International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

Identification of Plants Content by Infrared Reflection Process Using Patch Antenna

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Abstract: ***This paper presents exploiting of infrared radiation as often used inremote sensing images. A good understanding of the pathway of the radiation through plants especially the mint is necessary for a good explanation of reflection and transmission processes. The studies on this subject, are basing on how to benefit from plants content to use it in medicine.We observe also the effect of antenna to ensure stable reflected signal that permitsto discriminate plants by determine their composition. The transmission through leaves depends on directivity so we implement adequate antenna to boost reflected signal. Especially that infrared radiationsare characterized by high frequency so weak penetration. Moreover, the plant is like a film having the role of filter as result the difference of influence on the leaves describes the health quality of a given a plant to expect adequate use.***

Keywords: Plants, Infrared Radiation, Antenna, Optical Reflectance

1. Introduction

Different surfaces reflect electromagnetic wavessuch as the leaves of plants. Moreover, some plants reflect electromagnetic spectrum more intenselythan others. Indeed, the green vegetation absorbs blue and red light whereas itreflects green and especially infrared radiation.Sure, the differencein reflection and absorption is due to intrinsic characteristics depending on their content and health quality.Often the plant structures are composed of many primary elements for examples proteins, lipids, and other compounds [1]. These biomolecules with different structural units such diversity canbe between distinct types of tissues and cellular structures. According to this complexity we should get wide background on biomolecules as composites of organs, tissues and cells to master applied plant sciences.In this work, we study the ability of plants to interact with infrared referring to their content. Theinfrared radiation (IR) is used in a various fields thank to its usefulness either quantitative or qualitative analysis [2, 3]. However, using IR emitter alone is unable to recover distribution information ofthe sample's chemical composition. Therefore, it is difficult to determine whether the componentsof interest are within sample. From that, we implement patch antenna to improve directivity and expect the nature of elements in tissues with accepted approximation.In fact when we consider the heterogeneity of plant structures, the dataobtained are limited.We focus in this work on how to discriminate the contents of plants as analysis about distribution of plant constituents [4,5].Indeed, using infrared radiations is anon-destructive method by maintaining native compositions of plant samples without the need of extraction or separation. Referring to literature the IR micro spectroscopy has a variety of imaging methodologies including Raman microspectroscopy, fluorescence imaging, and laser imaging that are also alternatives to analyze plant structures [3]. Thus, we can exploit more plant content in scientific research related to chemical and physical properties of tissues as we study in our case the mint to propose medical uses in our future work.Various factors should be taken in consideration like temperature, water, andnutrients. Many reports have appeared in the literature about this topic [4,6–14].The IR region in electromagnetic spectrum is characterized by different length wave [15,16]. Physical basis anddevelopmentof IR spectroscopy can be found in [3, 15, 17–20]. We have taken the choice about IR as we find it very suitable method for analysis especially for heterogeneous plant samples due their distribution and chemical composition of the components [21, 22].When more elements are involved, bonds can also bend [23,24].Typically the mid-IR spectra represent numerousabsorbance peaks due to fundamental transitions due content of each plant on minerals ions. Above that detection may adopt X-ray [25], light [26] and exploiting of Telescope. It is awesome to discover a wide family of minerals [27] as it constitutes the core of smart and newer technology that is applied in many fields such as food industry and medicine. To establish the process of detection and discrimination we should have a huge knowledge about materials properties [28]. For sample the reflection coefficient is very important [29] to increase selectivity. Refer to literature [30] emission and reflection of electromagnetic wave permit to determine nature of mineral.By accurate analysis of measurement data we get appropriate identification [31], we notice that the quality of process depends on the principle of detection [32] and the quality of used instruments. Finally, the study of plant content is like semiconductor composition by taking process of doping in consideration [33].

2. Experimental Dispositif

The infrared radiation is a portion of radiation spectrum. However, the goal is to study howobjects reflect, transmit, and absorb the infrared and observe healthof vegetation and composition. Thus, the goal is how we can benefit from the plants constituents' to heal diseases. As reflection our eyes perceive the green because wavelengths in the green region of thespectrum are reflected by pigments in the leaf of plant, while the visible wavelengths areabsorbed. So the principle is that when we change the components in plants at result we make influence on the reflection and transmission .Thereon, the absorbanceis a part of the photosynthesis process. The plants are very important for human protection by reflecting radiations back into the atmosphere. The healthy plants reflect more nearinfrared or short wavelength infraredthan visible. So healthyplants look more infrared. When a plant becomes unhealthy, it reflects more of the visible red light andless of the invisible infrared. From that, we should take on consideration many factors such as dryness andspecific minerals existence.

