2023 生醫系畢業成果展

2023 DBSE Graduation Exhibition

摘 要 集 錦

Abstract Collection

Prior Featuried Diffusional Encoder-Decoder Recognition and Segmentation Neural Network

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- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

Although it's lower than 1% of possibility that a person will have brain tumor, the death rate of whom is higher than 66%.It is because most brain tumors locate in Central Nerves System(CNS), which causes cramp, spasm, and further impacts people's lives.Therefore, brain tumor segmentation has become more and more discussed in recent years, which is also my main subject of study.

METHODS

My study merges the feature of compact modeling form in Activate Contour Models and the learning process of neural network models,and then intergrates it to fast Data Density Functional Transform(fDDFT). In the frame of fDDFT, we can get the critical value of tumor segmentation by calculating the image's topological feature.In the mean time,it offers compact, light global convolutional kernel to achieve very low time complexity.

RESULTS AND DISCUSSION

My study rescale the image to 25% of its original size to calculate the potential energy density function distribution, and then revert to original.In the result, we can find this method can keep the accuracy high and lower the time cost of calculating.It is because potential energy density function created by fDDFT has the attritube of super smoothness which allows random rescale while maintain the accuracy.However, for the images with sparse tumor distribution and edema, it is hard for my study to separate them precisely.

NOVEL ASPECT

Higher accuracy and lower time consumption.

Heartrate monitor with APP

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- 學系/年級:Biomedical Sciences and Engineering/Senior

- Poster Presentation: Yes
- Oral Presentation:Yes

INTRODUCTION

A simple heartrate monitor, with an easy understanding APP to monitor the user's heartrate for those need.

METHODS

A heartrate detacter using Arduino, and an APP using Android studio Bluetooth to connect the monitor.

RESULTS AND DISCUSSION

The connection between Android and APP heavily restricted by distance, it's fine if using on self monitor. However, in order to sent the data to the internet, we need to save it and upload to the net. Quite inconvenient if we want to get the data immediately. And the devices is not sensitive enough to collect the data correctly without having enough time to stabilize.

NOVEL ASPECT

And easy understanding App to connect the heartrate monitor device.

Investigation of Nanofiller Effect from molybdenum disulfide in PVDF-based Triboelectric Nanogenerators

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- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

Polymer and composite triboelectric nanogenerators have so many advantages, like mechanical properties, durability and transparency and so on. Besides, all eyes have been on nanogenerators having self-powered systems and one common way is combining with kinds of nanomaterials. However, lots of subjects focus on enhancing effects by adding nano materials, but there is no discussion about the best relation between nano materials process and components. Therefore, we adopt hydrothermal method which has advantages like low temperature process, better output and so on. We investigate nano materials effect from molybdenum disulfide in PVDF-based triboelectric nanogenerators and the connection between parameters of processes and output.

METHODS

Experimental procedure is as follows. First, we compound with ammonium molybdate, thiourea and DI water and mixed solution put on hot plate heat and homogenize then 3-sulfanylpropanoic acid is added. Second, the solution put into autoclave is heated 24 hour in the oven. After that, we purify the solution and dry that, then we will get MoS2 powder. Part of PVDF film, we blend with PVDF powder and DMSO (Dimethyl sulfoxide) and heat the mixture, and then conduct spin coating to gain PVDF film. Finally, we get composite film after blending with PVDF solution and MoS2 powder.

RESULTS AND DISCUSSION

In the beginning, we experiment and search for concentration and parameters of PVDF, then find that PVDF film easily form at 15% concentration and they solidify at 90°C. Moreover, we measure and confirm that the PVDF film is biased towards γ phase by XRD (X-Ray Diffraction). But PVDF in β phase is found that it can promote triboelectric nanogenerators' effect so that we try to transfer γ phase to β phase by annealing in order to get better effects. Furthermore, we also find that PVDF film can improve the efficiency if PVDF which mixes with MoS2 powder becomes composite material. After that, we still need to search for the best parameters of composite material to get the optimal result. In the future, we hope that Nano material - MoS2 would have more flexible and better potential with other applications or in biomedical sensor production processes.

