Acknowledgement Receipt

The USPTO has received your submission at **09:05:49** Eastern Time on **19-SEP-2022** .

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eFiled Application Information

EFS ID	46640087
Application Number	63407741
Confirmation Number	5487
Title	METHOD OF ACOUSTICALLY DETECTING EARLY TERMITE INFESTATION
First Named Inventor	Nick Gromicko
Customer Number or Correspondence Address	16111
Filed By	James A. Sheridan/Marcie King
Attorney Docket Number	81251.0016
Filing Date	
Receipt Date	19-SEP-2022
Application Type	Provisional

Application Details

Sequence	Submitted Files	Page Count	Document Description	File Size	Warnings
1	Transmittal.pdf	3	Provisional Cover Sheet (SB16)	2622826 bytes	PASS
No validation errors found.					
2	ADS.pdf	8	Application Data Sheet	2225543 bytes	PASS
No validation errors found.					
3	Specification.pdf	27		120706 bytes	PASS
No validation errors found.					

Document Description	Page Start	Page End
Specification	1	20
Claims	21	26
Abstract	27	27

4	Figures-.pdf	10	Drawings-only black and white line drawings	19231455 bytes	PASS
No validation errors found.					
5	fee-info.pdf	2	Fee Worksheet (SB06)	37450 bytes	PASS
No validation errors found.					

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated

documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

If you need help:

- *To ask questions about Patent e-Filing, or to suggest improvements to the online system, or report technical problems, please call the Patent Electronic Business Center at (866) 217-9197 (toll free) or send email to EBC@uspto.gov.*
- *Send general questions about USPTO programs to the USPTO Contact Center (UCC) .*
- *For general questions regarding a petition, or requirements for filing a petition, contact the Office of Petitions Help Desk at 1 800-786-9199.*

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	METHOD OF ACOUSTICALLY DETECTING EARLY TERMITE INFESTATION
First Named Inventor/Applicant Name:	Nick Gromicko
Filer:	James A. Sheridan/Marcie King
Attorney Docket Number:	81251.0016

Filed as Small Entity

Filing Fees for Provisional

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
PROVISIONAL APPLICATION FILING FEE	2005	1	150	150
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**150**

Doc Code: **TR.PROV**
Document Description: Provisional Cover Sheet (SB16)

PTO/SB/16 (01-22)
Approved for use through 05/31/2024. OMB 0651-0032
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
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Provisional Application for Patent Cover Sheet

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c)

Inventor(s)

Inventor 1 — Remove

Given Name	Middle Name	Family Name	City	State	Country
Nick		Gromicko	Frederick	CO	US

All Inventors Must Be Listed – Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. — Add

Title of Invention	METHOD OF ACOUSTICALLY DETECTING EARLY TERMITE INFESTATION
Attorney Docket Number (if applicable)	81251.0016

Correspondence Address

Direct all correspondence to (select one):

(•) The address corresponding to Customer Number	( ) Firm or Individual Name
Customer Number	16111

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

- (•) No.
- ( ) Yes, the invention was made by an agency of the United States Government. The U.S. Government agency name is:
- ( ) Yes, the invention was under a contract with an agency of the United States Government. The name of the U.S. Government agency and Government contract number are:

Doc Code: **TR.PROV**
Document Description: Provisional Cover Sheet (SB16)

PTO/SB/16 (01-22)
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Entity Status
Applicant asserts small entity status under 37 CFR 1.27 or applicant certifies micro entity status under 37 CFR 1.29

- (●) Applicant asserts small entity status under 37 CFR 1.27
- ( ) Applicant certifies micro entity status under 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
- ( ) No

Warning

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

Signature

Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/James A. Sheridan 43114/			Date (YYYY-MM-DD)	2022-09-19
First Name	James A.	Last Name	Sheridan	Registration Number (If appropriate)	43114

This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **This form can only be used when in conjunction with EFS-Web. If this form is mailed to the USPTO, it may cause delays in handling the provisional application.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or paten. Accordingly, pursuant to the requirements of the Act, please be advised that : (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, t o a n other federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	81251.0016
	Application Number	
Title of Invention	METHOD OF ACOUSTICALLY DETECTING EARLY TERMITE INFESTATION	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Nick		Gromicko	

Residence Information (Select One) ● US Residency Non US Residency Active US Military Service

City	State/Province	Country of Residence
Frederick	CO	US

Mailing Address of Inventor:

Address 1	3115 Holly Street
Address 2	
City	Frederick
State/Province	CO
Postal Code	80516
Country	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	16111		
Email Address	email@sheridanlaw.com	Add Email	Remove Email

Application Information:

Title of the Invention	METHOD OF ACOUSTICALLY DETECTING EARLY TERMITE INFESTATION		
Attorney Docket Number	81251.0016	**Small Entity Status Claimed**	☒
Application Type	Provisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	10	**Suggested Figure for Publication (if any)**	

PTO/AIA/14 (01-22)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	81251.0016
	Application Number	
Title of Invention	METHOD OF ACOUSTICALLY DETECTING EARLY TERMITE INFESTATION	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	◯ Limited Recognition (37 CFR 11.9)
Customer Number	16111		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

PTO/AIA/14 (01-22)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	81251.0016
	Application Number	
Title of Invention	METHOD OF ACOUSTICALLY DETECTING EARLY TERMITE INFESTATION	

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

PTO/AIA/14 (01-22)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	81251.0016
	Application Number	
Title of Invention	METHOD OF ACOUSTICALLY DETECTING EARLY TERMITE INFESTATION	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

PTO/AIA/14 (01-22)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	81251.0016
	Application Number	
Title of Invention	METHOD OF ACOUSTICALLY DETECTING EARLY TERMITE INFESTATION	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 — Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Applicant:

Address 1			
Address 2			
City		**State/Province**	
Country		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

PTO/AIA/14 (01-22)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	81251.0016
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Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/James A. Sheridan 43114/			Date (YYYY-MM-DD)	2022-09-19
First Name	James A.	Last Name	Sheridan	Registration Number	43114

Additional Signature may be generated within this form by selecting the Add button. Add

PTO/AIA/14 (01-22)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	81251.0016
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Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

SPECIFICATION

TO WHOM IT MAY CONCERN:

Be it known that I, with name, residence, and citizenship listed below, have invented the inventions described in the following specification entitled:

METHOD OF ACOUSTICALLY DETECTING EARLY TERMITE INFESTATION

Inventor: Nick Gromicko

Residence: Frederick, Colorado

Citizenship: USA

Background

[0001] Termite inspectors may use visual cues and poking tools to identify termite activity and a degree of infestation. However, only about 25 percent of the building structure (FIGURE 1) may be accessible [IEEE Ultrasonic Symposium, 1991, pp. 1047–1051]. And, successful visual detection usually means that infestation is advanced (FIGURES 2a-2b), causing great expense and inconvenience for occupants of the building.

[0002] Technical tools may provide a deeper look into the structures, such as thermal imaging that scans for changes in interior wood condition. Other tools may interrogate the structures by transmitting RF or acoustic waves into the building structures and observing what's reflected in order to locate tunnels or termite movement. However, thermal and interrogation techniques can be expensive, bulky, and/or invasive (FIGURES 3a, 4a). Additionally, interrogation techniques may detect only advanced infestation (FIGURE 3b), and may be too simplistic to sense a type or an intensity of termite activity, such as tunnel movement, level of feeding, or scope of an alarm signal (FIGURES 4b-4c). Also, acoustic reflections may have to compete with higher levels of household noise resulting from increasing numbers of work-at-home occupants.

[0003] More frequent and thorough inspections using a combination of the most sophisticated tools may more often catch an early infestation. However, there's still a risk of forgetting to schedule an inspection, and the house or building may

sometimes be empty for months, such as when the occupants leave for a winter home.