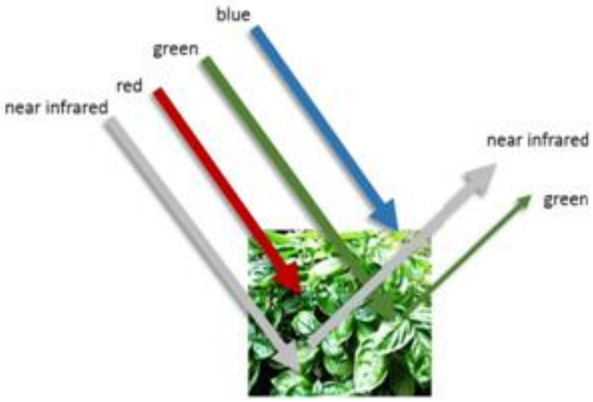

Figure 1: Plant reflection illustration

The infrared are characterized by their high frequency. However, we boost our system by appropriate antenna as shown in the figure below to reinforce reception of reflected signal to make analysis of plant composition.

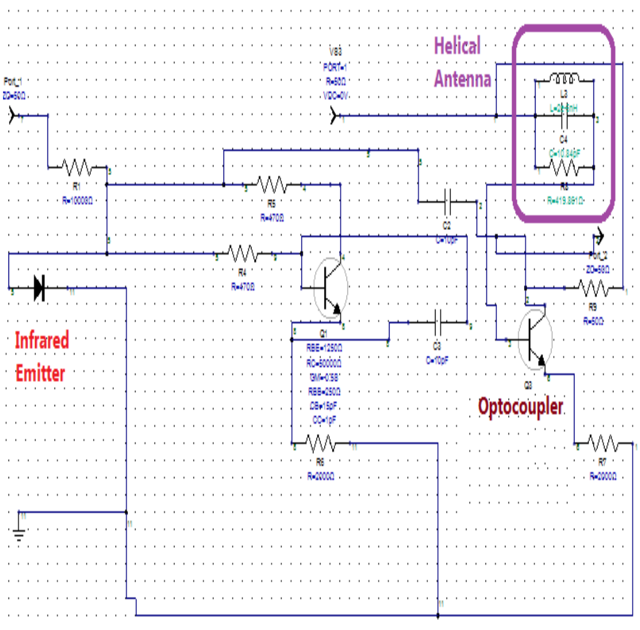

Figure 2: IR emitter and receiver circuit

The developed device contains emitter and receiver of infrared. Above we implement some transistors to amplify and get suitable signal to analyze. Theantenna is connected in the circuit to ameliorate received wave directivity. The acquisition is established by digital oscilloscope and Arduino board to measure reflected voltage relies to the doping specimen in the mint which is our studied plant. Thereon the difference of absorbance and reflectance is due to the effect of elements that we have used to dope our plant. Physically the ingredients within have impact on plant look as we can illustrate by photos in the figure.

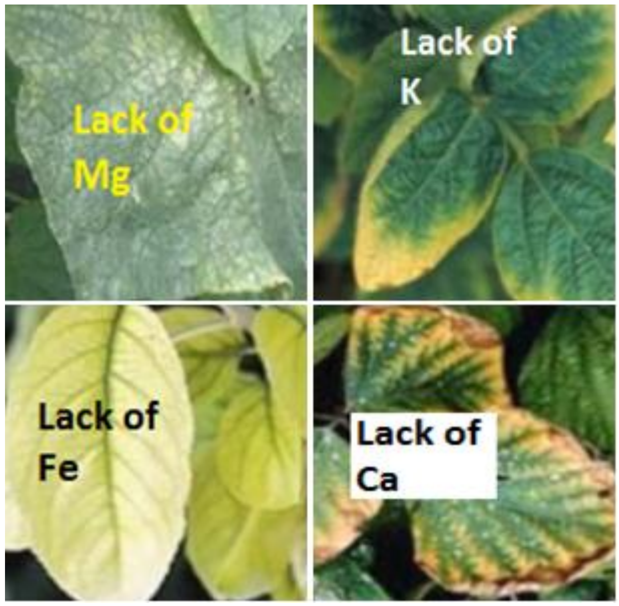

Figure 3: Symptoms of minerals lackage in the plant

We confirm that composition of a plant has impact on its health quality and infrared reflection. This work follows appropriate measurements that based on important interconnections that are given by these equations.

$$U=U_o.\exp(-\alpha.d)\quad(1)$$

$$\alpha= -\ Ln\ (U/Uo)/d\quad(2)$$

$$r=(1-\alpha^2)^{1/2}\quad(3)$$

Where:

U: Reflected voltage (V).
Uo: Feed voltage (V).
d: Infrared transmission distance (cm).
r: Reflectance of plant.
α: Plantabsorbance (cm^{-1}).

