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"PRO INVENT 2025"
Cluj-Napoca – Romania
15-17 October 2025
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National Institute for Research and Development in Optoelectronics
Department of Constructive and Technological Engineering
Lasers and Fiber Optics Communications
ITC

Amplifier controlled by the input signal level for a Cherenkov detector in saline environment

Mădălin Ion RUSU, Valeriu SAVU, Dan SAVASTRU
Patent application no.: A00273 /2022

NOVELTY: The input signal level-controlled amplifier for a Cherenkov detector in saline minimizes errors in calculating the energy and direction of the neutrino that interacted with the saline environment and generated the Cherenkov cone is characterized by adjusting the amplifiers' gain so that they does not enter into nonlinearities, relying on the response time of an amplifier together with the related comparator so that it is less than the delay time of the delay circuit related to that amplifier and on adjusting the thresholds of the comparators, obtaining linear amplifications.

The invention has the following advantages: ① presents simplicity in practical application; ② the reference is independent of the variations of the supply voltage of the amplifier and the influence of the temperature of the environment; ③ the amplification is controlled by the level of the input signal in such a way that the amplifier works in the linear zone; ④ the amplification of a group is adjustable between 0dB and 30dB; ⑤ minimizes intermodulations between two adjacent groups (x, y, z) by establishing the minimum distance between groups determined by prior measurements; ⑥ minimizes the calculation errors of the energy and direction of the neutrino that interacted with the saline environment and generated the Cherenkov cone of cosmic radiation; ⑦ the input signal level controlled amplifier for a Cherenkov detector in saline environment can be applied for Cherenkov cone detection in any environment provided the optimal frequency at which the attenuation of the medium is minimum and the minimum attenuation length of that medium are known.

DESCRIPTION: The invention refers to a system that controls the amplification factor of an amplifier depending on the level of the input signal, which uses a signal comparator that has a reference set on one of the inputs and the input signal to the system delayed by a time on the other well established so that the time response of the amplifier summed with that of the comparator is less than the delay time, the output of which determines the gain factor of the amplifier so that the gain is linear and 10 dB maximum obtaining a total controlled gain between 0 dB to 30 dB.

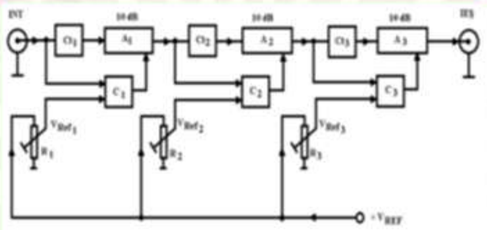

Fig. 1. – Functional block diagram of an input signal level controlled amplifier for a Cherenkov detector in saline environment.

APPLICATIONS: The input signal level-controlled amplifier for a saline Cherenkov detector is used to realize a saline Cherenkov detector.

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Synchronization system for multiplexed signals transmitted unidirectionally between two units via a single-wire shielded cable

Valeriu SAVU, Mădălin Ion RUSU, Dan SAVASTRU, Dragoș MANEA
Patent application no.: A00647 /2023

NOVELTY: The technical problem that the invention solves is to transmit the repetitive synchronization signal at the beginning of each complete data transmission sequence by synchronizing the clock oscillators of the transmit and receive block and resetting the transmit and receive counters with a negative signal relative to a reference level equal to half the supply voltage and inverted with respect to data and command signals that are cycled and positive with respect to the same reference. Comparators are used to extract the data and/or command signals for positive signals relative to the reference and the counter reset signal from the receiving block and clock oscillator synchronization from the same block for negative signals relative to the same reference, which eliminates crosstalk between the data channels and the synchronization channel and by transmitting the synchronization signal repetitively at the beginning of each data cycle makes it possible to eliminate desynchronizations at the receiving block.

THE INVENTION HAS THE FOLLOWING ADVANTAGES: ❶ eliminates crosstalk between the synchronization channel and adjacent data/commands channels that may or may not be encoded; ❷ eliminates crosstalk between the synchronization channel and its own data channel; ❸ eliminates desynchronizations between the transmission and reception blocks; ❹ improves the quality of data/command information transmission.

DESCRIPTION: The invention refers to a system for synchronizing multiplexed signals transmitted unidirectionally between two units through a single-wire shielded cable that synchronizes the signals between the two units, through repeated initializations of the transmission and reception blocks of the communication signals between the units and by separating the signals of data by the signal of repeated initializations, by transmitting data signals between two successive initializations.