Summary

[0004] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key aspects or essential aspects of the claimed subject matter. Moreover, this Summary is not intended for use as an aid in determining the scope of the claimed subject matter.

[0005] In an embodiment, there is disclosed a method of using a portable sampling device for early detection of termite activity within a suspect zone of a building made with wood. The suspect zone may contain environmental noise maskable of at least one sound pattern of the termite activity discoverable in the building. The method may further comprise collecting an environmental knowledge base representing a variety of environmental noises potentially present in the suspect zone. The method may further comprise establishing a termite pattern library representing a variety of termite sound patterns discoverable during a termite inspection of the suspect zone. At least a portion of the pattern library may be accessible by or storable within the sampling device. A deep learning model based on an artificial neural network may be provided for learning to discern the at least one sound pattern from the variety of sound patterns in the presence of the variety of environmental noises.

[0006] The method may further comprise training the deep learning model on the variety of sound patterns in the termite pattern library in order to produce an intelligent algorithm installable in the sampling device for detecting the termite

activity. During the termite inspection, a primary audio transducer may be configured to the sampling device and directed toward a sample location in the suspect zone. An audio sample may be collected from the sample location and be substantially within the human frequency range of 20Hz - 20kHz. The method may further include evaluating the audio sample, using the intelligent algorithm, for a match with at least one of the variety of sound patterns in the termite pattern library. The sampling device may be configured to indicate an intensity of the termite activity if the intensity is greater than an activity threshold.

[0007] In a further embodiment, there is disclosed a method of using a portable sampling device for early detection of termite activity within a suspect zone of a building made with wood. The suspect zone may contain environmental noise maskable of at least one sound pattern of the termite activity discoverable in the building. A termite pattern library may be established and may contain a variety of termite sound patterns discoverable during a termite inspection of the suspect zone. At least a portion of the pattern library may be accessible by or storable within the sampling device. The method may further comprise placing a contact transducer configured to the sampling device in firm contact with a solid surface in the suspect zone and responsive to the termite activity. A substantially omnidirectional microphone may be placed in an open area of the suspect zone and also configured to the sampling device for collecting environmental noise.

[0008] The method may further comprise collecting a vibrational sample from the contact transducer and concurrently collecting a noise sample from the omni microphone. The method may further comprise aligning the vibrational and noise

samples in time and subtracting a scaled portion of the noise sample from the vibrational sample such that the difference is minimized. The aligning and subtracting may thereby produce a cancelled sample. The cancelled sample may be correlated with one or more of the variety of sound patterns for identifying the termite activity and discovering a degree of correlation for each correlated pattern. The sampling device may indicate the at least one sound pattern of the termite activity when the degree of correlation is greater than a correlation threshold.

[0009] Additional objects, advantages and novel features of the technology will be set forth in part in the description which follows, and in part will become more apparent to those skilled in the art upon examination of the following, or may be learned from practice of the technology.

Brief Description of the Drawings

[0010] Non-limiting and non-exhaustive embodiments of the present invention, including the preferred embodiment, are described with reference to the following figures, wherein like reference numerals refer to like parts throughout the various views unless otherwise specified. Illustrative embodiments of the invention are illustrated in the drawings, in which:

[0011] FIGURE 1 illustrates a wooden house, a potential object of a termite inspection.

[0012] FIGURES 2a-2b illustrate prior art inspection results for visually detecting termite tunnels in cases of advanced infestation.

[0013] FIGURES 3a-3b illustrate prior art inspection results for a thermal imaging tool for detecting termite infestation.

[0014] FIGURES 4a-4c illustrate prior art spectral distributions for an acoustic sampling of termite activity.

[0015] FIGURE 5 describes varieties of termite activity preferable for discerning early infestation, in accordance with an embodiment of the present disclosure.

[0016] FIGURE 6 illustrates performing a termite inspection using an intelligent algorithm installed on a smart phone for a method of detecting early termite infestation, in accordance with an embodiment of the present disclosure.

[0017] FIGURE 7 illustrates a flowchart for a method of detecting early termite infestation, in accordance with an embodiment of the present disclosure.

[0018] FIGURE 8 illustrates training a deep neural network (DNN) learning machine for a method of detecting early termite infestation, in accordance with an embodiment of the present disclosure.

[0019] FIGURE 9 illustrates spectragrams of audio samples for a method of detecting early termite infestation, in accordance with an embodiment of the present disclosure.

[0020] FIGURE 10 illustrates a second flowchart for a method of detecting early termite infestation, in accordance with an embodiment of the present disclosure.

Detailed Description

[0021] Embodiments are described more fully below in sufficient detail to enable those skilled in the art to practice the system and method. However, embodiments may be implemented in many different forms and should not be construed as being limited to the embodiments set forth herein. The following detailed description is, therefore, not to be taken in a limiting sense.

[0022] When elements are referred to as being “connected” or “coupled,” the elements can be directly connected or coupled together or one or more intervening elements may also be present. In contrast, when elements are referred to as being “directly connected” or “directly coupled,” there are no intervening elements present.

[0023] The subject matter may be embodied as devices, systems, methods,

and/or computer program products. Accordingly, some or all of the subject matter may be embodied in hardware and/or in software (including firmware, resident software, micro-code, state machines, gate arrays, etc.) Furthermore, the subject matter may take the form of a computer program product on a computer-usable or computer-readable storage medium having computer-usable or computer-readable program code embodied in the medium for use by or in connection with an instruction execution system. In the context of this document, a computer-usable or computer-readable medium may be any medium that can contain, store, communicate, propagate, or transport the program for use by or in connection with the instruction execution system, apparatus, or device.

[0024] The computer-usable or computer-readable medium may be, for example but not limited to, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, device, or propagation medium. By way of example, and not limitation, computer readable media may comprise computer storage media and communication media.

[0025] Computer storage media includes volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information such as computer readable instructions, data structures, program modules or other data. Computer storage media includes, but is not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can

accessed by an instruction execution system. Note that the computer-usable or computer-readable medium could be paper or another suitable medium upon which the program is printed, as the program can be electronically captured, via, for instance, optical scanning of the paper or other medium, then compiled, interpreted, of otherwise processed in a suitable manner, if necessary, and then stored in a computer memory.

[0026] Communication media typically embodies computer readable instructions, data structures, program modules or other data in a modulated data signal such as a carrier wave or other transport mechanism and includes any information delivery media. The term “modulated data signal” means a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media includes wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, RF, infrared and other wireless media. Combinations of the any of the above should also be included within the scope of computer readable media.

[0027] When the subject matter is embodied in the general context of computer-executable instructions, the embodiment may comprise program modules, executed by one or more systems, computers, or other devices. Generally, program modules include routines, programs, objects, components, data structures, etc. that perform particular tasks or implement particular abstract data types. Typically, the functionality of the program modules may be combined or distributed as desired in various embodiments.

[0028] As may be appreciated, based on the disclosure, there exists a need in the art for a sensitive and non-invasive method of termite inspection that can discern a type and an intensity of termite activity, thereby detecting an early infestation and avoiding catastrophic damage. Also, there exists a need in the art for a portable device that acoustically detects a variety of sound patterns of the termite activity that may conduct through wooden structures which otherwise appear undamaged. Additionally, there exists a need in the art for the acoustic detector to filter out environmental noises present in an inspection area and which otherwise would mask the sound patterns. Further, there exists a need in the art for a small stationary monitor to automatically and periodically monitor for early termite infestation in several key locations around the house.

[0029] Referring now to FIGURES 5-7, in various embodiments, there is described a method of using a portable sampling device for early detection of termite activity within a suspect zone of a building made with wood. In FIGURE 6, the suspect zone is a kitchen. The suspect zone may contain environmental noise maskable of at least one sound pattern of the termite activity discoverable in the building. The method may include collecting and storing an environmental knowledge base representing a variety of environmental noises potentially present in the suspect zone. The variety of environmental noises may include one or more of the following human-made and natural noises potentially inside or outside of the building: a dog barking, a door shutting, air blowing from a HVAC system, an airplane flying overhead, street noise, talking near the suspect zone, a baby crying, a police siren, a faucet running, an appliance humming, and music from

the room next door.

