Research Article

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The Forensic Resonance Revolution

Vass Arpad A*

Vass Consulting/FAST Director/Forensic Recovery Services, 105 Carson Lane, Oak Ridge, USA.

***Correspondence:**
Vass Arpad A, Vass Consulting/FAST Director/Forensic Recovery Services, 105 Carson Lane, Oak Ridge, USA.

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ABSTRACT

Locating skeletal elements scattered on the surface of the ground or human remains contained within clandestine graves, continues to be one of the greatest challenges for law enforcement, the military, and human rights organizations worldwide. This is for two reasons: 1) no two scenarios are the same since each scene or location has different taphonomic parameters; and 2) no detection method formerly available is specifically designed to locate human bone or tissue at a distance. This manuscript describes the scientific concepts (the piezoelectric properties of bone and/or unique identifying resonance frequencies found in both living and deceased individuals) used in the development of new technology which was then used to locate a deceased woman who had been missing for 3 to 4 weeks prior. This technology transmits electrical energy through the ground, and because of the crystalline nature of both bone and DNA, allows for the detection of specific human remains using resonance frequencies in the sub KHz range at a distance of many miles.

Keywords
Human remains, Piezoelectric, Quantum Oscillator, Resonance, Stand-off detection.

Introduction
There are currently several means of locating clandestine graves: manual probing, canine searches, ground penetrating radar (GPR), magnetometers, soil resistivity, plant/fungi growth, visual observation (e.g. subsidence or mounding), aerial searches, etc., all of which are limited by a multitude of drawbacks and are time consuming [1-5]. Manual probing is inexpensive and is used to locate disturbed soil regions, but cannot confirm the presence of a corpse and can only be used in small areas. GPR also locates areas of disturbed soil, but can be expensive. Under ideal conditions, and if the grave is very fresh, GPR can sometimes indicate the presence of a corpse, but can be easily fooled by objects in the environment (e.g. roots, stumps, rocks, debris, man-made objects, etc.) and requires a significant amount of training to interpret the signals indicative of clandestine graves. Canines that detect human remains, commonly referred to as human remains detection (HRD) canines (K9), are minimally represented in the law enforcement canine population across the United States. For a variety of reasons, this canine detector specialty has not been given the attention that is afforded both the explosive and narcotic specialties. One concern facing HRD canine units is that there is a great disparity in both training and certification standards and that the alerts may not completely be in response to odor alone with some indication that perhaps canines are also partially reacting to the electrical properties of bone as well, although validating this hypothesis requires additional research (refer to discussion below). Additionally, law enforcement personnel are not always aware of the canines' capabilities and in some cases simply do not understand how to utilize this type of technology. This potentially jeopardizes search and seizure as well as probable cause rules currently established for search warrants and chain of custody. Many agencies usually employ a combination of these methods when searching for clandestine graves, mass graves, or missing persons, which also results in increases in costs, significant utilization of man-hours, logistics, and time concerns. Many clandestine burials occur in remote areas with difficult terrain, are typically shallow, and can be wrapped in some type of material, which has the potential to affect all of the above-mentioned technologies. Additionally, the decomposition of human remains is a complex process that varies extensively with the taphonomy, and it is likely that no two bodies will decompose in exactly the same way due to the manner of their demise and the environmental factors, which influence the decompositional process [6,7].

