amount of nutrient level such as nitrogen and potassium are determined. This sort of soil quality testing is quite efficient in comparison to existing lab testing methods and it can lead to increase in agricultural yield for cultivation thereby preserving natural resources to a greater extent.

## PROS OF THE UWB RADAR FOR SOIL QUALITY TESTING

- Low cost UWB RADAR is a hand held device and unique of its kind in soil quality testing.
- A signal processing technique such as a Dyadic Wavelet Transformation Technique is used for processing the Images captured using Digital Camera in the Data Acquisition System.
- Dyadic Wavelet Transformation technique provides highly efficient use of image analysis and provides a range for the given nutrient index for a corresponding type of soil.
- Amount of mineral content in the soil can be determined using the proposed UWB RADAR.

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