NOVEL ASPECT

Flexible, Triboelectric nanogenerator, PVDF, Nanomaterial

The effects of exosomal miR-148a-3p from WJMSC on radiotherapy for head and neck cancer cells

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- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

Head and neck cancer is a malignant tumor that develops around the throat, nose, and mouth region. Radiotherapy is one of the major treatments for head and neck cancer. However, radioresistance remains an unsolved problem. Recent studies indicated that radiation-induced bystander effects (RIBE) activity links to radioresistance and promotes tumorigenesis through exosome secretion. Our previous study showed that miR-148a-3p expression in plasma was one of the miRNAs related to radiotherapy responses. Furthermore, a study showed that miR-148a-3p is highly expressed in exosomes derived from Wharton's jelly mesenchymal stem cells (WJMSCs), a widely applicated cell type for cancer therapy. This study aims to reveal the functions of exosomal miR-148a-3p upon radiotherapy in head and neck cancer.

METHODS

Head and neck cancer cells were overexpressed with miR-148a-3p and radiation could be accomplished. Colony formation assay and wound healing assay were used to investigate the proliferation and migration ability of radiated head and neck cancer cells. The effects of miR-148a-3p on DNA damage response and genome instability were examined by immunofluorescence assay. miR-148a-3p expression in conditioned media from WJMSCs was measured by qPCR assay. WJMSC-derived exosomes are isolated by using size exclusion columns and exosome markers were determined by western blotting assay.

RESULTS AND DISCUSSION

miR-148a-3p could enhance radiosensitivity through inhibiting the proliferation and migration abilities of head and neck cancer cells. Besides, miR-148a-3p might induce DNA damage response (DDR) and genome instability by increasing γ-H2AX foci and micronuclei formation. By treating Triton-X and RNaseA to conditioned media from WJMSCs, the miR-148a-3p expression could be detected, which demonstrated that miR-148a-3p was packaged into WJMSC-derived exosomes. The protein expression of exosome markers, CD63 and CD81, gave evidence of exosome existence. The expression of ITGA5, the direct target of miR-148a-3p, could be suppressed by treating WJMSC-derived exosomes to head and neck cancer cells. This indicated that miR-148a-3p was successfully transferred into head and neck cancer cells through WJMSC-derived exosomes. In conclusion, the findings showed that miR-148a-3p had the potential to enhance radiosensitivity and induce DDR of head and neck cancer cells. To investigate whether exosomal miR-148a-3p could also regulate the radiosensitivity of head and neck cancer cells, the WJMSC-derived exosomes will be isolated and transfected with miR-148a-3p and applied in vitro tests. We hope to conduct in vivo experiments in the future, and further develop a novel adjuvant treatment for improving radiotherapy on head and neck cancer.

NOVEL ASPECT

miR-148a-3p acts as a radiosensitizer and exosomal miR-148a-3p could become a therapeutic molecular for head and neck cancer treatment.

Classification for Breast Cancer Diagnosis via DeepLearning-Enabled Raman Spectroscopy

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- 學系/年級：Biomedical Sciences and Engineering/Senior

- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

Raman spectra contain rich molecular information, especially mixtures, which are more difficult to analyze. This study aims to realize an accurate, general and ready-to-use method combining surface-enhanced Raman spectroscopy (SERS) with deep learning models, and to analyze the peak differences of different Raman reporters on breast cancer and normal cells, Use the Pseudo Siamese Neural Network (pSNN) of Spatial Pyramid Pooling (SPP) to predict the proportion of unknown mixture, and use Non-negative Least Squares (NNLS) and Linear Discriminant Analysis (LDA) to obtain each proportion and compare it with the actual proportion. classification, and practical results compared with traditional statistical methods.

METHODS

1.Data Collection and Preprocessing:Culture breast cancer and normal cells. Obtain spectra by analyzing different cell reporters, including varied mixtures. Apply preprocessing for high-quality data. Compare effects on training.2.Data Labeling:Label Raman samples for reporter mixtures and record proportions.3.Building pSNN-SPP Model:Use pSNN with SPP for Raman data. Reconstruct data for input. pSNN learns features, and SPP captures variations.4.Model Training:Train pSNN-SPP model on labeled data for mixtures.5.Proportion Prediction:Use the model to predict unknown mixture proportions.6.Proportion Classification:Apply NNLS and LDA for predicted vs. actual proportions.7.Performance Evaluation:Assess model with accuracy, recall, F1 score.8.Compare Traditional Methods:Evaluate the deep learning model against traditional approaches.9.Result Interpretation:Analyze predictions, explain reporter differences in cell types.

