Journal of Entomology and Zoology Studies
Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(5): 1984-1988

Received: 20-07-2018
Accepted: 23-08-2018

Muneeba Shafi Shah
PhD Scholar, Division of Veterinary Microbiology and Immunology, F.V.Sc & A.H, Shuhama, SKUAST, Jammu and Kashmir, India

Urfeya Mirza
PhD Scholar, Division of Veterinary Surgery and Radiology, F.V.Sc & A.H, SKUAST, Jammu and Kashmir, India

Sheikh Shubeena
PhD Scholar, Division of Veterinary Extension, F.V.Sc & A.H, SKUAST, Jammu and Kashmir, India

Bisma Gull
PG Student, Division of Veterinary Microbiology and Immunology, F.V. Sc & A.H, SKUAST, Jammu and Kashmir, India

Muneesa Shafi
PG Student, Department of Electrical Engineering, Kurukshetra University, Thanesar, Haryana, India

Sheikh Shaheen
Technical Support Engineer at Convergys, New Delhi, India

Correspondence
Muneeba Shafi Shah
PhD Scholar, Division of Veterinary Microbiology and Immunology, F.V.Sc & A.H, Shuhama, SKUAST, Jammu and Kashmir, India

Nanotechnology: A Miniature Miracle

Muneeba Shafi Shah, Urfeya Mirza, Sheikh Shubeena, Bisma Gull, Muneesa Shafi and Sheikh Shaheen

Abstract
Nanotechnology is the study of extremely small structures of 0.1 to 100 nm size. It is a relatively new field of science and technology. Nanotechnology represents an important scientific advancement and can contribute several benefits to human and animal health. Nanotechnology has various applications in the field of health and medicine, electronics, energy and environment. Numerous advancements in nanotechnology helps in treatment of various neuro degenerative disorders such as Parkinson's disease, Alzheimer's disease which are otherwise less curable by conventional medicines. Another wonder of nanoscience is nano-pharmaceuticals which detect diseases at an earlier stage. In just few years nanotechnology has shown a great progress in human and veterinary medicine. Scientists predict that such a progress in nanotechnology could represent a measure breakthrough in addressing some technical challenges faced by human and veterinary professionalists. Nanotechnology has a bright future, when merged with other technologies resulting in the emergence of new innovative hybrid technologies. Thus nanotechnology will raise our technological capabilities to another level, improving healthcare and quality of life, increase our standard of living and will drive further economic expansion into medical and veterinary profession.

Keywords: Alzheimer, medical, nanotechnology, Parkinson, veterinary

1. Introduction
Nanotechnology is the study of controlling matter on an atomic and molecular scale. Nanotechnology deals with structures of size 100 nanometers or smaller in at least one dimension [1]. The term nanotechnology was first used by Taniguchi in 1974 to describe production technology at ultrafine dimensions [2]. Era of molecular nano technology started in year 2011. Nanotechnology provides a fundamental understanding of various phenomena and materials at nanoscale and create structures, devices and systems having novel properties and functions owing to their small or intermediate size [3]. Nanotechnology involve work from top down ie, reducing the size of large structures to smallest structure e.g. photonics applications in nano electronics, nano engineering and changing individual atoms and molecules into nanostructures [4].

2. Classification of nanoparticles: [5]

Chemical composition	Characteristics	Functions
Fullerenes and carbon nanotubes	Lack of water solubility	Vehicles for nanodrug delivery and photothermal cancer ablation
Liposomes	Vesicles composed of a lipid bilayer surrounding a hollow core	Liposomes can carry both hydrophobic and hydrophilic drugs and molecules to a target site
Polymeric nanospheres	Uniform spherical structures made from non-biodegradable or biodegradable polymers	Effective agents for transdermal drug delivery
Dendrimers	Large, complex molecules with a well-defined branched chemical structure	Allow carriage of drugs or molecules for imaging
Polymer coated nanocrystals	Prevents aggregation and helps in establishing a stable nano suspension	Macrophage based delivery to sites of HIV infection and sequestration
Nano shells	Spherical particles consisting of dielectric core surrounded by a thin metallic shell	Biomedical imaging and cancer treatment
SPIO nanoparticles	A core of magnetite with coating of polysaccharides, polymers or monomers	Possess superparamagnetic properties useful for biomedical imaging, diagnosis, and therapeutics
Quantum dots	Semiconductors with unique optical and electrical properties	Their distinct fluorescence spectra make them valuable tools for biomedical imaging

