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Radiotherapy Physics

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Introduction

Half of all cancer patients would benefit from radiotherapy as part of their treatment. A video of an image-guided treatment was shown and explained. An introduction to the radiobiology of radiotherapy using cell survival curves was given to explain the need for fractionated delivery of treatments.

Methods

A brief overview of some of the physics and technology behind a radiotherapy treatment was given. The need for an accurate measurement of the radiation dose delivered was covered along with a short discussion of dosimetry at a national primary standard laboratory and how this is transferred into a hospital environment. This was linked to the various commissioning measurements required during the installation of a new treatment machine (linear accelerator, linac) and the on-going quality assurance tests during its working life.

Results

The need for accurate beam data collection was explained and connected to beam modelling in treatment planning systems. The process of treatment planning was described along with the types of personnel carrying out the tasks. The uses of various types of imaging were described for treatment planning and verification. The safety aspects of radiotherapy were discussed as very high doses of radiation are used for these treatments.

Conclusion

Linacs need to be housed in a special room, bunker, with very thick concrete walls to keep the radiation dose to staff to acceptable levels. Also a number of other safety features are required. These are designed by a specially trained physicist to meet local regulatory requirements. Also the need for the training and authorising of all staff to carry out specific tasks to ensure patient safety was described. Finally some future developments in radiotherapy, such as MR linacs, particle therapies and the use of artificial intelligence were discussed.

Keywords: Linacs, Cancer, Radiobiology, Radiotherapy.

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An Introduction to Physics in Healthcare

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Introduction

This study is based on an introductory talk given to the Harmattan school in March 2021. It aimed to show undergraduate physics students some of the many ways the concepts and techniques covered in a physics degree course are applicable to important diagnostic and therapeutic techniques used in modern medicine.

Methods

Medical physics can be said to have begun with the discovery of X-rays in 1896; developments since then have resulted in sophisticated CT scanning. Other diagnostic applications developed by physicists include ultrasound, nuclear medicine, magnetic resonance imaging, endoscopy and pulse oximetry.

Results

Radiotherapy, which uses several different types of ionising radiation, plays an important role in cancer treatment. Another key role for physicists is in radiation protection.

Conclusion

Medical physics offers many exciting opportunities for physics graduates, and they are encouraged to consider it as a career path.

Keywords: Physics concepts; Modern medicine; Diagnosis; Treatment; Careers.

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Radiofrequency (RF) Interactions with the Human Body

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Introduction

Our current civilization owes a lot to the understanding of electricity and magnetism from the time of Charles-Augustin de Coulomb to the unified electromagnetic theory by James C. Maxwell. Electromagnetic waves (EM) are electrical and magnetic disturbances that sustain each other as they propagate in space. Radiofrequency (RF) wave is a form of EM wave that occupies regions between 30 kHz – 300 GHz on the EM spectrum and form the basis of telecommunication applications as in mobile phones, television, Wi-Fi, and satellite communication, as well as food processing and household appliances such as the microwave oven. Since we live daily in the sea of these waves, it is important to understand how they interact with the human body.

Methods

Generally, the interaction of EM waves with any material is determined by the electrical properties of the material such as its permittivity, permeability, and conductivity. The human body is a lossy dielectric primarily due to its water content (dipolar molecules) and free ions. The non-zero conductivity of body tissues gives rise to attenuation of RF waves as they propagate through it, leading to energy deposition within the tissue. Other factors such as the tissue size, shape, orientation with respect to the polarization of the incident field, and the nature of the incident field (Near or Far-field), also affect the interaction of RF wave and energy absorption.

Results

When deposited in large amounts, energy from RF radiation can produce heat within the body which can portend different biological effects. In addition, other non-thermal effects such as altering the circadian rhythm, or interference with medical implants such as a cardiac pacemaker may occur.

Conclusion

Adequate RF dosimetry as specified by the specific absorption rate (SAR), allows for safe regulation of human RF exposure, and their use in various biomedical applications.

Keywords: Radiofrequency (RF); Electromagnetic waves; Permittivity; Permeability; Conductivity; Cardiac pacemaker.