Concepts and Methods

Piezoelectricity

The piezoelectric and crystalline (hydroxyapatite) properties of bone, however, provide a relatively easy method for locating both animal and human remains since bone will produce an electric field when pressure is applied to it. Piezoelectricity was discovered by Pierre Curie in 1880 when conducting pressure studies using quartz. 'Piezo' in Greek means pressure, and piezoelectricity is a well-known phenomenon utilized in medicine (ultrasound, tissue regeneration), electronics (including power harvesting), and in dipole induction in crystals (Quartz, Rocelle salts, barium titanate, etc.) [8-13]. Regardless of the form of the bone: fresh ($Ca_5(PO_4)_3OH$), dry ($Ca_3Na(PO_4)_{3,}$ or ash ($Ca_3(PO_4)_3$), it maintains its piezoelectric properties – the 'pressure' resulting from either the weight of the soil from being buried or the weight of the bone lying on a surface. To confirm this scientific discovery, this manuscript's author conducted a simple experiment using a voltmeter's leads attached to a bone sample, and confirmed that simply blowing air on the bone applied sufficient pressure to cause up to a 2.0 mV increase in the electric field output of the bone. Interestingly, electricity and magnetism go hand in hand, because a changing electric field creates a magnetic field, and a changing magnetic field creates an electric field. The crystalline structure and the piezoelectric properties of bone combined with the resulting electromagnetic field can then be used to easily locate bone specimens (at a distance) by means of standard dipole antennae detection techniques using either in-line or offset modes of operation [14,15]. This particular technology has been shown to detect skeletal elements at a distance of over 480 m (1,600 ft) and this finding was not only used to detect and locate the skeletal elements recovered in Georgia v. Ryan Duke, but was ruled admissible by the Irwin County Criminal Court, May 2022, State of Georgia, USA.

Another related phenomenon is the deformation of the crystalline structure and mechanical movement of bone when exposed to strong electric fields. If the electric field alternates, the bone will begin to vibrate. The vibration amplitude is maximized when the bone's mechanical resonant frequency matches the frequency generated by the alternating electric field [16]. This is not difficult to achieve since the human body can produce a relatively large pulsed induced voltage (up to 17V when walking) which can be transferred to its surroundings in either a grounded or an ungrounded state [17]. This induced voltage and its effect on bone, either on the surface or buried, can be used to locate skeletal elements and follows Newton's second law of motion (Force = mass x acceleration) which was published in 1687 [18]. When using this technology to locate bone, the '<u>force</u> (or magnitude) of the generated electric field = the <u>mass</u> of the bone x the rate (<u>acceleration</u>) when traveling'. The author confirmed this concept by conducting handheld dipole antennae experiments while walking at various speeds toward bone fragments (very slow shuffle to a rapid pace) which proved that detection of bone can become quite difficult as one approaches an acceleration of zero (little to no induced voltage generated), but effortless as speed increases. The force does not seem to be significantly affected by the amount of mass although some mass must be present for this technology to be successful.

Resonance

While the evaluation of piezoelectricity sources using dipole antennae to locate bone has significant merit, it still can be misleading when looking for a specific individual since it will detect all types of bone (human and nonhuman) as well as all sources of piezoelectricity (underground power lines, water running through metal pipes, etc.). To overcome these issues, another type of remote sensing technology was developed which can locate a specific individual, living or deceased. This technology is based on quantum resonance frequencies. To date, the use of resonance in forensics has primarily been limited to specific medical applications (detection of osteoporosis, ageing blood spots) and in voice recognition (identification and modulation) [19-21].

Dr. Royal Raymond Rife (1888-1971), a brilliant American optics engineer and inventor of the Rife machine in 1920, is credited with the discovery that all organisms possess a unique resonant frequency and used this concept to cure dozens of diseases [22]. The basis of that concept is that as atoms join together to form molecules which in turn are held together with covalent bonds, they emit and absorb unique electromagnetic frequencies. These frequencies are unique and different molecules have different electromagnetic oscillations and therefore they each possess distinctive signatures. In fact, one of the interesting discoveries which occurred during the course of the experiments the author conducted (refer to discussion below on how these experiments were conducted) is that not only do all elements have their own unique resonance frequencies, but elemental groupings (alkali metals, transition metals, etc.) in the periodic table also have their own specific harmonic frequencies which can be used to correctly place newly discovered elements into their associated groupings or verify that they are currently placed in their correct group.

Resonance is a phenomenon that occurs when the vibrational amplitude of the natural, unique frequency of a substance (in this particular case the mineral component of bone, nDNA (nuclear), RNA, or mDNA (mitochondrial)) is increased due to a force applied to it by another object vibrating at the exact same frequency. Resonance occurs with all sorts of vibrations or waves and includes mechanical, orbital, acoustic, electromagnetic, nuclear magnetic (NMR), electron spin (ESR) and quantum resonances [23]. Natural frequency, also termed eigenfrequency, is the frequency at which an object normally oscillates without being affected by an external force of an identical frequency. Eigenvalues can also be the squares of the natural frequencies. The pattern at which an object oscillates at its natural frequency is called the normal mode. If however, the object is stimulated by an external force which is identical to the object's normal mode, then this amplified frequency is termed the resonant frequency [24]. While many external force modes exist (sine, ramped, square, triangle, Gaussian, etc.), not all will provide the optimal amplification or transmissibility necessary to detect and identify individual specific frequencies.