3. Nanoparticle delivery systems

3.1 Encapsulated nanoparticles

- Lipid-bases capsules - Nanoliposomes, archaeosomes, nanocochleates, micelles
- Polymer-based capsules – Nanospheres, nanocapsules, polymersomes, micelles

3.2 Polymer-based capsules

- Natural polymers (e.g. albumin, collagen, algirates, gelatin, chitosan, nano spheres
- Synthetic polymers (e.g. PLA, PLGA, PCL) [6]

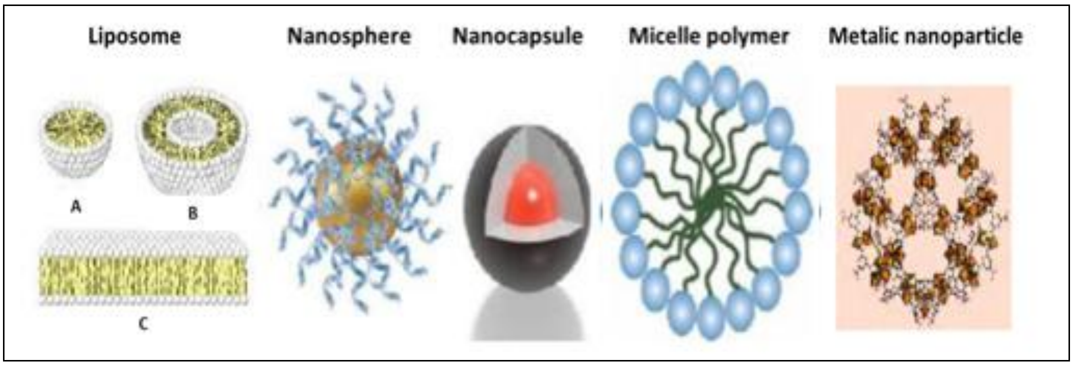

Fig 1: Architecture of nanoparticles [7]

4. Applications

Nanotechnology has numerous potential applications in different fields like health and medicine, electronics, transportation, energy and environment and space exploration [8].

4.1 Nanotechnology in energy and environment: Nanotechnology plays a critical role by protecting the environment and providing sufficient energy for a growing world. Much advanced techniques of nanotechnology can help in energy storage, its conversion to other forms, ecofriendly manufacturing of materials and better enhancement of renewable energy sources. Nanotechnology can be used for less expensive energy production and for renewal energies in solar technology, nano-catalysis, fuel cells and hydrogen technology. Thus nanotechnology helps in developing new ecofriendly and green technologies which minimizes undesirable pollution [4].

4.2 Nanotechnology in Modified Medicated Textiles: Nanotechnology has led to the development of new antibacterial cotton, leading to production of antibacterial textiles. Application of conventional antimicrobial agents to textiles has been reported and this technique has advanced by focusing on inorganic nano structured materials that acquire good antibacterial activity and hence their application to the textiles [8].

4.3 Nanotechnology in human medicine

4.3.1 Nanomedicine: Applications of nanocarriers is one of the most important aspects of nanomedicine, which has led to a marked increase in the number of studies describing improvements in traditional pharmacological bases used, especially in human therapeutics. A chemotherapeutic agent when encapsulated in the nanoparticle may cause less toxicity and cellular resistance to the drug compared to traditional medicines. A study using structured lipid nanoparticles against multidrug-resistant cancer cell lines demonstrated that the nanoparticles were highly effective in controlling tumor cell growth [9]. Drug detoxification is another application for nano medicine which has been used successfully in rats. Medical technologies makes use of smaller devices which are less invasive and can be implanted inside the body and have shorter biochemical reaction time. Compared to conventional drug delivery, nano devices are faster and more sensitive [10]. Nanotechnology based drug delivery can reduce costs and pain to the patients and led to passage of drugs through cell membranes and into cytoplasm, thus increasing efficiency.