Each plant behaves with infrared by specialmechanism based on its content. As we use laser beam to destruct some tumors this work has outlook to benefit from plants content to ensure adequate healing by providing infected area by some elements.The emission of radiation is influenced by many perturbations such as temperature, external light and ambient pressure. Thereon, the manipulation should be rigorous as possible. Besides, the studied samples should respect the same durations of doping and attacked by infrared under the same temperature to optimize results. The conception required infrared emitter source and photodiode sensor to receive the reflected signal that we analyze by digital oscilloscope, Arduino board and others software's interfaces for parameters calculationand curves representations to make identification. In summary, we give here an illustrative photo of the built system:

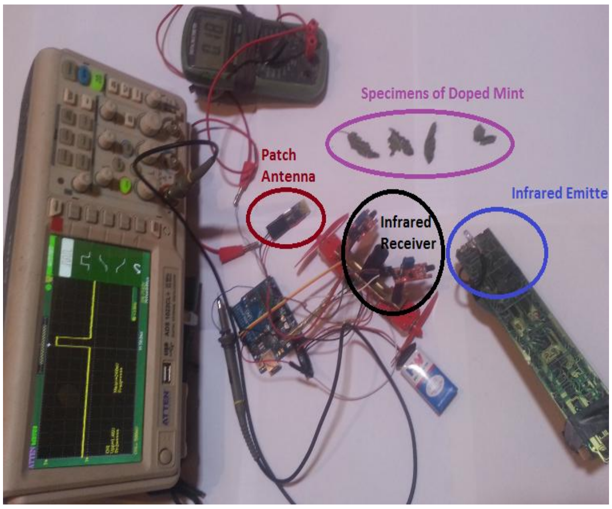

Figure 4: Detector fabrication

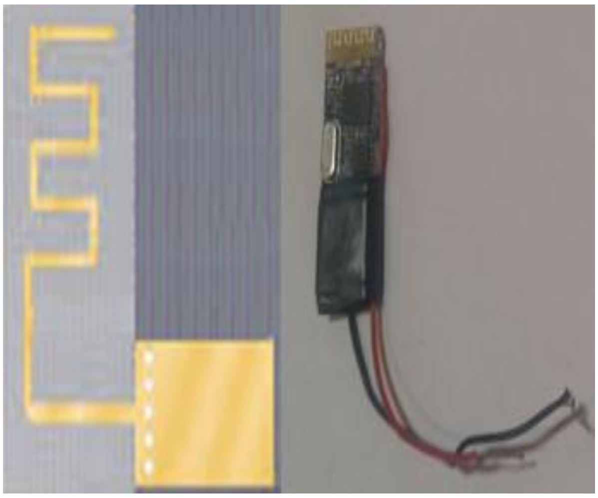

Figure 5: Integrated Patch antenna

3. Results and Discussions

The system presents innovationof exploiting infrared radiation boosted by patch antenna. The goal is to use electromagnetic wave to discriminate plants content. Above that, we inspire from their composition for uses in medicine. The harvest measurements on doped specimens are given in the following table for a distance d=1cm between the specimen and infrared emitter.

Table 1: Doped Mint measurements

Mint doped	U(V)	U'(V)	$\alpha(cm^{-1})$	r(%)
Al^{3+}	2.6	3.08	0.16	99
Cu^{2+}	2.43	2.96	0.39	92
Na^{+}	2.17	2.68	0.51	86
F^{-}	1.93	2.41	0.62	78

Table 2: Doped Mint measurements

Doped Mint	$\alpha'(cm^{-1})$	r'(%)	ε_α	ε_r
Al^{3+}	0.16	99	0.00	0.00
Cu^{2+}	0.20	98	0.20	0.06
Na^{+}	0.30	96	0.21	0.09
F^{-}	0.40	92	0.22	0.13

Where :

U,α, r are parameters without inserting antenna and U',α', r' are calculated parameters while the antenna is integrated in the circuit. However, $\varepsilon_\alpha$and ε_r are the difference or gap of attenuation and reflection between two cases.The type of implemented antenna has very high gain when they especially when installed on large ground plane. Moreover, it is characterized by its smaller size. The dimensions range is between 10x10 mm^2 to 25x25 mm^2. To get good antenna performances we should take in consideration that no components should be mounted near to the patch. Also we need to maintain sufficient minimum distance between emitter and receiverdevice where antenna is integrated. The antenna reinforces the directivity of reflected signal and the gain is enough to obtain suitable received voltage required for analysis. The simulations can be done using CST and ADS software's.We give illustration of the patch antenna as shown below:

The infrared sensor used during process of mint reflection can be depicted by the following figure. It doesn't required more than 5V. Moreover, it has adequate sensitivity and accurate values.