[0030] Continuing with FIGURES 5-7, in various embodiments, the method may also include establishing a termite pattern library representing a variety of termite sound patterns discoverable during a termite inspection. At least a portion of the pattern library may be accessible by or storable within the sampling device, shown in FIGURE 6 as a smart phone. Both the environmental knowledge base and the termite pattern library may be located in a centralized data location accessible through the cloud, as shown in FIGURES 6-7, and may be connectible to the portable device through a wireless internet link. The variety of sound patterns may comprise different types of termite activity indicative of a degree of infestation, and which may be useful in discerning an early infestation from an advanced infestation. The sound patterns (FIGURE 5) may include a dry rattle, a papery rustling sound, clicking sounds (also pop, crackle), and ultrasonic sounds.

[0031] Referring still to FIGURES 6-7, in various embodiments, the method may include providing a deep learning model based on an artificial neural network for learning to discern the at least one sound pattern from the variety of sound patterns and in the presence of the variety of environmental noises. Recent advances in speech-to-text technology and facial recognition, through machine learning, may be applied to recognizing termite ‘words’ (sound patterns) and/or filtering out the background noise that masks the sound patterns. In addition to the development of these neural networks, increases in processor speed and memory size may enable smart phones to provide this ‘voice recognition’ capability. Other

forms that the deep learning model may take include feed-forward techniques, recurrent neural network algorithms, and connectionist temporal classification (CTC).

[0032] Continuing with FIGURES 5-9, in various embodiments, the method may further include training the deep learning model on the variety of sound patterns in the termite pattern library to produce an intelligent algorithm installable in the sampling device for detecting the termite activity. The variety of termite sound patterns may include hundreds or thousands of audio samples of each sound pattern, classified into particular termite activities by human experts, and inputted to the model for developing the algorithm. The types of sound patterns may include alarm signaling (“dry rattle”, FIG. 5), movement in tunnels (“paper rustling”), biting sounds (“clicking”), and many others not classified here. The model may also be trained on sound patterns superimposed on the variety of environmental noises (FIG. 8). Once pre-trained on centralized servers, the model may be reduce to a small computational footprint for installation on the portable sampling device.

[0033] In various embodiments, samples of sound patterns may be collected from the field to support robust training of the Deep Learning Model. Each sound pattern may vary in the same way human speech varies depending on dialect, age, gender, and emotional state. Samples of a particular termite sound pattern may vary according to geography, type of wood or non-wood material, moisture content of wood, age of individual, age of the colony, population of the colony, size of the sampling environment, background noise, and temperature. The model

may make use of graphical processing units (GPU) or spectrograms (FIG. 9), which are frequency-time-amplitude signatures of an audio sample.

[0034] Referring again to FIGURES 6-7, in various embodiments, the method may further include directing , during the termite inspection, a primary audio transducer configured to the sampling device and toward a sample location in the suspect zone. For instance, the suspect zone may be the kitchen and the sample location may be a baseboard near the sink cabinet. The primary transducer may be a microphone built into the portable sampling device or smart phone. The primary transducer may also be a contact transducer (e.g. stethoscope or piezoelectric transducer) placeable against a solid surface in the suspect zone for improving a signal-to-noise (SNR) ratio between the termite activity and the environmental noise.

[0035] Continuing, the method may further include collecting an audio sample from the sample location (“Start” in FIG. 7). The acoustic energy collected may be substantially within the human frequency range of 20Hz - 20kHz. Alternatively, the sampling device and primary audio transducer may be configured to sample substantially in the ultrasonic range above 20kHz, and which may extend up to 100kHz. A length of the audio sample may be a matter of seconds, or may be a matter of minutes. The audio samples of may also be accumulated by the sampling device for uploading to the termite and environmental databases for further ‘lab learning’ and training of the deep learning model. The uploading may take place over a wireless link.

[0036] In a preferred embodiment, the method may further include evaluating the

audio sample, using the intelligent algorithm, for a match with at least one of the variety of sound patterns in the termite pattern library. If there is a match (“Yes” in FIG. 8), the sampling device may indicate an intensity of the termite activity. The fact of a ‘match’ may depend on the intensity being greater than an activity threshold. If the activity threshold is exceeded, the type of activity (sound pattern) may also be indicated and may include indicating a confidence level for detecting that type of activity. Indications of the type and the intensity may be displayed on a screen of the sampling device, and together may suggest the degree of infestation. There may be a persistent link between the portable sampling device and the centralized deep learning model in order to support the evaluation process and/or to further train the deep learning model with new audio samples.

[0037] If there is not a confident match (“No” or “Maybe”), the sampling device may recommend another sampling location, repeating the same sample, varying the distance on at the same sample location in order to get a different SNR, reducing the environmental noise at the source, or collecting a purely environmental noise sample. For example, referring to FIGURE 6, reducing the environmental noise may include turning off the water, turning off an appliance, waiting until a plane is done flying overhead, or turning off the dishwasher.

[0038] Continuing with FIGURE 7, in an embodiment, the indicating may include displaying an activity pattern, which may be a time-waveform image of the sound pattern, a spectral density image of the sound pattern, or a spectrogram. The indicating may also include an option to play back, for an operator of the termite inspection, a recording of the audio sample. The intelligent algorithm may also be

configured to remove the environmental noise from the audio sample and provide a filtered audio sample for playback to the operator. Given current technology, environmental noise which is louder than the termite activity may be suppressible for playback.

[0039] Continuing with FIGURES 6-7, in various embodiments, the method may include feeding a secondary audio transducer into the sampling device for receiving site-specific environmental noise within the suspect zone concurrent with the collecting of the audio sample with the primary transducer. In FIGURE 6, the secondary transducer may be mounted on a tripod. The intelligent algorithm may utilize this secondary and concurrent input to improve its evaluation of the audio sample and more accurately identify the type and the intensity of the termite activity in the suspect zone (kitchen. A noise cancelling (FIGURE 7) processor within the portable sampling device may subtract the site-specific noise from the audio sample and thereby improve the SNR of the audio sample. The cancelled audio sample may then be applied to the intelligent algorithm for detecting the termite activity.

[0040] In an embodiment not shown, the portable device may be one or more stationary monitoring units hidable at suspect zones around the building for automatically and periodically monitoring for termite activity. The stationary monitor may be battery powered or plugged into a nearby power supply, and may be similar in size to a smart phone (or slightly larger). The primary transducer may be one or more internal microphones, and the unit may include a contact transducer mounted firmly and vibrationally to an at-risk structure. An intelligent

algorithm application may be installed in the stationary unit for identifying the acoustic sample in terms of its particular type and intensity of termite activity. The stationary unit may be configured with a status output for alerting the operator of the inspection of possible infestation. The status output may be displayed on a unit housing and/or relayed to a remote location via Bluetooth, WiFI, or an internet connection based on cellular or other wireless infrastructures.

[0041] Referring now to FIGURE 10, in another embodiment, a method is described for using a portable sampling device to detect an early infestation of termite activity within a suspect zone of a building made with wood. The suspect zone may contain environmental noise (described above) maskable of at least one sound pattern of the termite activity discoverable in the building. The method may establish a termite pattern library containing a variety of termite sound patterns (described above) discoverable during a termite inspection of the suspect zone. At least a portion of the pattern library may be accessible by or storable within the sampling device.