4.3.2 Disease treatment: The most important application of nanotechnology is in the treatment of neuro degenerative disorders [11]. In CNS therapeutics, various nano carriers such as, dendrimers, nano gels, nano emulsions, liposomes, polymeric nano particles, solid lipid nano particles, and nano suspensions have been studied. Transportation of these nano medicines has been successful for management of CNS conditions such as, Alzheimer's disease, brain tumors, HIV encephalopathy, etc. In addition to this, nanotechnology can potentially be used in the treatment of various autoimmune diseases [12].

4.3.3 Tissue engineering: Nanotechnology can be applied in tissue engineering by repairing and reproducing damaged tissues. Nanotechnology can be made useful by application of suitable nanomaterial-based scaffolds and growth factors, artificially stimulated cell proliferation, in organ transplants or artificial implants therapy, leading to life extension [10].

4.3.4 Nanoparticles as Therapeutic Drugs: Nanoparticles NPs) that have been developed for novel immunotherapeutic properties can be used as therapeutic drugs. Under UV light, metallic NPs and their oxides produce reactive oxygen species that possess antimicrobial activity [13]. Metallic NPs incorporating Ag, Au, Cu, Ti, Mg, Zn, Fe, or metal oxides have significant antimicrobial, antifungal, and antiviral activities. Nanomaterials with inherent antimicrobial activities are called nano antibiotics [14].

4.3.5 Dermatology and cosmetics: Various possible indications of nanotechnology in dermatological science are sunscreens, moisturizers, phototherapy, antiseptics, vaccines, anti-ageing formulations, targeting of sebaceous gland, hair application in alopecia and hair gene therapy, transdermal drug delivery, nail cosmetic and lip cosmetics and treatment of skin cancer [15].

4.4 Nanotechnology in veterinary medicine: In today's veterinary scenario, if an animal gets infected with a disease, it takes days, weeks, or months before symptoms appear and the disease is detected, up to that time, the infection may get widespread and entire herds/fields might need to be destroyed. Nanotechnology operates at the same scale as a virus or disease-infecting particle, and holds the potential for very early detection and eradication [16]. The field of veterinarian sciences gains with nanotechnology as much as human medicine does: diagnostic tools (nano probes) that can be used *in vitro* and *in vivo*, targeted delivery of medications, therapeutic, nanomaterials, vaccine antigen vectors, or traceability of products of animal origin. Nanostructured antimicrobials were tested against *Brucella melitensis* strains, and efficacy results of nanoparticles were much better than conventional antimicrobials [17]. Another application of nanotechnology in veterinary medicine is nanoemulsion which acts as a potent destroyer of animal pathogens. Nanoemulsions don't affect cell structures of higher organisms, thus makes them ideal to use in animals.

4.5 Nanotechnology in animal production: Nanoparticles have been used as therapeutic agents in the human medical field for quite some time, but their application in veterinary medicine and animal production is still new. Many antibiotics are used as growth promoters in livestock feed, owing to great concern regarding microbial antibiotic resistance. Due to increased incidence of antibiotic-resistant bacteria, laws and regulations are made to end antibiotic use in the animal feed and in turn find a suitable alternative. Many reports have shown evidence that nanoparticles may be used as good alternatives for animal growth promotion [18].

Table 1: Mechanism of action of nanoparticles useful in animal production

Function	Type of nanoparticle	Mechanism of action
Nutriceuticals	Metal	Feed supplements at the nanoscale are more bioavailable to animals thus allowing more interactions in the gut and better absorbance
	Natural	Nanoparticle additives to food products for human consumption can increase bioavailability
Drug and Nutrient Delivery	Polymer	Loaded with traditional antibiotics which acts as shuttle to release them in proximity to a pathogen
	Natural	Enclose around nutrients to protect them from degradation in stomach
	Nanostructured	Designed to carry nutrients or pharmaceuticals through GIT for targeted release
Biocides	Metal	Lyse negatively charged Gram + and Gram – bacterial cell walls
	Polymer	Destabilize bacterial cell walls
Diagnostic Tools	Metal	Magnetic metal nanoparticles can disperse throughout the body and be imaged via MR
	Nanostructured	Fluorescence can be initiated via light activation
Reproductive Aids	Nanostructured	Purification of sperm through removal of damaged spermatozoa via surface markers recognized by nanoparticle-bound antibodies
Molecular Biology Agents	Nanostructured	Gene transfer mediation through interactions between nucleic acids, nanoparticles, and sperm
	Polymer	DNA transfection vehicles (as above)

5. Nanotechnology based diagnostics

5.1 Nano Biochips: Also called lab on a chip. It is a simple device (usually made of glass or silicon base) combining many processes for DNA analysis. The device is particularly designed to interact with cellular components with high level of specificity. Lab-on-chip device usually consists of microfluidic channels that provide paths for biomolecules to flow to individual sensors or biosensors. Nanofluidics can analyse, measure biomolecules such as DNA from their containing solutions, mix the solutions, digest the DNA, forming discrete products and then separating (isolating) and detecting the products [19].