RESULTS AND DISCUSSION

Through data collection and training deep learning models with and without preprocessing, we observed consistently high accuracy, exceeding 90%. Notably, the model without preprocessing achieved slightly higher accuracy because raw data untouched by manual processing possibly, and it retains the original spectral features crucial for classification. When using this deep learning model, I compared it with traditional statistical methods, revealing that deep learning offers both higher accuracy and improved real-time capabilities. This research suggests that utilizing the pSNN with SPP for classification and evaluation is effective with room for further enhancement. Understanding the model's internal architecture and applications, we anticipate future advancements in model capabilities.

NOVEL ASPECT

Exploring Medical Diagnostic Projects Integrating Deep Learning and Optics.

Automatic measurement of blood pressure with IoT platform

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- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

Blood pressure is an important index for doctors to diagnosis one's illness, such as hypertension. A long-term monitoring and real time data uploading to the internet benefit both patients and medical staffs. Potential hereditary disease can be detected previously by long-term monitoring, leaving the disease under control. Examining real time data online eases the workload for medical staffs, in which they do not need to check on patients physically. In our work, we automatically receive intermittent blood pressure data, and upload them to an online IoT platform name ThingSpeak. The data we capture from blood pressure monitor are systolic blood pressure, diastolic blood pressure and heart rate.

METHODS

Our big structure is to collect data from blood pressure monitor, therefore upload the data to ThingSpeak IOT platform for further analysis. Three major components we utilize are Omron HEM-7121 blood pressure monitor, Atmega328 microcontroller and ESP8266 wifi module. First, we use Atmega328 to automatically control the switch of blood pressure monitor. Then, Atmega328 will capture data through I2C from EEPROM, which is the register of blood pressure monitor. Eventually, we utilize ESP8266 wifi module to update our data to ThingSpeak platform.

RESULTS AND DISCUSSION

We can successfully and stably update our data to ThingSpeak at this stage. During our research period, we encounter some problems. For software problems, we were struggling with ESP8266 module for a while. On the other hand, hardware problems which caused by no proper operating blood pressure monitor remain some problems to be solved.

NOVEL ASPECT

Successfully capture data from BPM and upload data to ThingSpeak increase the possibility to adopt our device for practical use.

Implementing In-Home Gait Analysis with a Single Accelerometer and MATLAB Algorithms

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- 學系/年級：Biomedical Sciences and Engineering/Senior

- Poster Presentation: Yes
- Oral Presentation:Yes

INTRODUCTION

Gait measurement is a crucial tool for identifying symptoms related to various age-related degenerative diseases and neurological impairments. Importantly, early detection through gait analysis can serve as a preventive alert, as prevention remains the most effective way to mitigate the onset of diseases. However, existing equipment for gait analysis is primarily confined to specialized centers, such as pressure-sensitive walkway systems, and the cost of such equipment is considerably high. We aim to make gait measurement more widespread and affordable, enabling individuals and general clinics lacking access to expensive specialized instruments to obtain lower-cost measurement devices. Our goal is to achieve fast and repeatable measurements, using wearable devices (body-worn monitors).

METHODS

In each measurement session, participants wear a tri-axial accelerometer at the L5 lumbar level. They perform four intermittent straight-line walks, covering approximately 10 meters on a flat surface. Acceleration data collected during these walks is imported into MATLAB for processing. We focus on vertical acceleration, which is aligned with the body's upright direction.Then, Signal preprocessing is applied, followed by the application of a gait algorithm utilizing continuous wavelet transformation to estimate the time of initial contact (IC) and foot-off (FC) during the gait cycle. These times provide key gait features such as Step time, Stance time, Swing time, and allow for further statistical analysis of Variability and Asymmetry.

