

MINIATURIZED SYSTEM FOR CONFINED DETECTION AND LOCATION

The subject matter of the invention concerns a miniaturized system for detection, location and signaling in a confined closed space, more commonly known as "indoors", of radio transmitters, this system being of confined volumetric coverage. The invention finds application in confined spaces of small floor surface, particularly in an indoor environment, such as prison cells, examination rooms, classrooms in schools, offices and conference rooms in embassies, army barracks, etc., and more generally sensitive closed sites of small surface, when one wishes to detect, locate and/or characterize a radio transmitter whose operation is prohibited in the aforementioned zones.

In some of the aforementioned environments, such as prisons and examination centers, the use of radio communication devices such as portable telephones is prohibited. One of the problems occurring today is to detect, locate and signal all unauthorized radio communications in a closed space by controlling the confinement of this detection to avoid any intrusion or interference with the communications of external users not involved in the prohibition.

The prior art known to the patent applicant describes systems which detect illicit radio communications and/or locate the terminals which use these radio communications with conventional radio antennas. These devices sometimes emit a jamming signal in response. When they are searching a significant spatial coverage, such devices encounter many difficulties, due to the nature of the radiating pattern of the conventional antennas of pointlike type or reduced geometrical extent, and the nature of the propagation losses in $-20 \cdot \log_{10}(R)$ of the radiated power from a terminal to such a conventional antenna (R being the distance from the terminal to the phase center of the antenna). Since they try to provide a significant spatial coverage in an indoor environment, the conventional aerials and the systems which employ them are unsuited in terms of efficiency and coverage, because the system of propagation losses in $-20 \cdot \log_{10}(R)$, to which many propagation masks are added (walls, doors, etc.), makes it difficult to guarantee coverage and at the same time controlled confinement of the detection. In fact, the sensitivity of the system should be

augmented in order to guarantee a significant coverage of the zone despite the propagation losses and the many masks in the propagation pathways (walls, doors, etc.), but in this case the confinement is not enough either to avoid a large number of false alarms or to guarantee discretion with regard to external users and operators not
5 subject to the transmission ban. Also, these conventional systems seeking a significant indoor coverage are tricky to install and maintain in proper operation, and in practice they prove to be hardly effective.

Patent application WO 03/101023 describes a system and a method adapted to detect any intrusions in a wireless communication system involving a
10 monitoring by a wireless network node of interest during a monitoring cycle.

One of the problems left unresolved by the prior art is the implementing of a complete and reliable detection, location and signaling of the presence of radio transmitters in a confined closed indoor space of confined and controlled coverage.

Thus, there is a need at present to have a system enabling the detecting
15 and/or locating of radio communication devices whose use is prohibited in a confined space. The device of the present invention applies to the interior of an indoor space in general, and more particularly to spaces of reduced surface and volume, with a reliable efficiency, a controlled coverage, and a confined effect, whose confinement is perfectly controlled. The term "illicit or prohibited terminal"
20 means a terminal, a radio communication device, which is not authorized to transmit in a given perimeter or to communicate with the outside of this perimeter.

One of the purposes of the present invention is to propose a miniaturized system of detection, location and signaling of illicit transmitters operating in a confined environment and based in particular on the combination of a system for
25 reception/detection of illicit transmissions, a radio transmitter/relay of pager type, and a network familiar to the skilled person or any other equivalent radio messaging system.

The invention concerns a miniaturized system of detection and location of illicit radio transmitters operating in a confined closed environment, zone Z,
30 characterized in that it comprises at least the following elements:

- one or more miniaturized detectors, provided with an antenna, adapted to detect a signal emitted by the illicit radio transmitter,
- said miniaturized detector(s) being linked to one or more bidirectional radio relay transmitters outfitted with a transmission antenna, the detectors being adapted to transmit the signaling of the signals detected to at least one receiver of a radio messaging network connected to a signal processing module,
- the radio network operating on a frequency different from the frequency of operation of the illicit radio transmitters.

The bidirectional radio relay transmitter is, for example, adapted to label the signals detected by the receiver/detector with the date, the time, the location of the antenna of the detector of an illicit radio transmitter, and/or the location of an illicit radio transmitter and/or the nature of an illicit radio transmitter and/or the level of signal reception of an illicit radio transmitter.

A transmitter/relay can be outfitted with a command and transmission module adapted to activate procedures for autotesting, booting, and shutoff of the receivers/detectors.

The system utilizes, for example, relay transmissions of very low speed, adapted to signal the detections of signals emitted by the illicit radio transmitters.

Zone Z is, for example, a room and the antenna is installed on the ceiling of the room, with the antenna of the detector/receiver oriented toward the floor of the room and the transmission antenna being oriented toward one of the sides of the room or upward.

The miniaturized detectors/receivers and the bidirectional radio relay transmitters are disposed in ceiling fixtures.

The miniaturized detectors and the bidirectional radio relay transmitters are disposed, for example, in volumes of limited size, whose partly metallized surface serves as an antenna for the detection.