5.2 Microelectromechanical Systems (MEMS): MEMS are used in recent drug deliveries and can also be employed in diagnostics as smart capsular pills to give the image of lumen of the GIT allowing medical practitioners to observe the structures of GIT for possible diagnosis of bleeding, its site and potential cause [20].

5.3 Nano Biosensors: Nano biosensors, use indicators to distinguish between cells and recognize certain cells especially cancer cells using peculiar biomolecules released or produced by such cells so that the rate of growth and development of such regions of the body is monitored to deliver specific medicines to such regions [21].

5.4 Quantum dots: Quantum dots (Qdots) are special nano-crystal semiconductors made of Si or Ge that possess very strong fluorescence intensity which makes them suitable for sensitive image acquisition and signal amplification in real time. Many Qdots have been developed to detect various types of viral and bacterial proteins in order to diagnose pathogenic diseases with enhanced sensitivity and specificity over conventional organic fluorophores [19].

5.5 Medical diagnostics: Carbon nano tubes are used for detection of DNA mutation and for detection of disease protein biomarker. Nano particles are used in MRI and ultrasound image contrast agents and for targeted drug delivery, as permeation enhancers and as reporters of apoptosis, angiogenesis [22].

Nano Plex biomarker detection: These silica-coated, surface enhanced Raman scattering (SERS)-active metal nanoparticles allow robust, ultrasensitive, highly-multiplexed biomarker quantitation in any biological matrix, including whole blood [23].

A method for detecting cancer cells in the blood stream is being developed using nanoparticles called as nanoflares. Nanoflares are designed to bind to a genetic target in cancer cells and generate light when that particular genetic target is found [24]. A method for early diagnosis of brain cancer under development uses magnetic nano particles and nuclear magnetic resonance technology. The magnetic nanoparticles attach to particles in the blood stream called microvesicles which originate in brain cancer cells. NMR then detects these micro vesicle/magnetic nanoparticle clusters allowing an early diagnosis [24].

6. Future prospects

Nanotechnology has become the foundation for remarkable industrial applications and exponential growth. Some of the future applications of nanotechnology are:

6.1 In Propellants: In propellants, currently used micrometric Al powders were replaced by nano metric powders in order to investigate the effects of aluminium particle size on burning rate and agglomeration processes at the burning surface of solid rocket propellants [23].

6.2 Drug Delivery and Disease Treatment: Nanotechnology has the potential to revolutionize cancer treatment. Nanocrystals act as effective agents for selective targeting and destruction of cancer cells due to their unique properties [23].

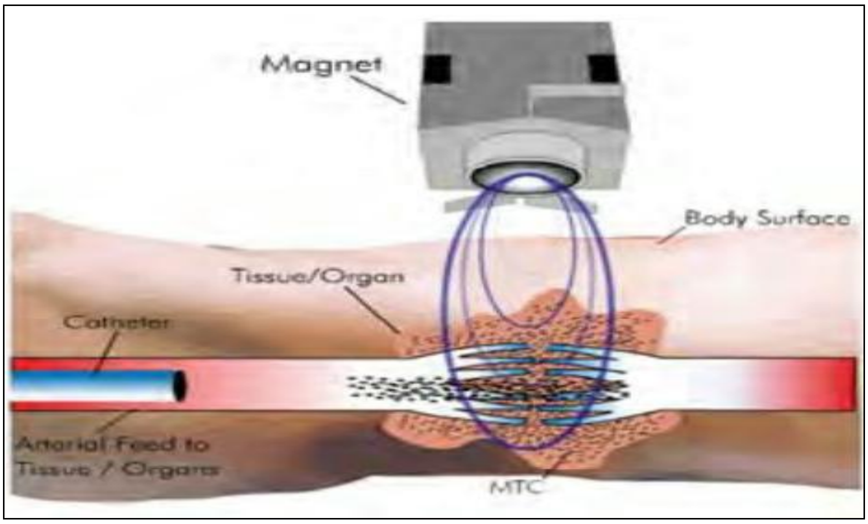

Fig 2: Nanotechnology in disease treatment

6.3 Nanobatteries: Nanobatteries are fabricated batteries employing at the nanoscale particles. These batteries may be nano in size or may use nanotechnology in a macro scale battery [23].