In quantum resonance, as in many others types of resonance, the frequency emitted by an object can be measured in SI units (International System of Units) of frequency (one event per second), or hertz. The hertz is named after a German physicist, Heinrich Hertz, who was the first person to prove the existence of the electromagnetic waves predicted by James Clerk Maxwell [25]. Terminology used to describe increased frequencies of a hertz include kHz (kilohertz, 10^3 Hz), MHz (megahertz, 10^6 Hz), GHz (gigahertz, 10^9 Hz) and THz (terahertz, 10^{12} Hz). Finally, the purity (quality and quantity) of an object can affect its frequency. The signal response from a resonating object can have varying levels of detection specificity, which involve three mechanisms. These include the uncertainty in the Quantum mechanical energy levels, collisional broadening where increased collisions broaden the signal thereby reducing specificity, and Doppler or thermal broadening (where thermal turbulence affects the motions of atoms) [26].

Reactive Power

The human body can, and does, act as an antenna [27] and can transmit electrical power through the Earth/air/ground plane, which is critical when using quantum resonance for human detection. Ground charges produce reactive electromagnetic (EM) standing waves that propagate along the surface radially from the transmitter (the body), and the propagation distance is related to the number and type of objects in the environment that act as dampeners. If this standing wave is identical to the natural frequency of an object within range in the environment, then the object will resonate. The maximum confirmed distance achieved to-date in unimpeded standing-wave signal propagation detection is approximately 96.5 km (60 miles). This was determined by measuring the distance from a standing wave generator - the quantum oscillator (refer to discussion section), to an identical object in the field which began to resonate in the presence of the standing wave. An interesting phenomenon produced from reactive power is its ability to be transmitted on a single wire without a return path. Although this was documented nearly 150 years ago, it has been almost completely disregarded or unknown. By replacing the single wire with a terrestrial body (such as the earth), it becomes possible to propagate the reactive waves to any part of the environment in the same fashion as a wire. Since the waves are reactive, the energy transmitted is returned. Thus, very little, to no real power is used [28].

Discussion

Quantum Oscillator

The background information and scientific concepts discussed above were utilized to develop a novel type of technology which is based on the unique natural frequencies generated by an individual's specific nDNA, mDNA, RNA or bone matrix (U.S. Patent Nos. 9,784,877 and 10,001,577). These sample types were chosen since they are crystalline in nature, a prerequisite for this type of detection technology, and DNA can have a half-life of over 500 years [29]. When searching for missing individuals (either living or deceased), ideal sample matrices include hair or keratin (nail clippings). The hair bulb contains nDNA and the shaft contains mDNA, while keratin 86 DNA (2 separate amplicons at 130 and 294 bp), found in nail clippings, are not affected by prolonged immersion in soil, air or water and these amplicons remarkably do not appear to be affected by temperature making them ideal choices as stable resonators [30].

The Quantum Oscillator (QO) is a dual antennae (transmitter and receiver), hand-held, remote sensing detector that amplifies (and transmits) the natural frequency of any crystalline object, including an individual's DNA (living or deceased), creating a corresponding resonant frequency emission from a matching sample in the environment. This frequency emission is then picked-up by the receiver on the QO and sets up a standing-wave oscillation which, when this occurs, signifies detection of the 'object'. Bone samples are used in a slightly different manner and only when the person is deceased. There are genetic variations in the bones of various ethnicities [31]. While many studies have discussed bone density issues and metabolic differences between ethnic groups, the reason for these differences are in the genetic chemical makeup in the bone matrix itself, specifically in the incorporation of metal ions such as titanium, aluminum and/or nickel in the bone, to name just a few. These discoveries were made using Laser Induced Breakdown Spectroscopy (LIBS) studies on human bone [32]. This allows us to be able to differentiate African, Caucasian, Hispanic/Native American, and Asian ethnicities with great success simply based on the bone mineral complex which in turn influences their natural frequencies making them distinctive. Obviously racial mixing would be a complicating factor when attempting to find deceased individuals.