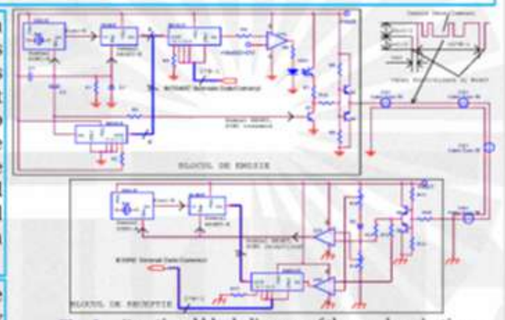

Fig. 1. – Functional block diagram of the synchronization system of multiplexed signals transmitted unidirectionally between two units over a single-wire shielded cable.

APPLICATIONS: Synchronous Time Division Multiplexing systems are commonly used in applications where the data rate of each signal is constant and known in advance.

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Planar surface plasmon resonance structure having a relief diffraction grating and method for making this structure

Aurelian POPESCU, *Dan* SAVASTRU.
Patent application no.: *A00706 /2024*

PROBLEM THAT NEEDS TO BE SOLVED MODE OF OPERATION:

The technical field. The invention consists of chemical or biological optical sensors, in particular sensors based on surface plasmon resonance (SPR) and structures in which surface plasmon resonance is achieved.
The technical problem that the present invention aims to solve consists in the development of a planar surface plasmonic resonance (SPR) structure, which allows the backlit structure illumination.
An innovative SPR structure with relief diffraction grating that assure coupling couples of light with surface plasmon-polaritonic waves was proposed.

SOLUTION:

Fig.1 – Schematic of the SPR structure according to the invention. MA - ambient medium; 2- gold film; 4-glass substrate; 5 - relief transmission grating.

The lighting is done through diffraction grating and after diffraction is incident to the metal film at an angle corresponding to the resonance conditions.

MODE OF OPERATION:

The incident at the angle α beam may be diffracted into +1 (case a) or -1 (case b) maxima. After the reflection from the SPR structure beam propagates either under angle 2α or in back direction.

FABRICATION METHOD: A thin film 2 of gold or another metal with good optical Properties is applied to the substrate 4A. A film of photoresist 5 is applied to the other substrate 4B. The diffraction grating with calculated period is created on the photoresist using known methods.
A drop of immersion oil is applied to one plate. After pressing, the drop 6 stretches over the entire surface of the substrate. Optically, both substrates form a homogeneous structure. In case of damage to the metal film, the substrate 4A is disconnected from 4B and replaced.

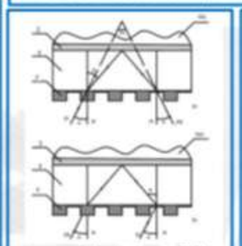

Fig.2 – Illustration of light diffraction on the transmission diffraction relay with raised profile and reflection from the SPR structure.

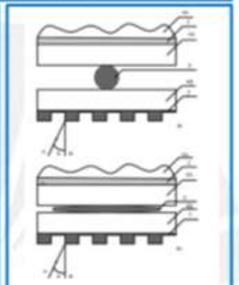

Fig.3 – Illustration of the process of making the SPR structure.

CONCLUSIONS:

The SPR structures proposed in this paper are planar and backlit. They completely replace the coupling prism. At the same time, unlike a prism, many diffraction gratings can be successfully integrated on a single substrate.

ACKNOWLEDGMENTS: This work was carried out through the NUCLEU Core Program carried out with the support of MCID, project no. PN 23 05, and Exploratory Research grant number PN-III-P4-PCE-2021-0585.

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Laser emission stabilization technique for detection by high spectral resolution lidar

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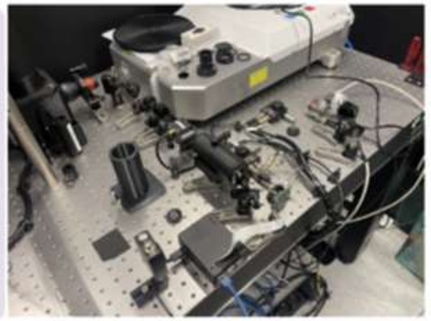
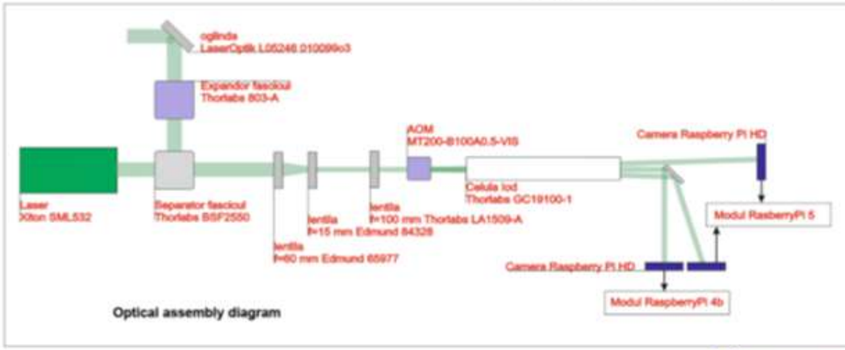
Patent request no. A/00543 / 19.09.2024; livio@inoe.ro