RESULTS AND DISCUSSION

For the Initial Contact (IC) events identified by the algorithm, we established a predefined reasonable range that should fall between 0.25 to 2.25 seconds between two IC events. Consequently, any values falling outside of this range were removed. However, Due to the use of a single tri-axial accelerometer, it was not possible to measure step width or definitively determine left and right step events. However, we believe that this does not impact the device's ability to fulfill the requirements of simple gait analysis. Variability values, describing the standard deviation of all steps during the walking trial, and asymmetry values, calculated by averaging the absolute differences between left and right steps (alternating) for each walking session, are interchangeable in their assessment. Therefore, they do not rely on detecting "true" right and left steps. Regarding the devices, we can utilize well-established devices like Axivity, readily available in the market, for measurement purposes. Additionally, we are in the process of developing our accelerometer device using the ADXL-355-PMDZ model. This device will have the capability to transmit data to a smartphone for storage.

Promoting widespread gait measurement is an ambitious goal. It not only requires refinement at the device level and the development of accelerometer data processing algorithms but also demands statistical processing to estimate gait features. Furthermore, it involves the comparison of data with that of healthy adults to detect early signs of motor abnormalities. Achieving these objectives necessitates considerable effort and technical expertise. The primary focus of this project remains on the development of wearable devices and the algorithmic extraction of specific gait events from accelerometer data.

NOVEL ASPECT

Propose a device for gait detection at home or in general clinics without the need for expensive equipment.

Automated Implementation of Prior Featurized Self-Attention-Embedded Neural Network in Hippocampal Recognition and Segmentation of Epileptic Lesions

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- 學系/年級：Biomedical Sciences and Engineering/Senior

- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

Epilepsy is one of the most prevalent neurological disorders worldwide, with an estimated prevalence rate of 0.4% to 1% reported by the World Health Organization (WHO). For individuals with intractable epilepsy, treatment options often include Anterior Temporal Lobectomy and Selective Amygdalohippocampectomy. However, current clinical practice heavily relies on manual interpretation of brain CT or MRI images to extract hippocampal data. This process is not only time-consuming and subjective but also demanding scarce medical expertise and resources. Furthermore, existing research mostly focuses on the long-term tracking of hippocampal atrophy. Consequently, the question of how to assist healthcare professionals in identifying and segmenting the hippocampus from MR or CT images for surgical planning remains a critical engineering challenge in this field.

METHODS

The main objective of this study is to utilize deep learning image segmentation techniques to identify the position and configuration of the hippocampus within 3D brain MRI images. This aims to assist physicians in achieving more precise localization of the epileptic focus during epilepsy surgeries, with the goal of minimizing damage to brain regions. We attempt to extract and enhance hippocampal features from medical images by using fast data density functional transform. These features are then fed into the E2DHipseg network structure for activation, incorporating ViT Transformer and multidimensional U-Net as its backbone. Finally, a self-attention mechanism is employed to fuse features from various dimensions, resulting in the deep learning network capable of hippocampal recognition and segmentation.

RESULTS AND DISCUSSION

There are mainly three significant challenges in this task: (1) Lack of standardized protocols for hippocampal delineation across different datasets; (2) Potential volume estimation errors due to low-resolution images; and (3) Insufficient recognition capabilities for the anterior and posterior segments of the hippocampus and its boundaries with the hippocampal sulcus. For the challenges mentioned above, we propose the Prior Featurized Self-Attention-Embedded Neural Network (PFSE-net) for hippocampal segmentation task. In the data preprocessing phase, we not only employ conventional Data Affine Augmentation techniques but also introduce the fast Data Density Functional Transform (fDDFT) for data feature extraction and enhancement. During the initial stage of our research results, we have demonstrated the utility of fast Data Density Functional Transform in facilitating the recognition and segmentation of hippocampal features. However, we have observed that solely relying on the fDDFT network may leads to misclassification of anterior and posterior portion of the hippocampus, as well as the detection of fragmentation within the hippocampal regions. Therefore, this project aims to further implement PFSE-net, incorporating ViT Transformer and multidimensional U-Net networks to enhance generalization capability of the overall network. Additionally, we will examine whether our proposed deep learning network demonstrates consistent segmentation abilities when validated with other datasets and investigate the presence of any additional engineering challenges during this validation process.