6.4 Nanoimprint lithography: Nanoimprint lithography is a method of fabricating nanometer scale patterns. It is simple nanolithography process with low cost high thorough put and high resolution [23].

6.5 Nanorobots: The future of nanotechnology could very well include the use of nano robotics. These nanorobots have potential to take on human tasks as well as tasks that human could never complete. The rebuilding of the depleted ozone layer could potentially be able to be performed. Nanorobots could single out molecules of water contaminants, thus keeping the environment cleaner than ever [22, 25].

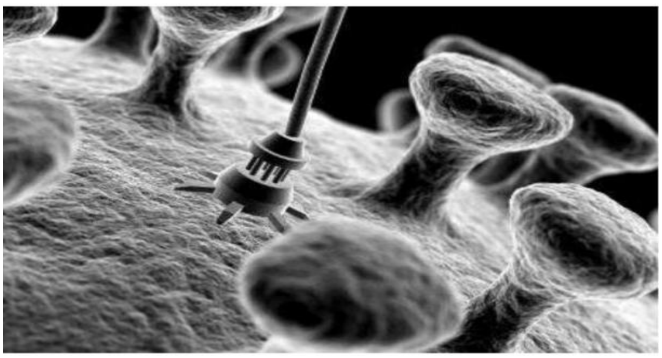

Fig 3: Nanorobots

6.6 Nanowires: Nanowires (NW) are nanosized channels that allow passage of electrical current at very low amplitude and can be constructed from carbon nanotubes. They are sensitive to any minute change in electrical properties at any slight adjustment for example when an additional molecule is attached to it. Nanowires with different antibodies attached are integrated into a single device, and can be employed as detectors for diseases like cancer [26].

7. Conclusion

Nanotechnology provides a tremendous amount of benefits to human and animal health. The high variety of nanoparticle engineering has allowed the development of a number of new antimicrobial products, with excellent efficacy results, quick and specific action. Although nanotechnology provides new directions for advancement of treatment and diagnosis of infectious diseases, it should be developed further for practical use in daily life. Furthermore, nanotechnology based therapeutics, vaccines, and diagnostics may foster easy, cheap, safe, and portable use of end products, which will help control infectious diseases, especially in developing countries, and improve public health. Nanoparticles make a great leap from traditional diagnosis and treatment to more advanced and improved ones by controlling many parameters in diagnosis and treatment. The future of nanotechnology, particularly nanodiagnostics will be conserved by giving proper attention to the associated ethical concerns and a global direction in the establishment of international standards, the possibilities in the sphere of healthcare delivery will continue being in leaps and bounds. Thus nanotechnology will raise our capabilities to a new level, improves quality of life and enhances economic development of a nation.

8. Acknowledgement

The authors would like to acknowledge their parents, for their unrelenting support, blessings and unsustained faith which helped us to sail our ship of ambition and anchor it in a harbor of success. We extend our sincere gratitude to the Division of Veterinary Microbiology and Immunology, SKUAST Kashmir, for their meticulous suggestions and constructive criticism throughout the academic pursuit.