Novelty

- Implementation of a technical solution for **emission control of a laser system** which is the core of a high spectral resolution lidar system.
- Solution is based on a Raspberry Pi module capable of monitor the emitted radiation and adjust the frequency of emitted radiation of the laser system in real time.
- The proposed system relies on an **acousto-optic modulator** (AOM) to split the laser emission into multiple diffraction orders.
- A Raspberry Pi 5 module, paired with two Raspberry cameras, monitors the laser's spectral stability by observing the behavior of these orders in relation to an iodine reference cell.
- The diffraction orders are compared to determine shifts in the primary emission wavelength, allowing for **real-time correction of the laser's frequency** based on intensity measurements.



Prototype – opto-mechanical assembly



Optical assembly diagram

Application in Advanced Lidar Systems

- This stabilization method is ideal for enhancing **high spectral resolution lidar** systems used in atmospheric sensing, environmental monitoring, and remote detection.
- By maintaining laser frequency stability, it **supports precise measurements** necessary for advanced optical diagnostics.

Advantages

- Low implementation cost due to use of affordable components
- High stability of laser emission through continuous monitoring
- Fast response time for real-time adjustments
- Easy deployment in existing lidar systems
- Fully automatic emission control, reducing the need for manual calibration

Acknowledgements

This work was supported by a grant of the Romanian Ministry of Education and Research, project number PN-III-P1-1.1-TE-2021-0714/Contract 103/LICARS within PNCDI III and by Romanian National Core Program contract PN 23 05/3.01.2023

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Ultrasensitive gas sensor array for greenhouse environment assessment (GreHSen) – PED393/2020

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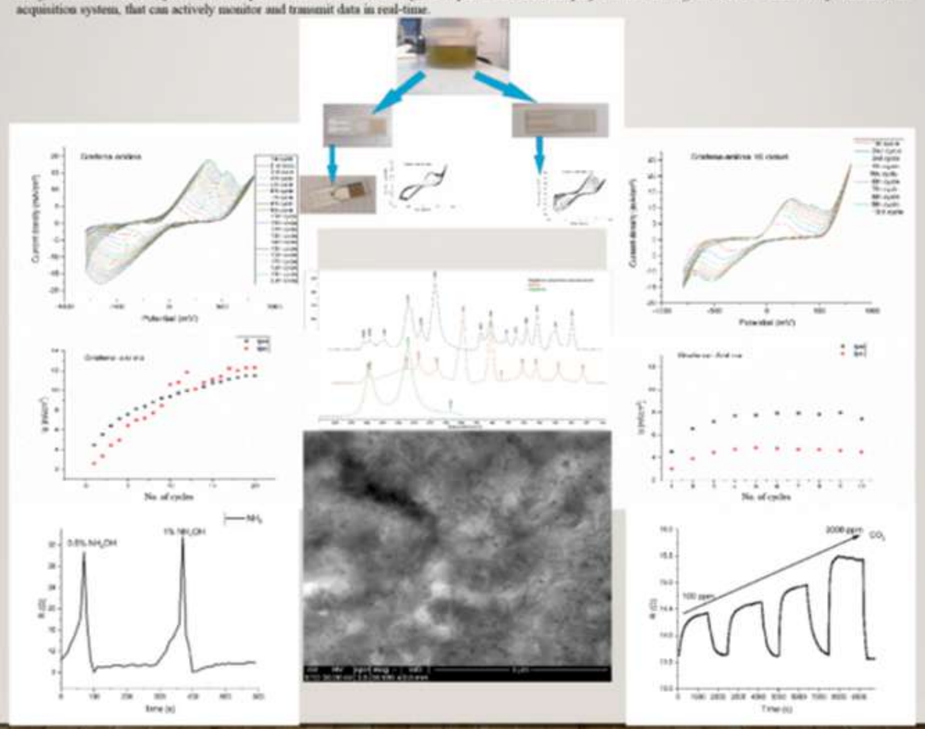
Abstract