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Introduction to Health Physics

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Introduction

In an effort to protect humans and the environment from harmful exposure to radiation, health physics is concerned with the development, deployment and dissemination of scientific knowledge and procedures for radiation protection. This branch of physics is well differentiated from the closely-related field of medical physics which focuses on the diverse applications of Physics in medical diagnostics and treatment procedures. Health physicists are involved in one or more specific areas of radiation protection such as: risk assessment, medical exposures to occupational and public groups, regulatory efforts and radioecology. Corpuscular and electromagnetic radiations such as alpha particles and gamma rays deposit energy in their propagation media, resulting to biological effects such as disruption of cellular functions, cell damage or even death.

Materials and Methods

The ionizing radiations may originate from nature (outer space, rocks and groundwater) or from artificial sources such as X-ray tubes, nuclear reactors and nuclear weapons. Skin burns, sterility, cancer and death are some observable somatic health effects of internal and external exposure to radiation while some other effects feature in offspring due to do genetic mutations. Radiation protection also involves avoidance of radioactive contamination during existing, planned or emergency exposure situations. In a process called nuclear activation, some materials become radioactive when they are exposed to radiation; hence, continuous radiation monitoring is necessary during radioactive decontamination. Radiation measurements and monitoring can be carried out using hand-held survey instruments, personal dosimeters and laboratory detectors.

Results

In addition to general measures of exposure durations, distance from sources and use of shielding materials, radiation protection principles are based on justification of the exposure situation in terms of its risks and benefits, optimization of processes and compliance with dose limits.

Conclusion

Radiation protection recommendations on dose limits are provided by local and international regulatory bodies such as the International Commission on Radiological Protection.

Keywords: Health physics; Radiation protection; Exposure; ionizing radiation.

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Application of the Fourier Transform in Medical Imaging

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Introduction

Fourier Transforms are widely used throughout physics to analyse periodic time series, including many uses in Medical Physics. In this introduction, I first remind the students of Taylor Series, which allows a function to be expressed as a sum of higher order polynomials where more terms usually results in a better fit to the original function. Building on this, a Fourier Series expresses a function as a sum of sinusoids, again where including higher frequency terms usually results in a closer approximation. Fourier Series are better at describing periodic functions. Finally, the Fourier Transform (FT) is introduced, where the discrete sum of increasing frequencies is replaced by a continuous integral, and the student is reminded of the concept of a complex Fourier Transform pair.

Methods

An important application of the FT in Medical Physics is in Magnetic Resonance Imaging (MRI) and the wider field of digital diagnostic imaging. The Larmor equation is fundamental to MRI, especially for spatially encoding the radiowave echoes from the patient to produce an image. This occurs by manipulating the Larmor equation by deliberately perturbing the overall magnetic field in the scanner by the temporary addition of magnetic gradient fields.

Results

The changes in radiowave frequencies in the echoes that this introduces can be de-coded using a FT to produce slices and in-plane localisation of signal in the MR image.

Conclusion

Finally, the importance of understanding the FT pair relationships is demonstrated by exploring the background behind some common MRI artefacts such as Gibbs' ringing, RF spikes, and spatial frequencies in the image.

Keywords: Fourier transform; Taylor series; Magnetic resonance imaging; Radiowave; Larmor equation.

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Radiation Detection and Measurement

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Introduction

Radiation detection and measurement is the use of detectors to sense and measure ionizing radiation (X-ray, gamma ray, alpha and beta particles). Generally, radiation detectors can be divided into radiation dosimeters, gas-filled detectors, scintillators and semiconductor detectors. Dosimeters include radiographic films, gafchromic films, thermoluminescent dosimeters, and optically stimulated luminescent dosimeters. They are usually regarded as passive dosimeters because readout can't be processed instantly. Measurements can be made in Grays (Gy). They are mostly used for estimating medical exposure, personnel monitoring and others.

Methods

The gas-filled detectors require the principle of ion-pair production. Common types include the Geiger Muller Proportional counters, ionization chamber. Measurement with these devices can be made in dose rates [milliroentgen per hour (mR/hr), count per minute (CPM), and millisievert per hour (mSv/hr)] and dose [Gray (Gy) and Sievert (Sv)]. They are widely used in oil and gas, medical diagnostic and environmental monitoring.