NOVEL ASPECT

A self-attention embedded deep learning network inspired by prior features across different dimensions.

G-sensor wristband

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- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

Nowadays, there are a variety of smart wristbands in the market which provide users with different functions and services. Most of them are with accelerometer sensors and gyroscopes that enable users to have a deeper understanding of their own activity through the algorithms behind the device. We aim to design a wristband that is able to record the data of the G-sensor in the long term so that those data can be utilized to analyze users' activity and other important content anytime and anywhere.

METHODS

Our gadget is designed with an STM32 microcontroller(STM32L475), a G-sensor(ADXL355), an Ambient light sensor(OPT3005), an SD card module, and a BLE module(DA14531). The microcontroller communicates with the G-sensor and SD card through SPI, the ambient light sensor through I2C, and the BLE module through UART. The sampling frequency of the G-sensor is 125 Hz, and that of the ambient light sensor(ALS) is 2 Hz. We not only record the long-term data in the SD card but also demonstrate the real-time data in the application through Bluetooth Low Energy(BLE). The ALS can effectively help professionals determine the real condition of the data recorded. Overall, our final goal is to minimize the size of the wristband when it still can reach our standards of 7~14 days of recordings.

RESULTS AND DISCUSSION

The G-sensor wristband can now function normally, and the data recorded in the SD card seldom gets lost. The most challenging thing is to make the volume of the whole device as delicate as possible. We have to consider the usage of electricity thoroughly and choose the suitable battery to maintain its constant working. We design our own layout board to attempt to measure the data.

NOVEL ASPECT

Our product provides the measurement of 3-axis acceleration and ambient light in the period of one to two weeks unstoppably.

Automatic measurement of blood pressure with IoT platform

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- 學系/年級：Biomedical Sciences and Engineering/Senior

- Poster Presentation: Yes
- Oral Presentation:Yes

INTRODUCTION

Blood pressure is one of the critical indicators of a patient's health condition. However, until now, most healthcare organizations still rely on nurses a lot to check out patients' blood pressure frequently, which might cause some delay if there is an emergent condition. To solve the problem, an automatic blood pressure monitor is needed. What's more, we utilize ThingSpeak platform to show real-time data, including systolic, diastolic blood pressure, and heart rate.

METHODS

Our gadget contains three major parts which are Omron HEM-7121 blood pressure monitor, Atmega328 microcontroller, and ESP8266 Wifi module. We use the Atmega328 chip to automatically activate the HEM-7121 and get the machine's data from its EEPROM. In the end, the Atmega328 will communicate with ESP8266 Wifi module through I2C to transmit the data to ThingSpeak IoT platform.

RESULTS AND DISCUSSION

Our device can successfully and stably upload the real-time data to ThingSpeak platform. Firstly, as soon as the device resets, we will clean out the memory page of EEPROM and turn on HEM-7121 to measure the blood pressure. Next, we receive the data from EEPROM and upload it to the IoT platform with TCP connection. To ensure a successful connection with ThingSpeak, each step will be checked multiple times. Finally, the result will be shown on the webpage. Subsequently, the whole process will restart after 30 minutes of waiting. We concur with a lot of obstacles during the process, such as the instability of data transmission and some hardware issues.

NOVEL ASPECT

Our device can be the first automatic blood pressure monitor that is truly feasible in real hospitals.

Leukemia inhibitory factor receptor promotes Epithelial mesenchymal transition in nasopharyngeal carcinoma cells

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- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

Abnormal expression of leukemia inhibitory factor receptor (LIFR) has been implicated in various types of human cancers. Binding of LIF to LIFR-gp130 receptor dimer transduces intracellular signalings and regulates functions of cell differentiation, stemness, and cell proliferation in a cell type-dependent manner. In this study, we investigated the role of LIFR in regulating epithelial-mesenchymal transition (EMT) in nasopharyngeal carcinoma (NPC) cells.