Figure 6: Infrared sensor

The measurements are taken after doping the mint with different solutions of evoked ions so we give in the following curves the variations to make comparisons.

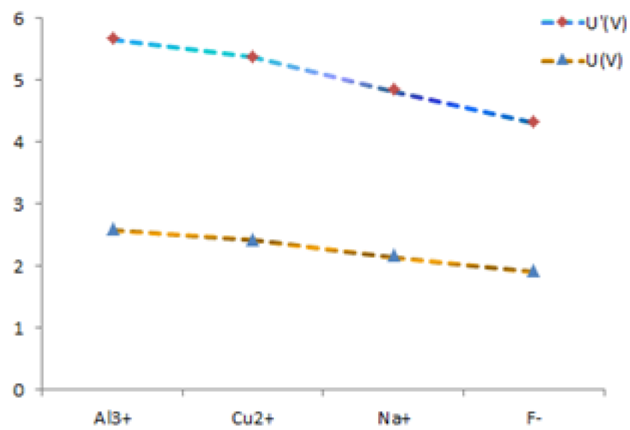

Figure 7: Reflected voltage of specimens

The reflected voltage is varying from a specimen to another depending on the element we used for doping. Thus, the aluminium ions have wide gap between reflected volatges when antenna is integrated and while it is avoided. The positive charge has strong effect on infrared reflection in comparison with negative charge ions that converge towards approaches values. The reason is due to initial composition of the mint as studied sample. Thereon, another plant will have different results.

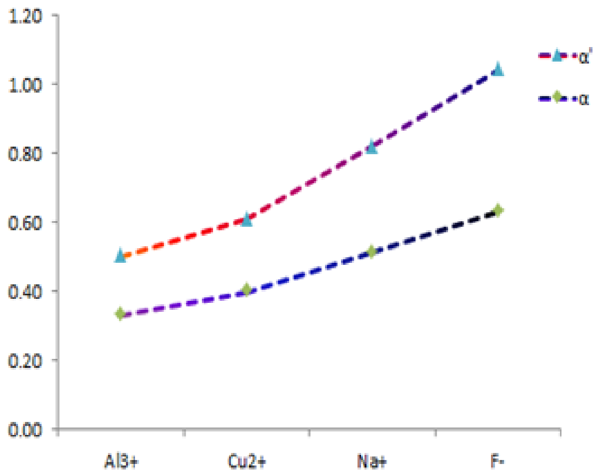

Figure 8: Attenuation coefficient

We have used in this experiment infrared emitter and receiver feeded both by 5V. However, whitout antenna we notive that antenna has impact on attenuation coefficient by ameliorating directivity of reflected wave. The wide difference is remarked for fluor ion so the infrared radiation has powered transmission on a plant doped by negative charge. Thereon, for plants like the mint it is prefered to dope it by cations to improve reflection process by constructing suitable reflective thin layer.

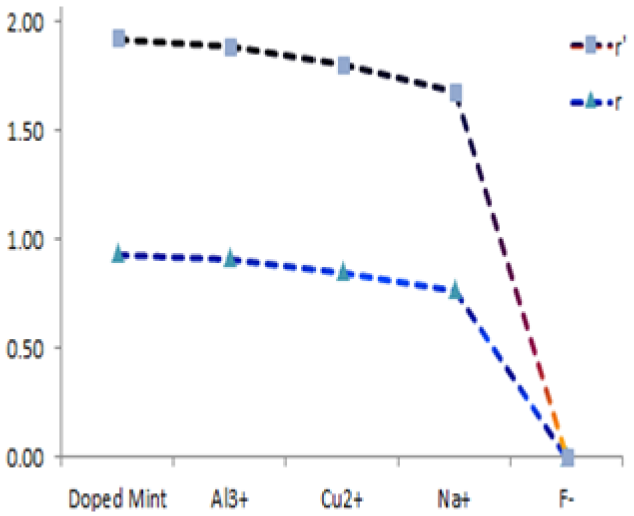

Figure 9: Evolution of reflectance

The reflectance is affected by the absorption or attenuation coefficient. Indeed, this process depends on chemical composition in the leaves of plant. Moreover, each source of infrared has appropriate frequency and wavelength. From that, we should make a good choice to get high performances of reflection and expect the nature of elements that are within the leaves of goal plant. The mint when it is adopted by fluor ions doesn't present any difference even antenna is used or no. Otherwise, The copper for example presents a gap of reflection coefficient when antenna is used in comparison to avoiding any integration of any type of antenna. So we observe losses of reflected signal without antenna.