Results

Scintillators are crystals that when ionizing radiation falls on them, can produce light. They are broadly divided into organic and inorganic scintillators. Organic types are from solid polycyclic aromatic hydrocarbons. A popular material of such is Anthracene. Since they are natural elements, the production of light is often limited. In-organic scintillators are high-density crystals, which are genetically modified to increase the production of light when ionizing radiation is incident on them. Some examples ate the Thallium-activated Sodium Iodide [Na I (Tl)] and Thallium-activated Cesium Iodide [Cs I (Tl)]. They are widely used for medical diagnostics, high energy physics and geophysical exploration.

Conclusion

Semiconductor detectors are devices that require very low energy to produce electron-hole pairs when ionizing radiation is incident on them. Common examples are silicon, diamond and germanium detectors. They have widely used radiation instrumentation and charged particle and gamma-ray spectrometers in physics.

Keywords: Radiation detection; Dosimeters; radiographic films; gafchromic films; Count per minute.

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Radiation Detection and Measurement: Calibration of MTS-N (LiF: Mg, Ti) Chips with a RadPro TLDcube 400 Manual Reader

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Introduction

A laboratory exercise was performed by determining the calibration factor for MTS-N chips for diagnostic imaging.

Materials and Methods

The following processes have been carried in a secondary standard dosimetry laboratory (SSDL) and dosimetry physics room.

I. Twenty Sensitive MTS-N chips were selected after their homogeneity and element correction factors have been determined. They were annealed at 400^{O}C for 1 hour and at 100^{O}C for 2 hours using an annealing oven (TLD Furnace Type LAB-01/400).
II. The chips were arranged in a bar-coded slide holder with 4 slots. Two each for equivalent deep dose (H_P 10) and equivalent shallow dose (H_P 0.07)
III. Irradiation of the chips at 100cm in air was carried out using a Cesium source (Cs-137) at 5-10mGy in the SSDL. Transport chips were not irradiated (5 chips).
IV. Readout was performed using the RadPro TLDcube 400 (Freiberg Instruments GmbH, Germany) to determine the measured results in counts for 2 (H_P 10) and 2 (H_P 0.07) for the irradiated chips
V. Readout was performed using the RadPro TLDcube 400 to determine the transport chips
VI. A plot of dose (mGy) against count (mGy/count) was performed using an excel spreadsheet (line graph)
VII. The slope was determined using the relation $y = mx + c$, where m = calibration factor (CF) of the chips
VIII. The coefficient of determination (R^2) was determined to verify the accuracy of the fit.

Results

The results are:

I. The percentage (%) deviation was = $\frac{D_{fit}-D_{actual}}{D_{actual}}$. The D_{fit} was obtained by plugging in the obtained count (x) into the line graph ($y = mx + c$). The actual dose was 5-10mGy.
II. A % deviation within $\pm$10% of the actual dose indicates that the calibration factor obtained is valid and that the error obtained were minimal.

Conclusion

It should be noted that large variations in % deviation have been reported in literatures. This is because of the fluctuation of LiF: Mg, Ti at lower energy range.

Keywords: SSDL; MTS-N chips; TLD furnace; TLDcube; Calibration factor.

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Electricity in the Heart: The Basic Principles behind Electrocardiography

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Introduction

The human nerve and muscle cells communicate and interact with each other through electrical and chemical signals. Regular electrical signals also control our heartbeat. A recording of the heart's electrical activity – an electrocardiogram (ECG or EKG), is produced by a process called electrocardiography.

Methods and Materials

We explored the basic principles of the electrical activity of the heart, especially as it relates to electrocardiography and some other related cardiovascular parameters. We also delved into the anatomy and internal workings of the cardiovascular system, phases of the cardiac cycle (systole, diastole), and the stages making up the cardiac conduction system.

Results

A detailed discussion on the generation of ECG signals and the positioning of electrodes for detecting and measuring action potentials is also featured. Moreover, we also examined the significance of different representations of the cardiac cycle (Wiggers diagram, the Wright table of the cardiac cycle, hand mnemonic for teaching the cardiac cycle, cardiac cycle process ontology - HeartCyc).