[0042] Continuing with FIGURE 10, the method may include placing a contact transducer configured to the sampling device in firm contact with a solid surface in the suspect zone for detecting the termite activity. For example, a piezoelectric or stethoscopic transducer may firmly contact the solid surface (e.g. baseboard) by magnet, tape, or by manually holding the transducer against the solid surface. An electrical cable may connect the output of the transducer to the sampling device via an audio jack or USB port. The method may further include placing a substantially omnidirectional microphone in an open area of the suspect zone,

configured to the sampling device, for collecting environmental noise. Alternatively, this environmental microphone may be directional and pointing away from the sample area in order to emphasize the environmental noise.

[0043] Referring still to FIGURE 10, in various embodiments, the method may further comprise collecting a vibrational sample from the contact transducer and concurrently collecting a noise sample from the omni microphone. For example, initiating the START button on the sampling device may initiate both samples. The frequency range of the samples may span the human frequency range of 20Hz - 20kHz, an ultrasonic range above 20kHz, or portions of both ranges.

[0044] The method may further include aligning the vibrational and noise samples in time in order to account for latency between the two recording processes and/or to account for room echo and time-of-travel differences. Then, a scaled portion of the noise sample may be subtracted from the vibrational sample such that the difference is minimized, thereby producing a cancelled sample having a substantial amount of the environmental noise removed from the vibrational sample. A correlator installed in the sampling device may accomplish the aligning and subtracting steps, and may store at least a portion of the variety of termite sound patterns available from the pattern library.

[0045] Proceeding further with FIGURE 10, finally, the method may include correlating the cancelled sample with one or more of the portion of sound patterns for identifying the termite activity and discovering a degree of correlation for each correlated pattern. The sampling device may indicate the at least one sound pattern of the termite activity when the degree of correlation is greater than a

correlation threshold. The degree of correlation may be a correlation coefficient valued between 0 and 1, where the correlation threshold may be ≥ 0.7 or a threshold which optimizes a speed and a confidence of the termite inspection. Indications of the sound patterns and the degree of correlation may be displayed on a screen of the sampling device. The display may include an activity pattern of the at least one sound pattern such as a time-waveform image, a spectral density, or a spectrogram. The portable device may also include an option to play back a recording of the cancelled sample for assessing one or more of a degree of infestation and a type of the at least one sound pattern.

[0046] If the degree of correlation is below the corresponding threshold (“No” or “Maybe”), the sampling device may recommend another sampling location, repeating the same sample, reducing the environmental noise at the source, or collecting a purely environmental noise sample. For example, referring to FIGURE 6, reducing the environmental noise may include turning off the water, turning off an appliance, waiting until a plane is done flying overhead, or turning off the dishwasher.

[0047] In another embodiment, referring still to FIGURE 10, the alignment (above) of the vibrational and the noise samples may occur across a sliding timescale in the correlating process. The correlator may also operate on the vibrational and noise samples using a deep neural network for real-time noise suppression.

[0048] Although the above embodiments have been described in language that is specific to certain structures, elements, compositions, and methodological

steps, it is to be understood that the technology defined in the appended claims is not necessarily limited to the specific structures, elements, compositions and/or steps described. Rather, the specific aspects and steps are described as forms of implementing the claimed technology. Since many embodiments of the technology can be practiced without departing from the spirit and scope of the invention, the invention resides in the claims hereinafter appended.

WHAT IS CLAIMED IS:

1. A method of using a portable sampling device for early detection of termite activity within a suspect zone of a building made with wood, where the suspect zone contains environmental noise maskable of at least one sound pattern of the termite activity discoverable in the building, the method comprising:

collecting an environmental knowledge base representing a variety of environmental noises potentially present in the suspect zone;

establishing a termite pattern library representing a variety of termite sound patterns discoverable during a termite inspection of the suspect zone, at least a portion of the pattern library accessible by or storable within the sampling device;

providing a deep learning model based on an artificial neural network for learning to discern the at least one sound pattern from the variety of sound patterns and in the presence of the variety of environmental noises;

training the deep learning model on the variety of sound patterns in the termite pattern library to produce an intelligent algorithm installable in the sampling device for detecting the termite activity;

directing, during the termite inspection, a primary audio transducer configured to the sampling device and toward a sample location in the suspect zone;

collecting an audio sample from the sample location and substantially within the human frequency range of 20Hz -20kHz;

evaluating the audio sample, using the intelligent algorithm, for a match with

at least one of the variety of sound patterns in the termite pattern library; and

indicating, by the sampling device, an intensity of the termite activity if the intensity is greater than an activity threshold.

2. The early termite detection method of claim 1, further comprising:

indicating a type of the matched sound pattern, when the activity threshold is exceeded, the type and the intensity suggesting a degree of infestation

3. The early termite detection method of claim 1, wherein:

the variety of environmental noises include one or more of the following human-made and natural noises potentially inside or outside of the building: a dog barking, a door shutting, air blowing from a HVAC system, an airplane flying overhead, street noise, talking near the suspect zone, a baby crying, a police siren, a faucet running, an appliance humming, and music from the room next door.

4. The early termite detection method of claim 1, further comprising :

feeding a secondary audio transducer into the sampling device for receiving the environmental noise within the suspect zone concurrent with the collecting of the audio sample with the primary transducer.

5. The early termite detection method of claim 1, wherein :

the primary transducer is one of the following:

a microphone in open air, and

a contact transducer placeable against a solid surface in the suspect zone for improving a signal-to-noise ratio between the termite activity and the environmental noise.

6. The early termite detection method of claim 1, wherein :

the portable sampling device is a smart phone configured with an application for the intelligent algorithm.

7. The early termite detection method of claim 6, wherein :

the primary transducer is a built-in microphone of the smart phone.

8. The early termite detection method of claim 1, further comprising:

the indicating by the sampling device including one or more of a time-waveform image of the sound pattern, a spectral image of the sound pattern, a confidence indicator, and a recording of the termite activity for playback.

9. The early termite detection method of claim 1, wherein:

the portable device is a stationary monitoring unit positionable at one or more suspect locations around the building for automatically monitoring for the termite activity.

10. The early termite detection method of claim 1, wherein:

the environmental knowledge base is one or more of stored in a centralized database connectable to the portable sampling device and accumulated by the sampling device during multiple termite inspections.

11. The early termite detection method of claim 1, further comprising:

cancelling environmental noise in the suspect zone during collection of the audio sample, where the device is configured with a secondary microphone for pointing away from the termite activity in order to obtain site-specific environmental knowledge to be subtracted from the audio sample during the cancelling.

12. A method of using a portable sampling device for early detection of termite activity within a suspect zone of a building made with wood, where the suspect zone contains environmental noise maskable of at least one sound pattern of the termite activity discoverable in the building, the method comprising:

establishing a termite pattern library containing a variety of termite sound patterns discoverable during a termite inspection of the suspect zone, at least a portion of the pattern library accessible by or storable within the sampling device;

placing a contact transducer configured to the sampling device in firm contact with a solid surface in the suspect zone and responsive to the termite activity;

placing a substantially omnidirectional microphone in an open area of the suspect zone and also configured to the sampling device for collecting environmental noise;

collecting a vibrational sample from the contact transducer and concurrently collecting a noise sample from the omni microphone;

aligning the vibrational and noise samples in time and subtracting a scaled portion of the noise sample from the vibrational sample such that the difference is minimized, thereby producing a cancelled sample;

correlating the cancelled sample with one or more of the variety of sound patterns for identifying the termite activity and discovering a degree of correlation for each correlated pattern; and

indicating, by the sampling device, the at least one sound pattern of the termite activity when the degree of correlation is greater than a correlation threshold.

13. The early termite detection method of claim 12, further comprising:

playing back for an operator of the termite inspection the cancelled sample for assessing one or more of a degree of infestation and a type of the at least one sound pattern.

14. The early termite detection method of claim 12, wherein:

the degree of correlation is a correlation coefficient between 0 and 1, and the correlation threshold is > 0.7.

15. The early termite detection method of claim 12, wherein:

the correlating is performed on the audio sample using a deep neural network for real-time noise suppression.