The use of antenna in this expirment shows that directivity of reflected wave is very important to minimize losses. Above that, both conditions of expriment and instruments have incertitudes to evitate as possible. The curves below are describing how is varying reflection and attenuation gaps with and without antenna. From comprasion of reflectance and transmittance we get ideas about suitable uses of plant composition in a good way.

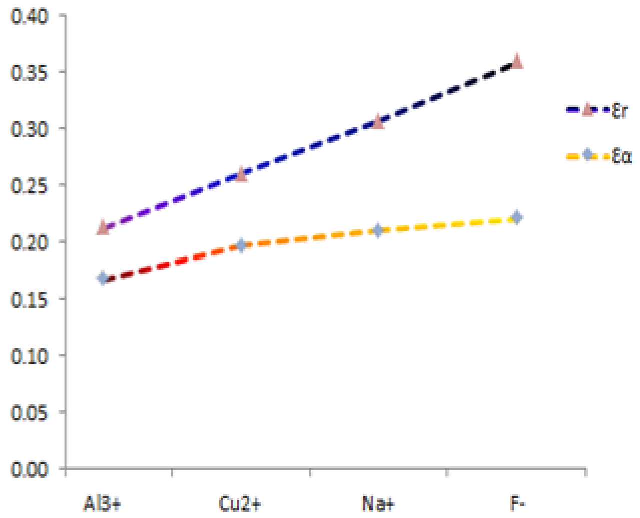

Figure 10: Reflectance coefficient error

Moreover, the reflectance error measurement answers to the discrimination of plants cause the difference of reflection is noticed especially for positive doping. Thereon, these parameters together let this method to be robust and qualified as promising technique to identify plants with accepted precision depending on instruments quality and goal plant.By analyzing these results the range of frequency has a huge effect on plants identification especially that each chemical element has its resonance frequency to get suitable reflection. The magnetic properties are very important to make adequate discrimination process. Indeed, the perturbations due interferences are probable if other devices are around.The utilization of patch antenna has positive effect on how to expect chemical composition of a plant as we have described the mint as sample in this work. By tuningthe frequency, choosing of good infrared emitter and high quality of sensor receiver the circuit is able to identify plants elements with adequate precision.The infrared waves are electromagnetic waves that react nearbyplants so we obtain a reflected signal to analyze especially when antenna is inserted to get a stable signal.The integration of patch antenna has opposite flow against noises so we can discriminate different kinds of plants.Tosum up that, this detector has enough sensitivity and selectivity under specific range infrared frequency to determine nature of element inside leaves of a plant.

4. Conclusion

The patch antenna improves performancesof infrared sensor especially directivity and stability of reflected signal. Indeed, this kind of antenna is characterized by its high gain so it permits suitable analysis of reflected radiation by plants. Moreover, the system ensures good sensitivity as it ismore efficient. In fact, adding patch antenna reinforce the power of reflected electromagnetic wave towards adopted sensor otherwise small size which is a crucial advantage thank to its simplicity to be integrated in such systems.By adjusting infrared source we can study any plants composition. Thereat, the circuit is an alternative for plants content discrimination. As a result, after identification of a given plant we can apply laser beam to care the content into infected are for example in our body as new method of healing. The similar process has been used in doping of semiconductors by laser beam.

The reflected voltage changes for various specimens rely on their contents. We conclude that each element has its appropriate reflectance. Above that the hybrid composition can be determined by matrix of abundance coefficients. The adopted method is reliable to discriminate many samples of plants constituents refer to their intrinsic properties. To sum up, this technique is both able to predict and expect the nature of leaves. By doping we induce fluorescence response as integration of biology in physics.The highselectivity was confirmed is confirmed which is due existence of ions and phenomena binding inside leaves. We examined the sensorprovided by patch antenna ensuresselective detection. The experimental results of this study provide a new basis for bio-vegetal interesting as we can exploit in further studies, including promising medical uses.

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