Conclusions

Finally, we considered abnormal electrical activity in the heart, implications for blood circulation and volume distribution in the human body, key issues relating to timing and ectopic stimulations, as well as typical conditions that could arise from impaired electrical functions of the heart. In conclusion, we highlighted the benefits of health-conscious behaviours and the part ECG can play in ensuring early detection and diagnosis of cardiovascular diseases, thus safeguarding healthier lives.

Keywords: Electrocardiography; Electrocardiogram; Cardiac cycle; Conduction system; Blood circulation.

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A Virtual Lab Work on the Measurements of Percentage Depth Dose and Inverse Square Law

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Introduction
Medical Physics (MP) career in Nigeria has been struggling to gain recognition. Many Physics undergraduates have little or no understanding as regards MP career while the few that know were privileged to undergo students' industrial training in one of the few Radiotherapy Centers in the country. This lack of understanding could be attributed to few Radiotherapy Centers in the country, few clinical MPs to teach in higher institutions amongst other reasons. To bridge this knowledge gap, a virtual laboratory work on basic Medical Physics was presented. This virtual lab work was aimed at teaching the students on how a linear accelerator works and measurement of beam data (PDD) using 3D water phantom.

Materials and Methods
A video clip from Elekta was used to explain the importance of each component of linear accelerator, how beam is produced, how beam data can be measured and how a patient can be placed on the couch for treatment.

Results
A 3D water phantom was shown and PDD measurement was described. Students were taught on why beam data measurements are taken in a 3D water phantom and not directly on human. Students were also taught the basis of radiation protection, the inverse square.

Conclusion
Students' performance were tested using practical questions on PDD, inverse square law and components of LINAC, 75% of those who participated answered all the questions and scored more than 80%. Few students could not answer all questions, this was attributed to issues with internet and question time duration. Students were able to understand how a LINAC works, recognize a 3D water phantom and what measurements are done and as well understood the role of a Medical Physicist in dosimetry.

Keywords: Medical physics; Water phantom; PDD; Elekta; LINAC.

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Career Opportunities in Clinical Engineering

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Introduction

We all recognise the value and contribution of engineering to our world. The computer you are most likely watching this presentation through owes its design and build to engineering; the building you are in is the result of civil engineering expertise. Our roads, our bridges and tunnels rely on engineering. As do our transport systems – from cars and buses to trains and planes – all are the product of engineering. Think of engineering and people we picture skyscrapers and train stations; jets and rockets; power stations and transmission cables; huge construction projects and maybe even robotics and space exploration applications. These are all wonderful examples of what we consider engineering. But, there's another branch of engineering that is often less well known, less well appreciated, less often seen. But one which, I believe, should be lauded above the rest, with as many challenges to solve and hurdles to overcome but which directs its efforts and sees its fruits in making poorly people better, improving the quality of people's lives, keeping people healthy and indeed saving peoples' lives.

Methods

We introduce Clinical Engineering in this discussion. The diversity of career opportunities engineering in healthcare is huge but for this short introduction I've tried to break it down into four broad themes. Health Technology Management – looking after the technology that is being used in healthcare.

Results

Health Technology Application – using technology in clinical and other healthcare settings. Health Technology Innovations –designing, developing and deploying new technology for use in health and wellbeing Health Technology Assessment – assessing value of technology and the best way to use it.

Conclusions

If you have an interest in any aspect of engineering and want to apply that to improving lives, then Clinical Engineer will offer you the perfect career.

Keywords: Clinical engineering; Health technology management; Health technology application.

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Pulse Oximetry Explained Using Light Waves to Analyse Haemoglobin

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Introduction

Haemoglobin (Hb) is a protein found in the erythrocytes that carry oxygen from lung to the tissues and organs in human body. Each erythrocyte contains several hundred million haemoglobin molecules. Each haemoglobin contains four heme groups with an iron atom is attached, which means one Hb can bind four molecules of oxygen. In general, haemoglobin is one of the key parameters in human health.

Method

Pulse oximetry is a non-invasive method that is used for measuring the oxygen saturation of haemoglobin at the surface of the skin or tissue. This technique also provides valuable information related to the cardiovascular system. Pulse oximeter is a medical device that monitors the oxygen saturation of a patient's blood and changes in blood volume in the measured skin or tissue, producing Photoplethysmography (PPG). PPG is an optical technique used to detect volumetric changes in blood in the peripheral circulation.