16. The early termite detection method of claim 12, wherein:

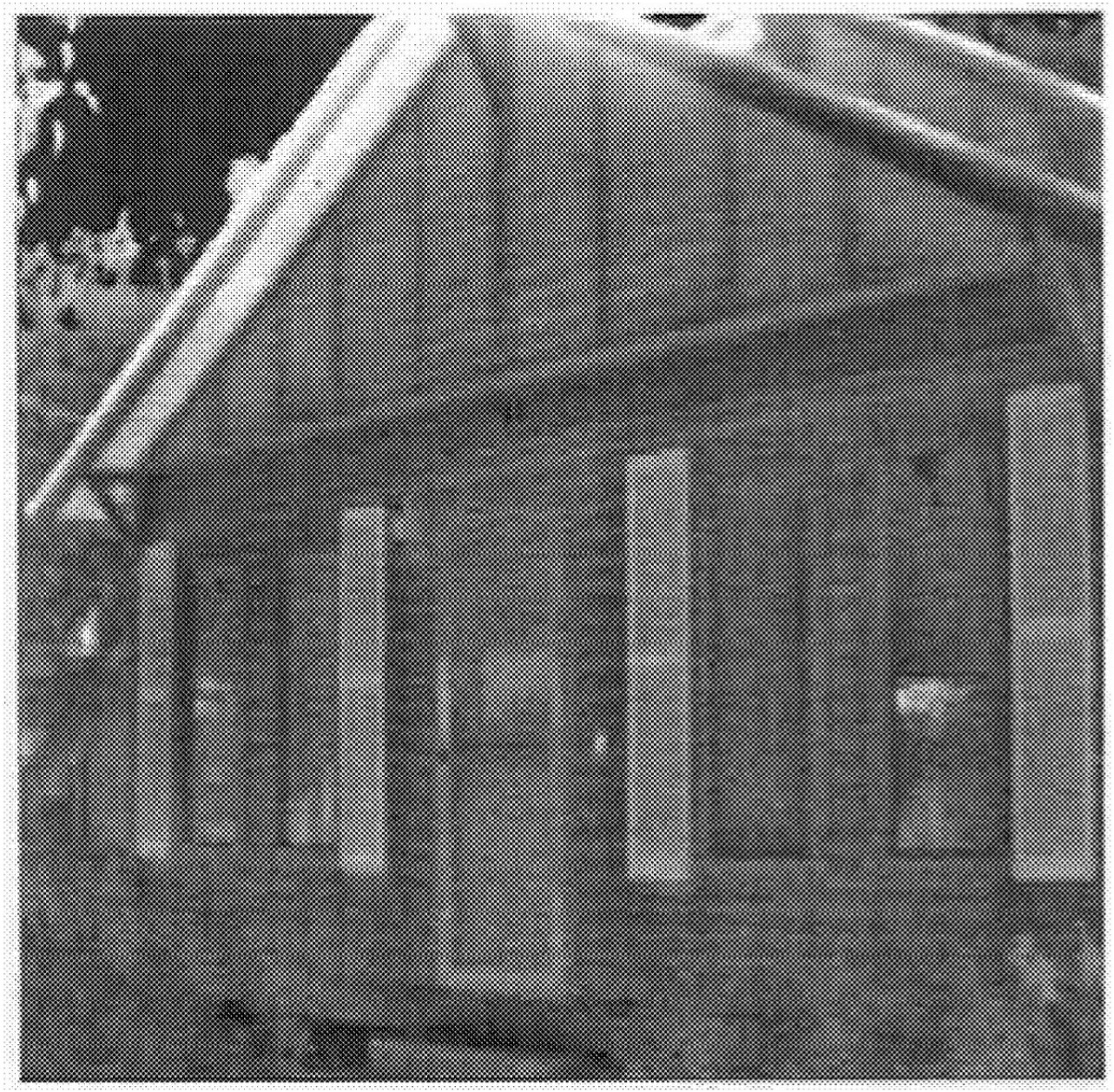
the correlating occurs across a sliding timescale.

17. The early termite detection method of claim 12, wherein:

the variety of environmental noises include human and natural noises found inside and outside of the building, including one or more of a dog barking, a door shutting, air blowing from a HVAC system, an airplane flying overhead, street noise, talking near the suspect zone, a baby crying, a police siren, a faucet running, an appliance humming, and music from the room next door.

Abstract

There is disclosed a method for early detection of termite activity within a suspect zone of a building that contains environmental noise maskable of the termite activity. An environmental knowledge base may be collected to represent background noises potentially present in the suspect zone. A termite pattern library may represent a variety of termite sound patterns discoverable during a termite inspection. A deep learning model may be trained on the sound patterns and the environmental knowledge for learning to discern the presence of termite activity and for producing an intelligent algorithm installable in the sampling device. A primary audio transducer may be configured to the sampling device and directed toward a sample location in the suspect zone to collect an audio sample. By operation of the intelligent algorithm, the device may indicate at least one sound pattern and an intensity level of the termite activity.