The signal processing module is adapted, for example, to analyze the communication streams and provide statistics and a local mapping of the calls.

According to another variant, the signal processing module is adapted to identify the telecommunications subscriber devices attempting to communicate with the illicit radio transmitters.

The system uses, for example, a wireless Pager M2M network at 800
5 MHz, familiar to the skilled person.

Other characteristics and advantages of the device according to the invention will better appear after reading the following description, given as an illustration and in no way limiting, appended by figures which show:

- figure 1, an example of the system according to the invention, and
- 10 • figure 2, a variant of the invention in which the transmitter/relay and the receiver/detector are situated inside a volume of limited size.

Figure 1 shows an example of a system according to the invention in which the transmission/relay system is a radio messaging system of pager M2M type, familiar to the skilled person. The radio messaging uses frequencies different from
15 those of the illicit mobile telephones being detected, so that a band reject filtering of the radio messaging transmissions or a blanking of the detection on the radio messaging transmission parcels makes it possible to prevent inappropriate interactions between the receiver/detector and the pager/relay.

The system 1 is composed, for example, of a miniaturized
20 receiver/detector 2 of local and confined range, disposed in the area of a cell or a room Z. This receiver/detector 2 is adapted to pick up the signals coming from communication devices 10, such as mobile telephones, whose operation is not authorized in the room Z. This receiver/detector 2 is associated with a pager/relay 3. The receiver/detector 2 and its antenna 2A can be installed on the ceiling 4a with the
25 antenna 2A of the receiver/detector 2 oriented toward the floor of the room. A different orientation of the antenna 3A of the pager/relay 3 associated with the receiver/detector 2 is preferably chosen toward the top or toward the sides of the room. The receiver/detector 2 has a detection sensitivity adjusted to a low value, which limits its range to only the closed quarters in which its antenna 2A is located,
30 the associated pager/relay 3 being linked to an M2M network, 5, comprising a receiver/relay 6 equipped with an antenna 6A, for example, which allows it to

transmit the signaling of the detections of the receiver/detector 2 associated with it to a processing device 9 of the illicit transmitters detected. The frequency chosen for the M2M network is different from the operating frequency of the illicit radio transmitters. Any radio messaging system having a transmitter and a receiver could
 5 be used, without leaving the scope of the invention, in place of the Pager M2M network.

For each cell or room Z, one installs a set consisting of a miniaturized receiver/detector 2, 2A and a miniaturized transmitter/relay 3, 3A for radio messaging of M2M type, whose function is to transmit the signaling of the detections
 10 of the receiver/detector 2 to the receiver/relay 6 of the M2M network, in order to be processed by the processing system 9. The transmitter(s)/relay(s) 3 are miniaturized bidirectional terminals, of Pager type, making it possible to signal the detections of the receiver/detector 2 and label them with the date, the time, and the location (detector number, room number). The signals received and detected are labeled by
 15 associating them with one of the aforementioned parameters, for example. These pager transmitters/relays 3 are also outfitted, for example, with a command and transmission module 11 to activate autotesting, turning on and turning off of the receiver/detector 2. The receiver/detector 2 and the pager/relay 3 integrated within the ceiling fixture 4a are chosen so as to ensure electromagnetic compatibility by
 20 means of adequate filtering and blanking techniques known to the skilled person.

The transmissions/relays used are transmissions of very low speed, adapted for the signaling of detections of signals labeled, for example, with the date and time, the place (cell or room number), the receiver/detector number, or by identification elements of the illicit transmitter (carrier and frequency band, for
 25 example, band width, etc.), or by the signal reception level of the illicit transmitter.

It is possible to use networks of M2M pager type, such as the wireless modem Sigfox at 800 MHz, which lets one benefit from low costs.

Figure 2 shows an example of the installation of the elements making up the system according to the invention. It is possible to install the antenna, the
 30 receiver/detector 2 and the transmitters/detectors in a ceiling fixture 4a, in volumes 21 of limited size whose partly metallized surface serves as an antenna for the

detection, for example, of a lamp globe, lighting fixtures, or other components of a local habitat, in smoke detectors, motion sensors, telephone sets, shielding of doors, viewing holes of doors, etc. In particular, one can imagine an integration in LEDs, neon lights, low-wattage fluorescent tubes. It is also possible to use partly metallized
 5 bulbs or globes as an antenna for the receiver/detector. The power supply of the system can then come from the power supply system of the lamp or the bulb.

The transmitters and the detectors are, for example, concealed in the ceiling. One could use baffles adapted to locally optimize the confinement. A baffle could be made of ceiling grids of limited size and simple geometry (typically a
 10 square whose side measures a half wavelength of the transmission being detected).

In the installation phase, a classical metrology known to the skilled person (test mobile telephones, channel sounders, spectral analyzers, etc.) is used, for example, to facilitate the finding of sites for the receivers/detectors, proper antenna orientations, adequate filtering, sensitivity settings, etc.