Results

The PPG waveform consists of DC and AC components. The DC component corresponds to average or steady blood volume of both arterial and venous blood. The AC component refers to changes in blood volume during systole and diastole phases. In healthcare applications, PPG measurements can be applied to medical diagnosis (e.g. heart diseases, hypoxaemia and vascular) and to measure the physiological parameters (e.g. heart rate and oxygen saturation (SpO_2)). Most current commercial pulse oximeters work out the oxygen saturation by comparing how much red light and infrared light is absorbed by the blood.

Conclusion

It should be noticed that pulse oximeters have been used broadly during the COVID pandemic. Therefore, haemoglobin analysing based on pulse oximetry is still a hot topic in the healthcare application.

Keywords: Haemoglobin; Erythrocytes; Pulse oximetry; Heme group; Photoplethysmography.

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Magnetic Resonance Imaging (MRI) Radio Frequency Coils

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Introduction

Nuclear Magnetic Resonance (NMR) is a technique allowing the study of molecules utilizing their unique magnetic properties. Magnetic Resonance Imaging (MRI) is a medical modality that uses NMR principals and, through a remarkable set of hardware and software subsystems, creates images containing details of the anatomy. The essential transmitting and receiving radio frequency (RF) coil is one of the hardware subsystems in an MRI system.

Materials and Methods

In this training, there is a brief description of NMR, followed by an introduction to MRI. The key concept of transverse magnetic field creation and detection utilizing RF coils is then discussed. Volume versus surface coil differences are presented, as well as the idea of coil arrays. This is followed by circuit descriptions of a single loop coil and the concepts of tuning and matching for efficiency. Finally, a "design requirement" is presented for a coil, and then decisions on the design approach are made based on what was learned about coil types and implementations.

Results

Ultimately, this is intended to lead to a laboratory coil construction activity for those that are interested.

Conclusion

Robert Stormont is an Electrical Engineer and long-time employee of GE Healthcare. He is also a doctoral student at the University of Aberdeen, studying RF coils for Field Cycling Imaging (Fast Field-Cycling MRI).

Keywords: Nuclear magnetic resonance; Magnetic resonance imaging; Surface coil; Loop coil.

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Application of Cell/Tissue Mechanics in Medicine

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Introduction

A cell is a fundamental unit of life which contains internal structures and cytosol that helps it to perform various functions. The functions are defined in terms of biochemical cues. These have resulted into improvement and corrective measures (diagnosis and/or therapy) that affect the living system. However, there are inherent properties that are not defined by the biochemistry of cells/tissues. Some of these include the magnetic and mechanical properties of the cells/tissues. In cell mechanics (CM), theories/principles of applied mechanics are used to study of the mechanical properties of cells in relation to their physiology. It explores the generation and transmission of forces between cells and their environment. The forces can influence the ability of the cells to exchange biochemical signals which are essential for their normal physiological states.

Materials and Methods

Cell/tissue mechanics provides more understanding on the nature of cells/tissues in different aspects of medicine. It reveals more on why sickle cells and malaria infected cells have difficulties in their flow within the blood vessels. Also, CM studies show that the metastatic nature of cancer cells may be due their flexibility within tissue microenvironments when compared to health/non-cancer cells. Furthermore, cell mechanics is applied in other conventional medicine such as palpation and wound healing. Palpation, an ancient diagnostic technique, helps in detection of stiffening or pain in the abdomen especially for differentiating between ascites and tympanites.

Results

The ability of cells to migrate from undamaged tissues to neighbouring wound sites for healing is due to the migratory potentials of the cells as defined by cell mechanics. Classical models such Hertz, Derjaguin-Muller-Toporov (DMT) models and tools like optical tweezers, atomic force microscope, micropipette aspiration have been used in cell mechanics.

Conclusion

Cell mechanics can be applied to clinical medicine in order to provide insights into different diseased states of tissues/organs of patients.

Keywords: Cell mechanics; Cytosol; Physiological states; Biochemical signals; Ascites; Tympanites.