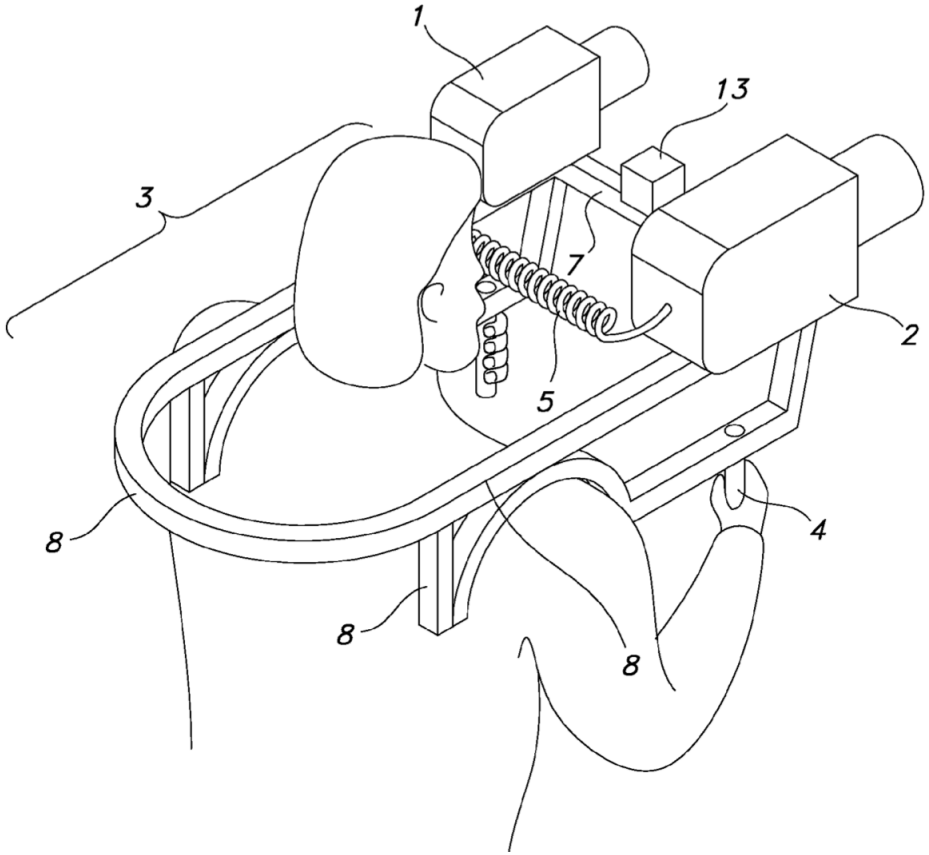
Wooden House
US20090046759A1

FIG. 1

FIG. 2a

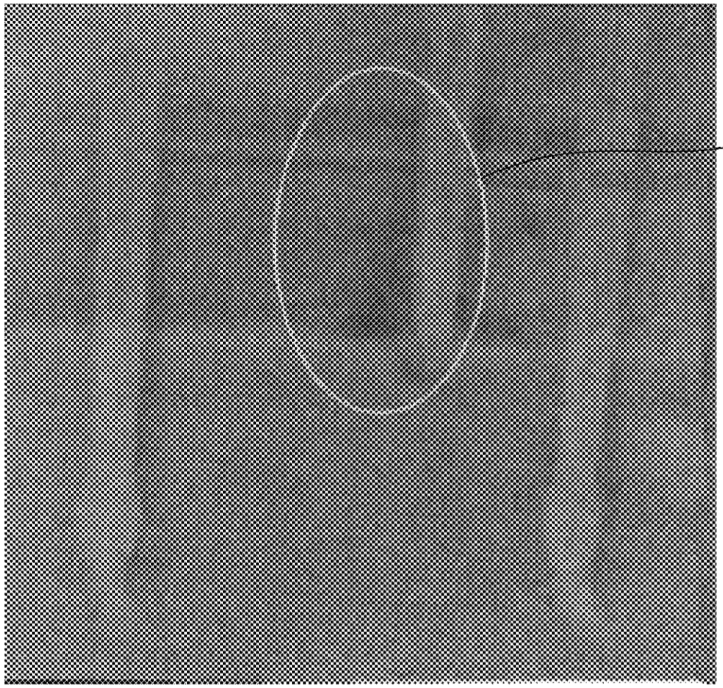
FIG. 2b

Termite Tunnel (or Mud Tube) On Wood Beam
Advanced Infestation



Thermal Imaging Apparatus

FIG. 3a



Thermal Scan of
Interior Wall Structure

FIG. 3b

PRIOR ART - Thermal Scanning (US20090046759A1)

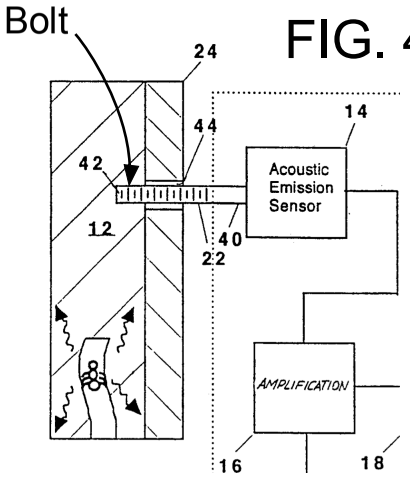


FIG. 4a

Termite Emission
US5285688

FIG. 4b

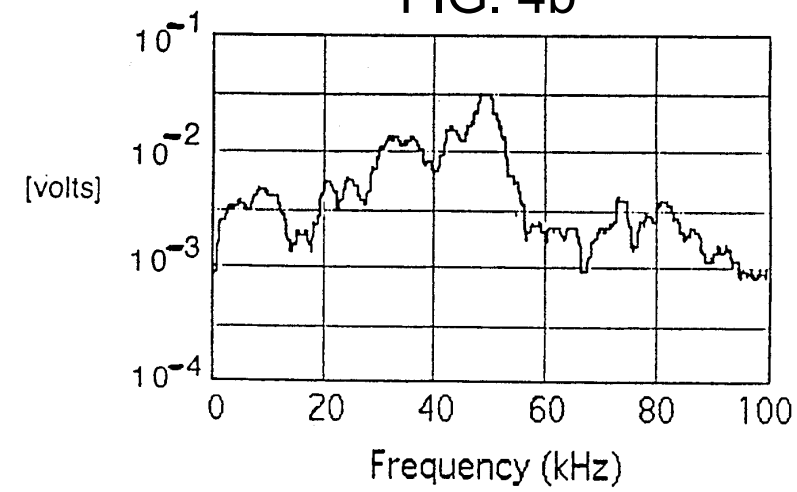


Fig. 3

PRIOR ART
Acoustic Responses

Spectral and Time-Domain Signatures of Termite Activity with peaks at 5kHz & 15kHz.

16th European Signal Processing Conference (EUSIPCO 2008), Gonzalez de la Rosa, et ii

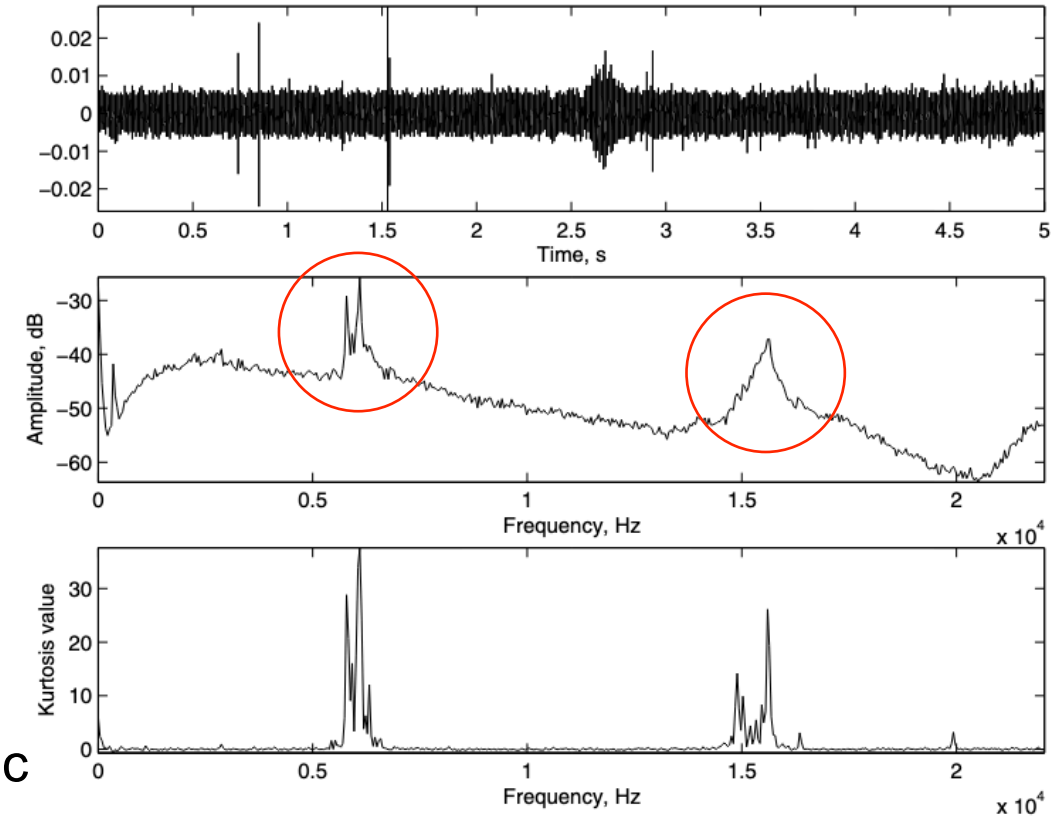


FIG. 4c

DRY RATTLE
occurring when nearby wood is disturbed, causing the termites to bang their heads on the wall of the tunnel as an alarm signal (Terminix ™)

PAPERY RUSTLING
as many termites move through tunnels (Terminix ™)

CLICKING SOUND
occuring in groups of 3-5 clicks over ~1 second as their mandibles bite and chew the wood (US20060028345A1)

ULTRASONIC SOUNDS:
in US 4,809,554 (~40kHz) and US 5,285,688 (45-65kHz)