METHODS

lepofectamine2000 transfection, western blotting, siRNA transfection, immunofluorescence assays

RESULTS AND DISCUSSION

Results of in vitro study demonstrated that elevated LIFR expression promotes EMT process in NPC cells. Overexpression of LIFR resulted in a decreased expression E-cadherin, an epithelial marker, and increased expressions of mesenchymal markers, including N-cadherin and Vimentin. Results of immunofluorescence assays found that the overexpression of LIFR induced a longer cellular protrusion compared to the control group. Together, these results demonstrate that LIFR promotes epithelial mesenchymal transition in NPC cells. The downstream effectors of LIFR in regulating EMT process in NPC cells need to be further investigated.

NOVEL ASPECT

LIFR promotes epithelial mesenchymal transition in NPC cells

Utilizing Bioinformatics Strategies to Identify Flavonoid Active Compounds with Anti-Colorectal Cancer Metastasis Potential in Chamomile

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- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

Colorectal cancer is a highly prevalent malignancy, and post-metastasis, its survival rates significantly decline. Consequently, identifying drugs with anti-metastatic properties is of paramount importance. However, novel targeted drugs are often expensive, and there is limited understanding of potential future side effects or sequelae. Thus, uncovering candidate drugs with novel therapeutic functions from previously utilized medications presents a competitive and clinically valuable strategy.

METHODS

By utilizing the GEO gene database, we selected colorectal cancer tissue data from clinical samples of individuals from various regions. Through analysis of gene microarray data, we identified gene modules associated with colorectal cancer metastasis. Subsequently, we inputted this gene module into drug functional prediction databases to compare and predict a series of potential drugs related to inhibiting colorectal cancer metastasis.

RESULTS AND DISCUSSION

Through the aforementioned bioinformatics analysis, we have successfully identified several candidate drugs with the potential to treat colorectal cancer and inhibit metastasis. Subsequent cell migration experiments further validated the significant anti-cancer cell migration effects of the flavonoid active compounds in chamomile. In the future, we intend to delve deeper into the identification of the molecular mechanisms underlying the inhibition of colorectal cancer migration by this active compound. We will also evaluate the results of animal experiments to assess the potential clinical application value in the future.

NOVEL ASPECT

The successful strategy of repurposing existing drugs will significantly broaden the range of clinical drug choices and also expedite the development of new medications.

Discovering Fundamental Wound Healing Formulas in "Pu Ji Fang" using Modular Network Analysis

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- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

Pu Ji Fang" stands as one of the most extensive compilations of traditional Chinese medicinal formulas. Within the realm of formulaic studies, it classifies medicinal components into four distinct roles: Emperor, Minister, Assistant, and Envoy. The Emperor ingredient takes center stage as the fundamental component of the formula, while the Ministers assume secondary roles. Assistants play a crucial role in alleviating any toxic or aggressive qualities inherent in the Emperor ingredient, and Envoys work to harmonize the entire formula. Through the utilization of data-driven correlation analysis, this research endeavors to uncover potential core modules within the "Pu Ji Fang." The primary goal is to forecast and select pivotal ingredients for wound healing, with a specific focus on WS1 fibroblast cells.

METHODS

Pu Ji Fang" as foundational data, a database is constructed using Microsoft Access. Apriori association rule analysis and modularity measures are employed to identify core modules. Adhering to the concept of "Emperor, Minister, Assistant, Envoy," eight potential modified formulas are hypothesized. Subsequently, the medicinal ingredients are extracted through processes such as soaking, filtering, concentrating, freezing, and drying. Further steps involve toxicity testing of the extracted compounds and conducting cell migration experiments using WS1 fibroblast cells to assess wound healing speed. The optimal formula is determined based on these results.

RESULTS AND DISCUSSION

Toxicity assessments of the medicinal compounds have revealed that the first, fifth, and sixth formulations exhibit reduced toxicity and are better suited for human application. The next phase will encompass cell migration experiments, aiming to assess the merits and limitations of the diverse formulations. Ultimately, more promising candidate formulas for wound healing have been identified and will be subjected to additional validation through animal model studies and investigation of molecular mechanisms.

NOVEL ASPECT

Leveraging artificial intelligence to enhance existing formulas and utilizing experimental data to identify the most appropriate modified formulations.