9. References

1. Chakravarthi P, Sri N Balaji. Applications of Nanotechnology in Veterinary Medicine. Veterinary World. 2010; 3(10):477-480.
2. Taniguchi N. On the Basic Concept of 'Nano-Technology', Proc. Intl. Conf. Prod. Eng. Tokyo, Part II. Japan Society of Precision Engineering, 1974.
3. Feneque J. Brief introduction to the Veterinary applications of Nanotechnology. Available in: http://www.nanotechnow.com/Jose-Feneque/Veterinary-Applications, 2003.
4. Anna Pratima Nikalje. Nanotechnology and its Applications in Medicine. Med chem, 2015; 5:2, http://dx.doi.org/10.4172/2161-0444.1000247.
5. Mcmillan J, Batrakova E, Gendelman HE. Cell Delivery of Therapeutic Nanoparticles. Progress in Molecular Biology and Translational Science. 2011; 104:563-601.
6. Bouwmeester H, Dekkers S, Noordam M, Hagens W, Bulder A, De heer C, Ten voorde, S. Wijnhoven. SIPS, A. Health impact of nanotechnologies in food production. Report 2007.014. *RIKILT* – Institute of Food Safety, Wageningen UR and National Institute of Public Health & the Environment, 2007.
7. http://www.academie-veterinaire
8. Fouda MM, Abdel-Halim ES, Al-Deyab SS. Antibacterial modification of cotton using nanotechnology. Carbohydr Polym, 2013; 92: 943-954.
9. Dian, L Yang, Z Li, F Wang, Z Pan, X Peng, X Huang, X Guo, Z Quan, G Shi, X Chen, B Li, G Wu. Cubic phase nanoparticles for sustained release of ibuprofen: formulation, characterization, and enhanced bioavailability study. International Journal of Nanomedicine, 2013; 8:845-854.
10. Kuskov A N, Voskresenskaya A A, Goryachaya A V, Shtilman M I, Spandidos D A, Rizos A K. Amphiphilic poly-N-vinylpyrrolidone nanoparticles as carriers for NSAIDS: Characterization and *in vitro* controlled release of indomethacin. Int. J Mol. Med, 2010; 26 (1):85-94.
11. Wong HL, Wu XY, Bendayan R. Nano technological advances for the delivery of CNS therapeutics. Adv Drug Deliv Rev. 2012; 64: 686-700.
12. Miller Stephen, Getts D, Martin A, McCarthy D, Terry R. Micro particles bearing encephalitogenic peptides induce T-cell tolerance and ameliorate experimental autoimmune encephalomyelitis. Nature Biotechnology, 2012; 30: 1217-1224.
13. Look M, A Bandyopadhyay, J S Blum, T M Fahmy. Adv. Drug Del. Rev, 2010; 62:378.
14. Allaker P, G Ren. Trans R Soc. Trop Med. Hyg, 2008; 102:1.
15. Tasleem Arif, Nuzhatun Nisa, Syed Suhail Amin, Sheikh Shoaib, Raheel Mushtaq, Muzaffar Rashid Shawl. Therapeutic and diagnostic applications of Nanotechnology in dermatology and cosmetics. Journal of Nanomedicine and Bio therapeutic discovery. 2015; 5(3):2155-983X.
16. Scott NR. Nanotechnology and animal health. Rev. Sci. Tech. Off. Int. Epiz. 2005; 24(1):425-432.
17. Seleem, Jain MN, Pothayee N, Ranjan N, Riffle A, Sriranganathan JS. Targeting Brucella melitensis with polymeric nanoparticles containing streptomycin and doxycycline. FEMS Microbiol. Letter. 2009; 294:24-31.
18. Emily K Hill, Julang Li. Current and future prospects for nanotechnology in animal production. Journal of Animal Science and Biotechnology. 2017; 8:26.
19. Rajasundari K, Hamurugu K. Nanotechnology and Its Application in Medical Diagnosis. Journal of Basic and Applied Chemistry. 2011; 1:26-32.
20. Sharma Rao B, Hashim U. Microfluidic Photomask Design Using CAD Software for Application in Lab-On-Chip Biomedical Nano Diagnostics. Advanced Materials Research. 2013; 795:388-392.
21. Beishon M. Exploiting a Nano-Sized Breach in Cancer’s Defences. Cancer World, 2013, 14-21.
22. Shetty NJ, Swati P, David K. Nanorobots: Future in Dentistry. The Saudi Dental Journal, 2013, 2-4.
23. www.innoresearch.net.
24. https://www.understandingnano.com/nanotechnology-medical-diagnosis.html.
25. Turos E, Shim JY, Wang Y, Greenhalgh K, Reddy GS, Dickey S, *et al*. Antibiotic-conjugated polyacrylate nanoparticles: new opportunities for development of anti-MRSA agents. Bioorg. Med. Chem. Lett. 2007; 17(1).
26. Reimhult E, Höök F. Design of Surface Modifications for Nanoscale Sensor Applications. Sensors, 2015, 15: Article ID: 163575, https://doi.org/10.3390/s150101635.