FIG. 5 **Some Varieties of Termite Activity Detectable as Sound Patterns**

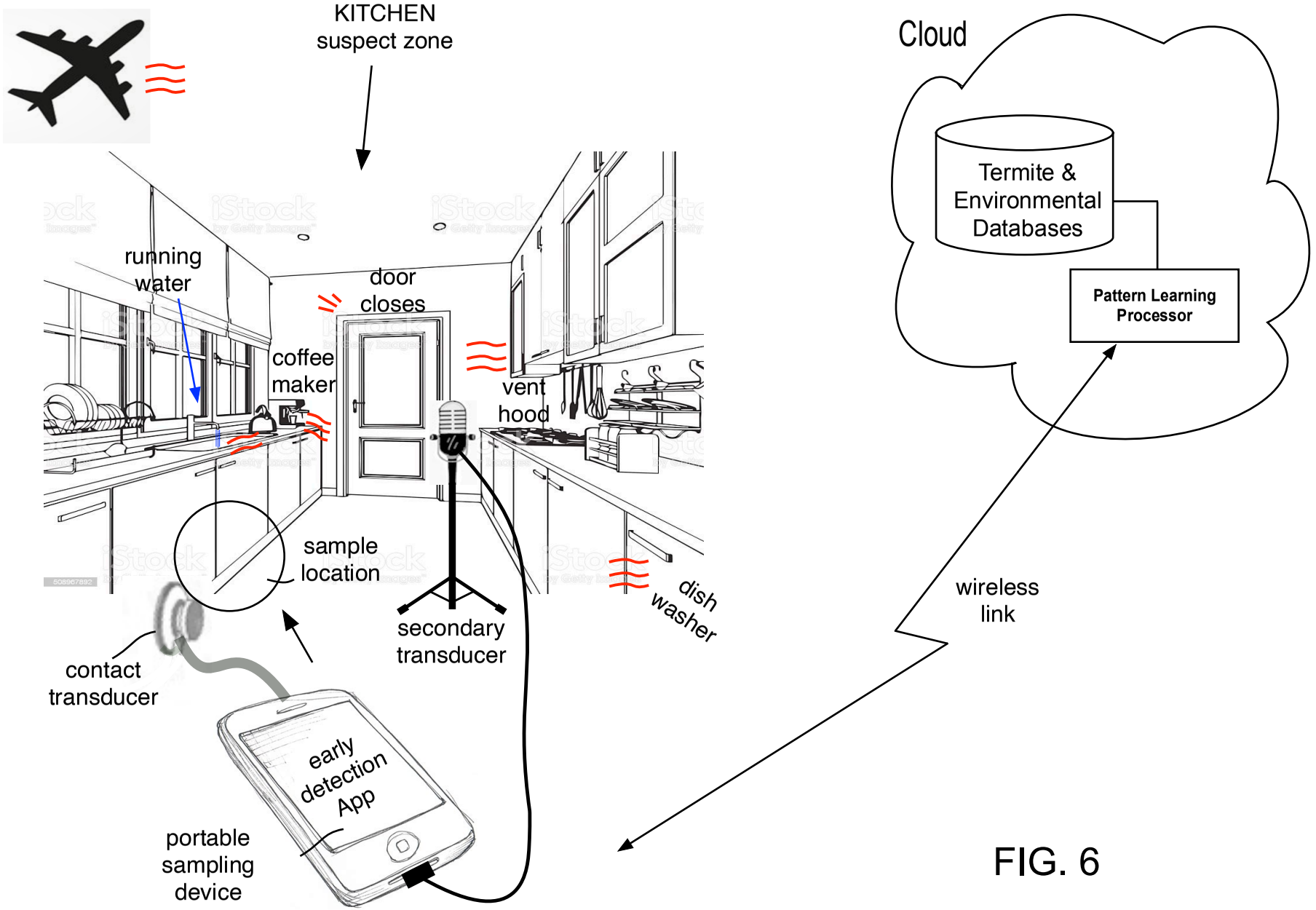
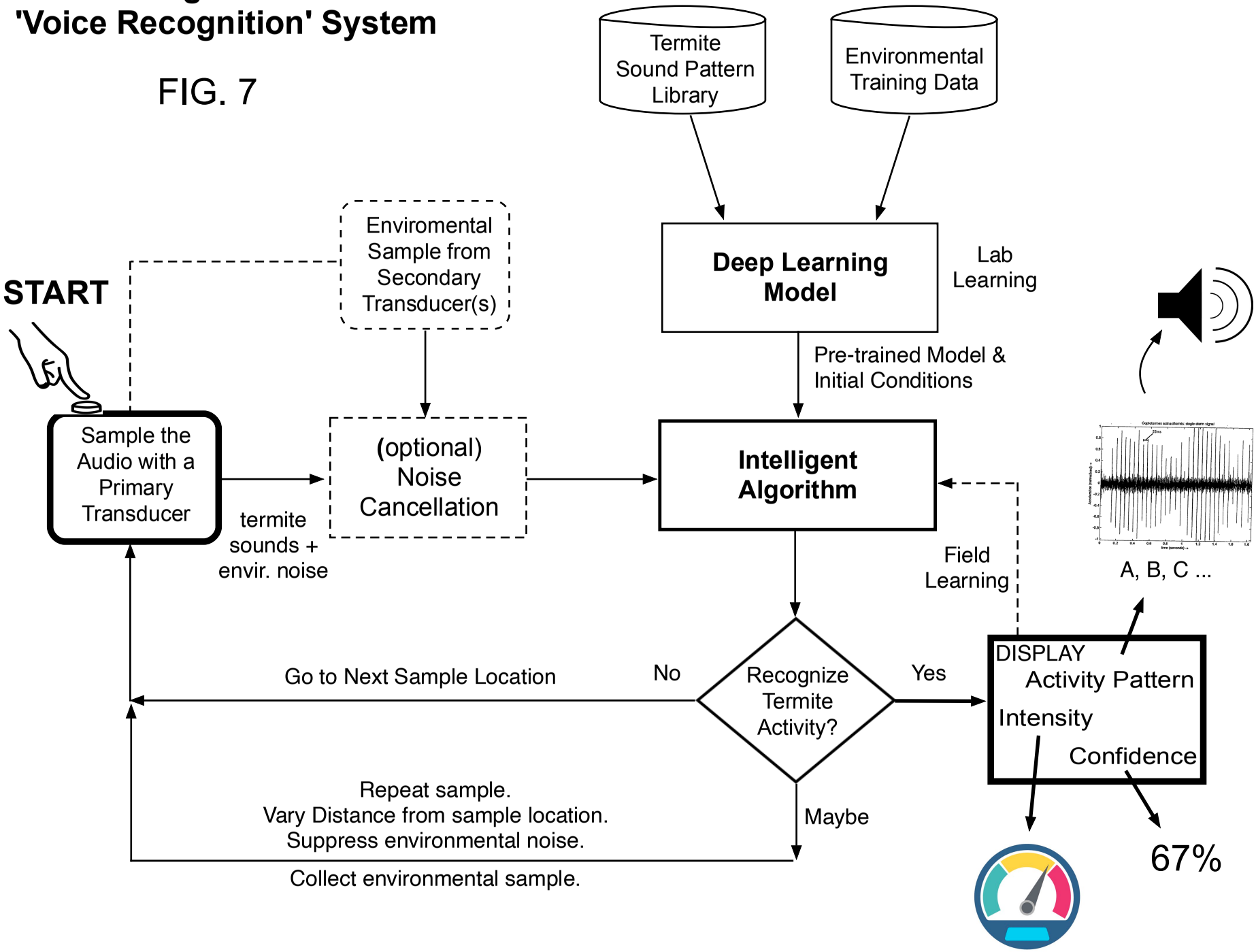