The efficient use of water and other resources as well as the development of an automated monitoring system are key issues in agriculture. The project – Ultrasensitive gas sensor array for greenhouse environment assessment (GreHSEN) – developed a monitoring sensor array which can specifically evaluate the level of dangerous gases produced inside of greenhouses (CO_2, NH_3). The demonstration model is an experimental model consisting in an integrated gas sensors array and an appropriate data acquisition system. The integrated gas sensors array is based on functionalized graphene, which allows amplification of detected electrical signals. The detection mechanism is based on the variation of resistivity/conductivity and interfacial properties of the active semiconductor layer (in our case the semiconductive polymer-modified graphene layer) when exposed to different gases. The typical sensing mechanism is as follows: first, the target analyte comes into contact with the sensing layer; the analyte affects the semiconductor layer with various molecular interactions, changing the distribution of the charge carrier density; this change in the charge carrier density results in a change in the resistivity of the sensors. We synthesized by electro-polymerization and magnetron sputtering thin layers of graphene-polyaniline and graphene-polypyrrole and tested them to CO_2 and NH_3. The sensor array showed a good response to the gases and fast recovery. The most important result obtained during the implementation of the project was the integration of the sensor array with the data acquisition system, that can actively monitor and transmit data in real-time.



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Project site: https://grehsen.inoe.ro/

NATIONAL INSTITUTE OF RESEARCH AND DEVELOPMENT FOR OPTOELECTRONICS

E-tongue like sensor for food safety (FoodESense) – PD87/2020

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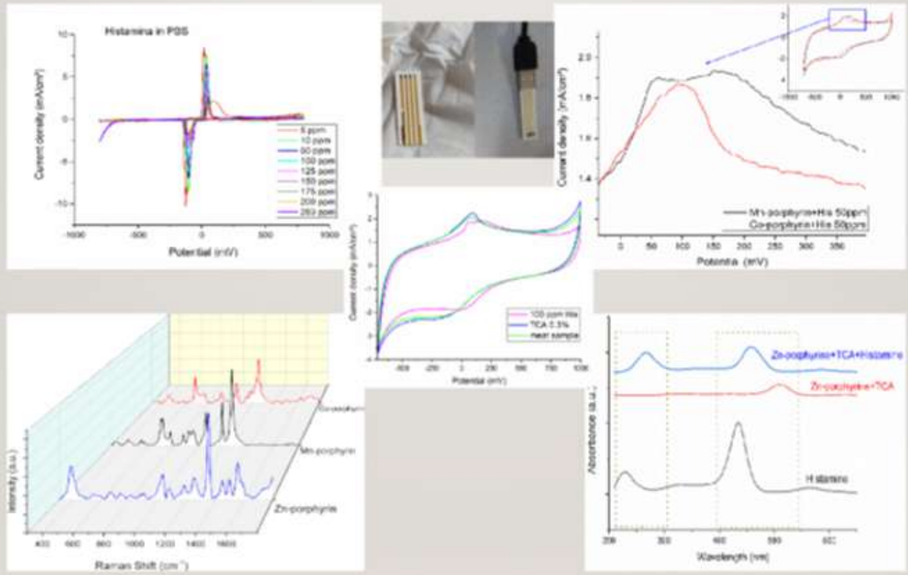
Abstract

The proposal is based on the development of an electronic tongue-like sensor for the evaluation of histamine in food products (the focus is on meat products, as they are most often subject to poor hygiene during production, processing and transport). Using a single ultra-sensitive electrochemical sensor, it is possible to measure the concentration of histamine, a representative compound for assessing the level of freshness (the caution level for histamine is 50 ppm, while the maximum allowed levels vary from 200 ppm to 500 ppm). This electronic language will ensure on-site quality control of food products, from producer to seller and to consumer, providing information on the condition of food along the distribution chain. To validate the sensor, tests were undertaken on real samples, purchased from commercial stores. 7 samples of different types of meat were tested: 1 fresh chicken sample, 1 fresh pork sample, 1 fresh beef sample, 1 pork and beef minced meat sample, 1 fresh pork sausage sample, 1 fresh pork sample smoked chicken and 1 sample of altered pork. The most important result obtained is the development of the sensor based on non-specific molecular imprinting, with graphene and thiophene electropolymerized onto Au support. This sensor represents an extension of the research project towards the "lab-on-a-chip" field. Even if the detection limit for histamine is relatively high (around 80 ppm), the manufacturing technique allows the immobilization of several distinct molecules on a small area of sensorial support.

Results



Acknowledgments: A.M. Iordache, S. Caramizoiu, A.M. Florea (Raduta), B. Bita, S.M. Iordache were supported by the CORE Program with the National Research Development and Innovation Plan 2022-2027, carried out with the sup-port of MCID, project no. PN 23 05. A.M. Iordache & V. Barna were supported by grant of the Romanian Ministry of Education and Research, CNCS - UEFISCDI, project number PN-III-P1-1.1-PD-2019-1144 (Ctr. No. PD87/2020).
Project site: https://foodesense.inoe.ro/