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Nuclear Magnetic Resonance (NMR) in Medicine

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Introduction

NMR is a physical phenomenon in which nuclei in a strong constant magnetic field are perturbed by a weak oscillating magnetic field and respond by producing an electromagnetic signal with a frequency characteristic of the magnetic field at the nucleus. NMR is routinely used in advanced medical imaging techniques, such as in magnetic resonance imaging (MRI). Water is an inorganic, transparent, tasteless, odorless, and nearly colorless chemical substance, which is the main constituent of the fluids of all known living organisms (acting as a solvent); each of its molecules contains one oxygen and two hydrogen atoms, connected by covalent bonds. A charged, spinning nucleus creates a magnetic moment which acts like a bar magnet (dipole). A collection of ^{1}H nuclei (spinning protons) in the absence of an externally applied magnetic field. The magnetic moments have random orientations and an external magnetic field B_0 is applied which causes the nuclei to align themselves in one of two orientations with respect to B_0. In the presence of an externally applied magnetic field, B_0, nuclei are constrained to adopt one of two orientations with respect to B_0. As the nuclei possess spin, these orientations are not exactly at 0 and 180 degrees to B_0 while a magnetic moment precessing around B_0.

Methods

New NMR methodology based on Bloch NMR flow equation and special functions detailed studies of processes taking place at the molecular level in living tissues has been developed. We study the flow properties of the modified time independent Bloch NMR flow equation which describes the dynamics of fluid flow under the influence of radiofrequency (RF) field.

Results

The computational methods developed have been demonstrated for:

1. clinical simulations of magnetic resonance contrast agents
2. NMR simulations of hemorheology
3. quantitative radiomics to differentiation between radiation necrosis and tumour progression
4. assessment of MR signal from Substantia Nigra in Parkinson's disease and control
5. modelling of chemical shift imaging for analysis of cancer metabolites
6. radiofrequency (RF) controlled computational theranostics for neurodegenerative diseases.

Conclusion

It was demonstrated that as the fluid velocity reduces as often encountered in cellular process, the imaging equation shows contrast in terms of magnetic resonance (MR) signals and that the behaviour of the MR signals is completely different for different tissues. It is quite interesting to note that the magnitude of the signals becomes so large at the molecular level. This makes it possible to follow processes at molecular level in real time with brighter images. This promises to be a good way of starting to develop training software to simulate MRI experiments and provide visual training tools to help understand computational MRI technology.

Keywords: Nuclear magnetic resonance; Magnetic resonance imaging; Radiofrequency field; Bloch NMR flow equation; Computational MRI.

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Understanding Digital Communications in Medicine

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Introduction

Digital communication has lead a paradigm shift in medicine and society, allowing information and ideas to be shared through computers, on-board electronic devices (the internet of things), and smart phones. Advances in data transfer speed and increased computational capacity is reshaping the world. The current state of digital communication is driving a wave of increased global connectivity. In medicine, the first and perhaps largest impact has been in the storage of digital images. More recently we have witnessed large scale digitization of complete medical records, allowing the data to be used in new and innovative ways. Emergence of the field of healthcare informatics has driven entrepreneurship to the forefront, with a large number of start-ups working in this space, many applying sophisticated deep learning algorithms to medical imaging. Geographic maps of healthcare start-ups show concentration in North America, with a small amount of activity in Africa. While this illustrates where we are today, it is not a map of tomorrow. It is generally assumed that innovations come from developed areas and are disseminated to developing regions. However, a new paradigm shift is the concept of reverse innovation, where investments are made to develop innovations in resource limited settings, followed by global dissemination. This concept leverages the proverb, "necessity is the mother of invention".

Methods

Stressing the importance of building domain knowledge for creation of new technologies, this lecture opened with the above outline on the current state of opportunities and provided the location of shared data sets for exploration and innovation. The aim of the lecture was to introduce students to the Digital Imaging and COmmunications in Medicine (DICOM) standard. Students were provided a historical background on the development of DICOM, its place as the backbone of modern medical imaging, and utility in decision making, image analysis, research and development. The function of standards was illustrated using the analogy of a common language, permitting the direct communication of information. The concept of an ontology was explored with its basic definition, "a set of entities and their relationships," and how DICOM exists as an ontology with both real world objects and their digital representations.