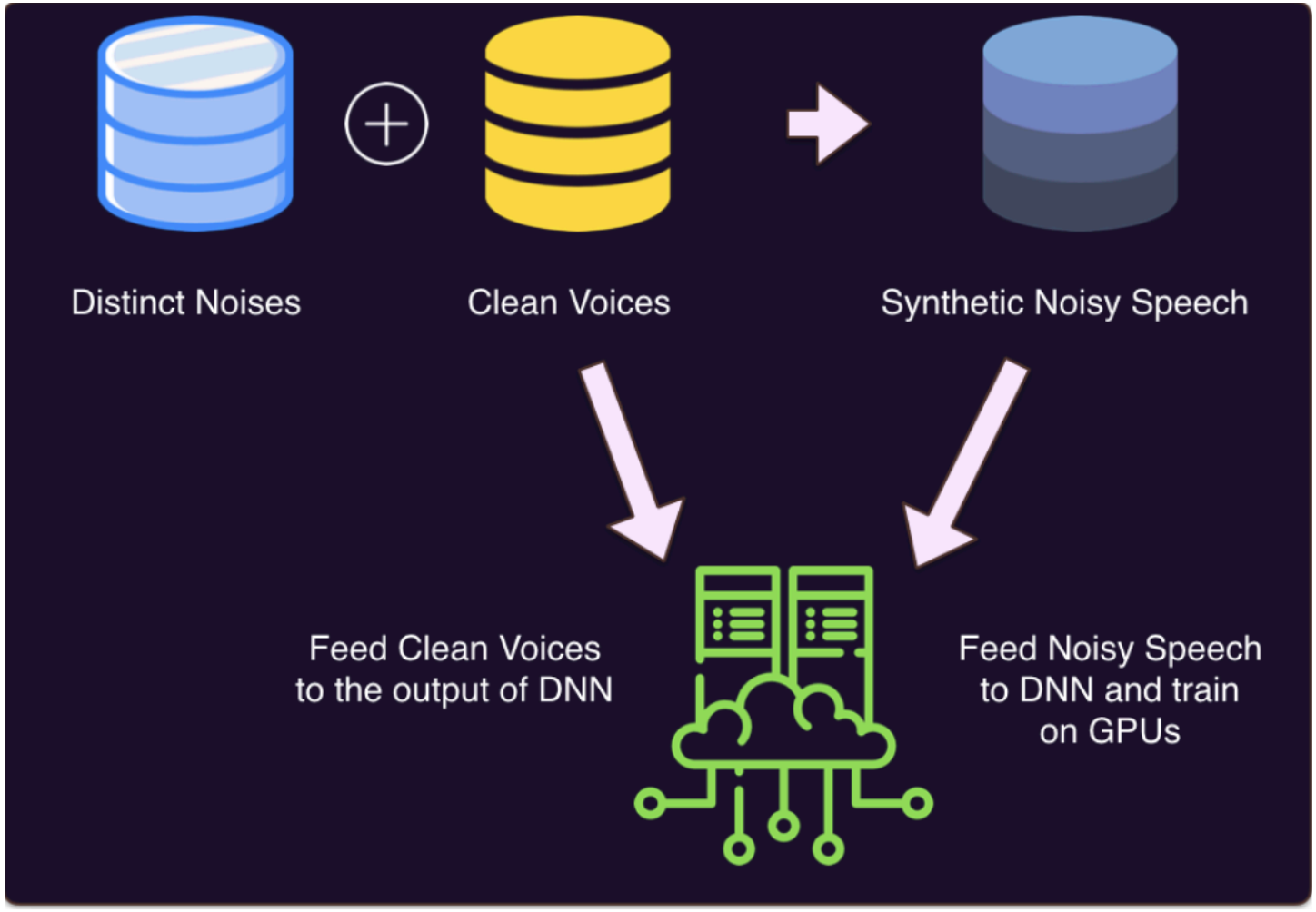
FIG. 6

Performing a Termite Inspection with Environmental Noise

Detecting Termites via 'Voice Recognition' System

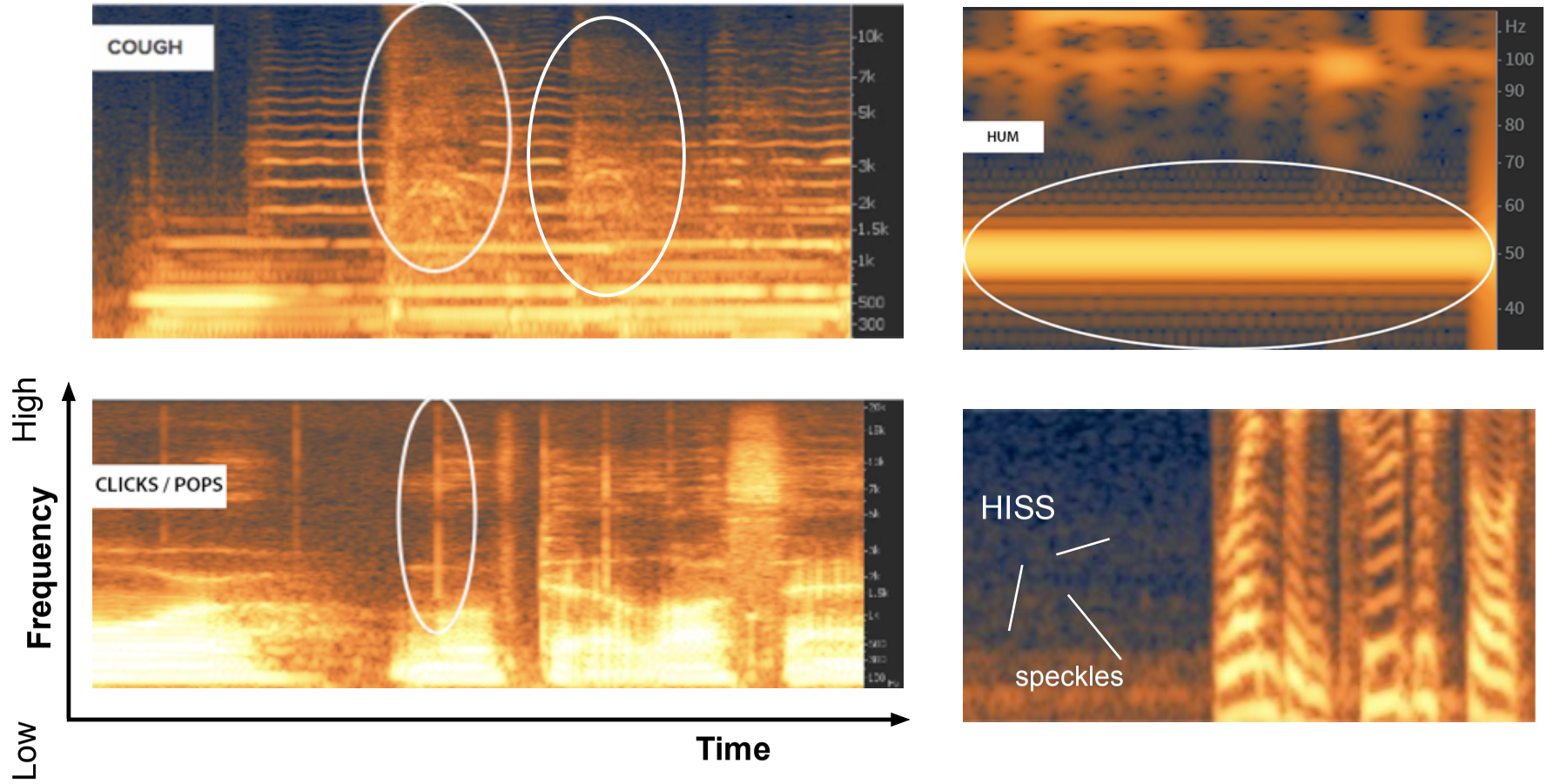
FIG. 7





PRIOR ART
Training Process for Krisp's Noise Suppression
Using a Deep Neural Network (DNN)

FIG. 8



**SPECTROGRAMS from izotope.com -
Examples of Human Voice/Music
each with a Different Background Noise
Which Can Be Removed with Machine Learning**

FIG. 9

Detecting Termites via Correlation

FIG. 10