In the QO, the chosen sample is electrically isolated in a faraday cage [33] and its natural frequency is amplified using a specific coil. The natural frequency oscillations of the sample energize the coil, driving it into a quarter wave resonance. When energized, the high-Q coil exhibits a voltage anti-node at the top terminal and a current anti-node at the bottom terminal. The coil's top portion thus produces a location of maximum electric field flux, while the bottom portion generates a maximum magnetic flux (load). The power received by the resonating coil is inductively converted back to real power through magnetic coupling of the coil at the current anti-node. The primary coil (circuit) acts as the energy input/output port to the system. Thus, power from the generator can be reactively transmitted by resonant coupling through the ground plane. (Alternatively, a frequency generator can not only be used to determine the objects' frequency, but can also be used as a transmitter, eliminating the need for placing a sample in the Faraday cage).

The inductance of the resonator is of extreme importance. The higher the value, the closer the coil acts as a pure inductor. The passive amplification due to the resonant cavity action (known as resonant rise) is directly equal to the quality factor of the coil. Larger inductance signifies higher Q and larger magnification of the electric components. The higher the electric field produced at the elevated terminal, the greater the ground charge displacement will be. For this reason, the top capacity is of importance for supplying sufficient surface area such that voltages of large amplitude can

QO search parameters		
Distance to target range potential	City: < 3.2 km (2 miles); Rural: < 24 km (15 miles); line of sight: < 96.5 km (60 miles)	
Sensitivity	milligram quantities	Confirmed ~20ul of blood 20 yrs old at 500 yds
Specificity	0.001 Hz frequency range: individual, familial line (paternal or maternal); live or deceased; racial affinity	Cannot distinguish identical twins
Accuracy – Location of target	Approximately 90% as confirmed by certified HRD canines	Distance to target within 10%; Mass of target within 55%
Water Environment	Fresh water - tested to a depth of 36.5 m (120 ft)	Salt water – tested to a depth of 27.4 m (90 ft)
Sub-surface Environment	Clandestine graves down to 2.1 m (7 ft.) depths	Mine shaft down to 91.4 m (300 ft.)
Search modes	Helicopters, planes, cars, boats, or on foot	
Fastest recovery	Searching 70 sq. acres in mountainous terrain using a helicopter: 5 min to confirmed find	
Age of oldest remains positively identified	buried for 150 years	Have had positive readings from ancient Indian mounds – could not confirm accuracy although canines also displayed a positive alert
Able to differentiate bone frequencies of Caucasian, African, Hispanic, Korean, Chinese and various American Indian tribes even when compared to possible environmental interferents	Partial listing of environmental materials that did not interfere with the detection of any human bone: Horse bone, Deer bone, Alpaca bone, Bear bone, Pig bone, Sheep bone, Cow bone, Coyote bone, Otter bone, Dolphin bone, Box Turtle shell, Cat bone, Dog bone, Sea urchin, Opossum bone, Rabbit bone, Chicken bone, Turkey bone, Alligator bone, Python bone, Raccoon bone, various Bird bones, Squirrel bone, Mountain Lion bone, Shark Cartilage, various sea shells/coral – Atlantic and Pacific varieties	

Table 1: Summary of QO critical performance criteria obtained from either experimentation or successful recoveries in the field. HRD: Human Remains Detection; QO: Quantum Oscillator.

be maintained without breakdown. Therefore, the top capacity in conjunction with the resonator inductance determines the operating frequency and top capacity voltage magnitude. The electrical oscillations are then projected into the air using the transmitter antenna and expand outward along the ground such that their propagation distance depends on the AC frequency and voltage developed at the transmitter. Since the transmitter and receiver (top and bottom antennae) are placed some distance apart with the transmitter linked to the oscillating energy source (the sample), and the receiver connected to the load, transmission of energy from source to load is possible with relatively high efficiency [34]. Due to the reactive power transfer between structures, very little energy in the system is lost or radiated – coining the term, non-radiating. Most of the energy remains within the system until used. In effect, the system and surrounding medium become part of an electric oscillator.