Detecting COVID-19 from CXR images using deep learning

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- 學系/年級：Biomedical Sciences and Engineering/Senior

- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

The COVID-19 pandemic has been devastating health systems throughout the world, and it continues to pose a threat due to the mutability of the virus. By implementing AI technology into health systems, we can ease the load of our health workers significantly, while also increasing the efficiency of the systems. The goal of this project is to create a reliable and fast detection system for detecting COVID-19 from chest x-ray images using deep learning. This not only reduces the cost of detection, but also frees up valuable time for doctors.

METHODS

In the following project, I trained and tested different deep learning models, namely InceptionResNetV2, VGGNet19, and YOLOv5_CLS, with a COVID-19 CXR dataset created by Dr. Cohen from the University of Montreal. The data was firstly filtered to get only COVID-19 and posteroanterior x-ray images. Then, data augmentation techniques such as rotation, vertical flip, and horizontal flip were applied to artificially create more images for training. For the normal CXR images, I used a CXR dataset from Kaggle.

RESULTS AND DISCUSSION

The results of this project are promising. The best performing model reached an accuracy of 0.9535, a sensitivity of 1.0, and a specificity of 0.9091. It exceeds at detecting true positives, but it struggles with false negatives. Overall, it is not quite reliable enough for practical use, but it serves as a great starting point.

NOVEL ASPECT

Using AI to support and enhance medical systems.

Indoor Localization System for Elderly Care Centers Using IMU Technology

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- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

We explore the development of an Indoor Localization System utilizing IMU (Inertial Measurement Unit) technology within elderly care centers. With an aging population, providing accurate and real-time tracking of residents' positions becomes crucial for their safety and well-being. The proposed system aims to enhance the efficiency of care and emergency response through precise indoor positioning.

METHODS

The methodology involves employing a mobile app to collect IMU signals from wearable devices worn by residents. These signals are then processed using MATLAB algorithms for accurate localization. The system's architecture integrates advanced sensor fusion techniques to minimize errors and enhance positioning accuracy.

RESULTS AND DISCUSSION

Preliminary results indicate the feasibility of the proposed IMU-based indoor localization system. By leveraging sensor data and advanced algorithms, the system showcases promising accuracy in tracking residents' movements within the care center. Challenges such as signal interference and calibration are addressed, demonstrating the system's potential to significantly improve elderly care management and emergency response.

NOVEL ASPECT

Innovative IMU-based system for real-time indoor tracking in elderly care, enhancing safety and response efficiency.

Development of Cancer Cell Membrane-Coated Indocyanine Green-Camptothecin-Loaded Perfluorinated Nanoparticles for Photodynamic Therapy in Triple-Negative Breast Cancer (MDA-MB 231)

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- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

Breast cancer is the most common cancer among women. Generally, patients with breast cancer undergo various treatment methods, among which the combination of chemotherapy and targeted therapy is the most effective in reducing the risk of recurrence. However, the side effects of the anticancer drugs used in chemotherapy can have significant physiological impacts on patients and may potentially have adverse effects on the treatment outcomes.

METHODS

The plan includes: 1) Investigating the nanoparticle size, surface potential, and encapsulation efficiency of ICG and CPT. 2) Measuring the photothermal and photodynamic properties of the particles through near-infrared light irradiation. 3) Conducting in vitro cell experiments to test the specificity of the particles for breast cancer cells (MDA-MB-231). 4) Performing cytotoxicity tests to compare the killing effects of encapsulated particles and free CPT solution.

RESULTS AND DISCUSSION

study focuses on the development and validation of cancer cell membrane-coated indocyanine green-camptothecin-loaded perfluorinated nanoparticles for photodynamic therapy in triple-negative breast cancer. The findings from this research hold the potential to significantly improve treatment outcomes by mitigating chemotherapy-related side effects and increasing patient adherence to therapy.

NOVEL ASPECT

By reducing the required dosage of chemotherapy drugs, this approach aims to minimize the adverse effects on patients.

Development of ICG-CPT-encapsulated PLGA nanoparticle semulsions for photochemotherapy of lung cancer

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- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

Cell membrane-encapsulated nanoparticle technology is becoming more and more frequently mentioned. This research developed a nano-particles AICEPNPs of poly-lactide-co-glycolide(PLGA) encapsulate not only with indocyanine(ICG) and camptothecin(CPT) by emulsion method , but also graft Alpha-fetoprotein (AFP) protein onto the surface of the particles.