DICOM was further expanded on as, not simply as an image or file format, but a set of standards with direct clinical impact. How DICOM helps drive workflow and allows for longitudinal evaluation of patients, improving diagnosis and treatment selection. Ancillary was a discussion of Picture Archiving and Communication Systems (PACS), described as the physical manifestation of DICOM. The components of PACS were outlined, including modalities (imaging systems), image archives (storage database), and workstations for interacting with the data. PACS was illustrated with an example of taking a photo with a smart phone (modality), sharing with friends on a social media platform (storage database), who could then interact with the data on their smart-phones (workstations).

Results

Concepts such as the DICOM information model, and application entity relationships were explored. Information object definitions and the DICOM data dictionary was introduced. Further communication standards were discussed with regard to service-object pairs, service class users, service class providers, roles, and association establishment. It was explained that most technologies utilize a subset of the DICOM standard and this is outlined within each device and application "DICOM conformance statement". The lecture results to a review of the benefits of DICOM to modern medicine including its role as a universal standard allowing superior image quality, a range of support to various devices, encoding of the medical data, and clarity in process description.

Conclusion

Subsequent to the lecture, multiple students engaged in a self-directed project working directly with DICOM data. Students were provided instructions for installation of python and image processing.

Keywords: Digital communication; DICOM; PACS; Internet of things; Picture archiving.

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Artificial Intelligence (AI) in Medicine

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Introduction

Artificial Intelligence (AI) has found prominent application in almost all facets of human endeavour. Healthcare has benefited a great deal from the potential that AI holds. Healthcare generate data in every step of its workflow from first consultation to follow-up after treatment. This big data has made AI have a synergetic relationship with healthcare. To avoid data maladministration regulatory guidelines such as HIPAA and GDPR have been put in place. Common area of involvement includes imaging, medical records, surgical robots, intelligent pharmacy, diagnosis-assisting tool etc. All these solutions aid in solving complex cases with increased accuracy in very little time. Thereby aiding decision making process of the Clinician for timely interventions. Radiology and Oncology are among the highest beneficiaries of AI in medicine.

Methods

It will be discussed in this presentation how AI has aided in diagnosing cancer at a level compared only to the expert Radiologist across all imaging modalities. It has also helped in image reconstruction, generating images at a faster rate and lower dose to the patient. AI-based Radiation planning assistant tool has also been developed to assist in planning radiotherapy treatments. It helps with a range of tasks from segmentation to dose calculation. AI has also helped in predicting treatment outcomes based on the interventions provided for a number of diseases.

Results

Despite all the benefits of AI, its applications in medicine is to be approached with caution. All insights generated should be subject to expert human approval before implementation.

Conclusion

AI is poised towards unlocking benefits of medicine, to treat ailments with fast recovery time and less side-effects.

Keywords: AI; HIPAA; GDPR; Radiology; Oncology; Medicine.

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Sound Waves (Ultrasound) in Medicine

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Introduction

Ultrasound imaging, also called ultrasonography, uses high frequency (2-15MHz) to probe objects and produces pictures (images) of the inside of objects. Bodies internal organs, movements of the heart and velocity of blood flow etc, can be viewed in real time. Ultrasound investigations very IMPORTANTLY do not use ionizing radiations. The knowledge of ultrasound among physics undergraduate students in Nigeria is at an understandable low. Dearth of faculty for this important medical physics specialty and the already crowded curriculum with general courses are major contenders for shortcomings in ultrasound education.

Methods

Introduction of NAMP-IPEM to students and awaken their interests in a probable career in medical physics. Any ultrasound system has three basic components: a transducer, or probe; the processing unit, including the controls and the display.

Results

Introduction of this topic in the NAMP-IPEM harmattan school just serves to make students aware of this physics-inundated concept. It is worthy of note that Ultrasound machines calculate distances to synthesize images from returning echoes. The ultrasound machines need to determine the distance of reflective interfaces from the transducer to form images at the appropriate position using propagation speed of 1540m/s. This is the underlying principle for the three major modes of ultrasound: A-mode, B-mode and M-mode.

Conclusion

NAMP-IPEM harmattan school has awaken their interests in a probable career in medical physics at post graduate level for deeper probe into ultrasound.

Keywords: Ultrasound imaging; High frequency; A-mode; B-mode; M-mode.