The processing system 9 is, for example, adapted to process the signals
 15 detected by the radio network. It can analyze communication streams, perform statistics and a local mapping of the calls. By using methods known to the skilled person, it is also possible to identify the telecommunications subscriber devices which are trying to communicate despite the ban by the signaling of the bands and
 20 the carriers used.

The invention applies in particular, but not exclusively, to communications in the frequency band [0.3 to 3 GHz]: private network PMR (400 MHz), cellular radio 2/3/4G, wireless network WLAN Wireless Local Area Network
 25 such as Wifi and short range direct communication networks like Bluetooth operating on industrial, scientific and medical bands ISM, Personal Communication Satellite network in L band (1.6 GHz and 2.4 GHz) such as Iridium, Thuraya, Globalstar, or even future communication services in radio navigation systems such as the GPS (Global Positioning System), Galileo and Glonass in L, S and C bands. It can also be extended to certain other radio communications systems liable to be
 30 locally banned in future:

- future extensions of S and C bands (WiMax/LTE at 3-4 GHz and 5 GHz),

- mesh network, mobile or ad hoc wireless network and Manet (Mobile Ad-hoc Networks) modes of UMTS Universal Mobile Telecommunications System, Wifi, LTE (Long Term Evolution) networks, etc.

5 It can also be disabled momentarily and locally or interfaced in a compatible manner with the use of certain radio communications systems authorized or tolerated in the locations covered by the invention:

- Femto Cells UMTS or LTE “supernet” on specific carriers,
- DECT wireless communications “supernet”,
- emergency / intervention calls.

10 It can also be interfaced in a compatible manner with the monitoring systems for communications authorized or tolerated in the locations covered by the invention.

Besides the processing of all networks between 0.3 and 3 GHz, the invention makes it possible to solve the critical problem of the confinement of the
15 detection and the signaling of detections to a single room in which a receiver/detector of controlled confinement is installed. The invention offers a system able to be deployed *à la carte* with subsequent coverage additions and with supplemental services, for example, the analysis of communication streams, statistics and mapping of calls, identification of the nature of the communication, etc.

CLAIMS

- 1 – A miniaturized system of detection and location of illicit radio transmitters (10) operating in a confined closed environment, zone Z, characterized in that it comprises at least the following elements:
- one or more miniaturized detectors (2), provided with an antenna (2A), adapted to detect a signal emitted by the illicit radio transmitter (10),
 - a detection sensitivity of the one or more miniaturized detectors (2) is adjusted to limit a detection range of the one or more miniaturized detectors (2) to only the confined closed environment in which the antenna of the one or more miniaturized detectors (2) is located,
 - said miniaturized detector(s) (2) being linked to one or more bidirectional radio relay transmitters (3) outfitted with a transmission antenna (3A), being adapted to transmit the signaling of the signals detected to at least one receiver (6) of a radio messaging network connected to a signal processing module (9),
 - a bidirectional radio relay transmitter (3) is adapted to label the signals detected by the receiver/detector with the date, the time, the location of the antenna of the detector of an illicit radio transmitter, and/or the location of an illicit radio transmitter and/or the nature of an illicit radio transmitter and/or the level of signal reception of an illicit radio transmitter,
 - the radio relay transmitters and receivers (3, 6) operating on a frequency different from the frequency of operation of the illicit radio transmitters.
- 2 – The miniaturized system as claimed in claim 1, characterized in that a transmitter/relay is outfitted with a command and transmission module (11) adapted to activate procedures for auto-testing, booting, and shutoff of the receivers/detectors (2).
- 3 - The miniaturized system as claimed in claim 1 or 2, characterized in that the system utilizes relay transmissions of very low transmission speed, adapted to signal and characterize the detections of emissions emitted by the illicit radio transmitters.

4 – The miniaturized system as claimed in one of the preceding claims, characterized in that zone Z is a room and the antenna (2A) is installed on the ceiling (4a) of the room, with the antenna (2A) oriented toward the floor (4b) of the room and the transmission antenna (3A) being oriented toward one of the sides (4c) of the room or upward.

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5 – The miniaturized system as claimed in one of the preceding claims, characterized in that the miniaturized detectors (2) and the bidirectional radio relay transmitters (3) are disposed in ceiling fixtures.

10 6 – The miniaturized system as claimed in claim 5 characterized in that the miniaturized detectors (2) and the bidirectional radio relay transmitters (3) are disposed in volumes of limited size, whose partly metallized surface serves as an antenna for the detection.

15 7 – The miniaturized system as claimed in one of the preceding claims, characterized in that the signal processing module (9) is adapted to analyze communication streams and provide statistics and a local mapping of calls.

20 8 – The miniaturized system as claimed in one of the preceding claims, characterized in that the signal processing module (9) is adapted to identify one or several telecommunications subscriber devices attempting to communicate with illicit radio transmitters.

9 – The miniaturized system as claimed in one of the preceding claims, characterized in that it uses a wireless Pager M2M network at 800 MHz for radio relay.