Results

Example Application of the Technology

The QO was used to assist in the location of a 58-year-old, Caucasian female who had gone missing 3-4 weeks earlier in North Port, FL, USA (North Port Police Department Case No. 20-060358). The woman had some form of mental illness and had been heavily medicated. The search began in the general area of her last confirmed sighting. Five pieces of hair taken directly from her hair brush (several with follicles attached) were used as DNA samples and placed in the Faraday cage of the QO. Local Law Enforcement had performed at least one unsuccessful search utilizing tracking and HRD canines approximately 4-7 days prior to requesting assistance. The search area was heavily wooded with extremely thick undergrowth. The search with the QO began approximately 0.4 – 0.8 km (¼ - ½ mile) from where she was eventually found. At the starting location, the QO was used to scan a 360 degree arc with only one positive reading indicating that her natural DNA frequency had created a resonant frequency return in the environment of higher amplification indicating a match. The indicated target area was approximately 61 x 61 m, (200 x 200 ft) in size and could not have been pinpointed more accurately due to the thick undergrowth. In the search area indicated by the QO, a certified HRD canine found her purse and several other items after crawling approximately 3m (10 ft) through very heavy undergrowth. A subsequent ground search by the Search and Rescue (SAR) team on site took approximately 1 hour after which the victim was located visually by a searcher within the 61 x 61 m, (200 x 200 ft) search area designated by the QO. The decedent was in a prone position and fairly well preserved given the amount of time she had been missing. The surprising preservation of the body in such a warm environment might have been due to her being heavily medicated. Law Enforcement and the SAR team were of the opinion that she would not have been found had the QO not been able to narrow down the search area due to the extremely heavy undergrowth, which significantly hindered the K9's ability to detect odor and gain access to the site.

Conclusions

The successful outcome of this particular case is just one of many where the QO was able to assist in locating missing living or deceased individuals or objects. The advantage of this technology is that it can be specific to one particular individual therefore being able to locate a specific person in a clandestine grave, mass grave, cemetery, surface scatter, landfill, or on the battlefield. The QO has also been able to track decompositional plumes in the subsurface.

Successful recoveries have been made in bodies of water to a depth of 36.5 m (120 ft), in mine shafts down to 91.4 m (300 ft), live finds when individuals were hiding from law enforcement, graves over 150 years old, and in numerous environments from desert biomes to tropical jungles (Table 1). While not as specific, this technology has also been successful when using samples obtained not just from the missing individual, but also from their relatives (parents, grandparents, siblings, or children). The instrument's extreme sensitivity (mg), specificity, and the added benefits of being able to estimate distances (+/- 10% accuracy if precalibrated for the search area) to targets and the potential mass (+/- ~55% accuracy) of targets makes the QO a valuable tool which can be used in conjunction with other technologies in the forensic toolbox to locate and identify missing individuals. Mass in general is difficult to assess especially in older missing person cases or when dismemberment has occurred either by the perpetrator or by scavengers. Since the return signal in the QO is somewhat based on the surface area of the object, bones which have begun to crack, exfoliate or chemically break down create a larger return signal, masking the true mass of the object. This is very apparent when dealing with human cremains. Even though the mass may be quite small, the surface area is extremely large and can return a signal indicative of a full skeleton.

Currently there are 5 teams in different states across the United States (Virginia, Florida, California, Michigan and Illinois) which are independently field testing the QO in various environmental settings. These teams include SAR teams (focusing more on human remains < 5 years old and live finds), law enforcement (primarily 10-50 year old cold cases) and military (primarily Killed/Missing in action – KIAs/MIAs overseas in the Pacific and European theaters and Continental United States (CONUS)) cold cases. Recovery teams are also using a version of this technology to locate unexploded ordinance in the European theater. Current estimates based on positive QO responses from searches indicate a greater than 90% confirmation when properly trained and certified canines are used to verify QO responses. No technology is 100% accurate and the QO is no exception and while there are some circumstances that can limit detection capability, they will not be addressed in this article due to National Security concerns.

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