METHODS

We encapsulate ICG,CPT into PLGA by using sonication, and the form of the particles will finally be nanoemulsions. The size and surface potential of nanoemulsions can be determined by Dynamic Light Scattering (DLS), and the difference between before and after grafting AFP protein can be compared.The encapsulation and loading rates of CPT and ICG in PLGA nanoemulsions can also be measured by a UV-vis spectrophotometer.
A drug release test and stability test were conducted for CPT and ICG respectively to know the trend of drug release and the stabilization effect of the photosensitizer.In addition, due to the elevated temperature caused by AICEPNPs upon irradiation with 808 nm near-infrared light, it can cause damage to cancer cells.

RESULTS AND DISCUSSION

Nano technology has been dedicated and played a critical role in our life for ,it is no doubt that it brings lots of benefits to medications nowdays.Basic measurements of particle size and potential indicate successful encapsulation of ICG and CPT into PLGA.The PLGA-coated particles also exhibit a reduced release rate of CPT, contributing to sustained therapeutic effects

NOVEL ASPECT

Encapsulation in nanoemulsions can significantly reduce the degradation of ICG.

Development of Perfluorinated Cancerous Exosomes for Enhanced Target Photochemotherapy in Triple-Negative Breast Cancer

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- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

Breast cancer has emerged as one of the most prevalent forms of cancer in our modern era. In 2020, a significant milestone was reached as the number of individuals diagnosed with breast cancer surpassed those with lung cancer, establishing it as the leading cancer worldwide. Among various subtypes of breast cancer, triple-negative breast cancer stands out due to its heightened resistance to multiple drugs (MDR) and aggressive metastasis capabilities. To combat these challenges, scientists have turned to artificial nanocarrier technology for drug delivery and cancer treatment.

METHODS

Encapsulation efficiency was determined using ultraviolet-visible spectroscopy , while the impact of photothermal therapy/photodynamic therapy on our drug nanocarriers was evaluated using near-infrared radiation at 808 nm and 6 W/cm2

RESULTS AND DISCUSSION

The results obtained thus far highlight the tremendous potential of our developed nanocarriers in facilitating photothermal therapy/photodynamic therapy, preserving drug stability, and efficiently encapsulating drugs. These findings bring us closer to achieving breakthroughs in cancer treatment and pave the way for further advancements in nanomedicine.

NOVEL ASPECT

our drug carriers exhibit minimal drug leakage based on release experiments

Integrated magneto-electrochemical biosensor for quantification of albumin-to-creatinine ratio in kidney disease

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- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

Chronic kidney disease (CKD) and acute kidney injury (AKI) have caused increasing morbidity and mortality in recent decades and are related to gout, hypertension, and cardiovascular disease. CKD and AKI are now recognized as major public health problems. A urine test is a general method for the diagnosis of renal diseases. Renal disease biomarkers include albumin and creatinine. Monitoring these two biomarkers in urine helps detect possible glomerular damage. The albumin-to-creatinine ratio in urine is a direct reflection the kidney function. However, routine urine examinations are complex, time-consuming, and inconvenient for patients. Accordingly, the rapid, precise, and easy-to-apply detection method is essential to make patients detect CKD or AKI earlier.

METHODS

1. Implementation of a setup on the dual-channel electrochemical measurement chip
2. Albumin Concentration Detection: Immunomagnetic Beads Method and Electrochemical Measurement
3. Creatinine concentration detection: use the Jaffe reaction (catalyze picric acid) to generate a current change and measure it using an electrochemical method
4. Programming the MCU to communicate via I2C with the chip for control and data retrieval
5. Transfer of data from MCU to mobile application
6. Plotting of data with a graphical user interface

RESULTS AND DISCUSSION

We will establish a simple, sensitive, and rapid detection method and equipment and use methods such as magnetic nanobeads and Jaffe reaction to realize the detection of albumin-to-creatinine ratio (ACR) in urine. First, artificial urine will be used for system verification. The next step is to detect actual clinical cases to be used in early kidney diseases.

NOVEL ASPECT

Combining applications of electrochemistry, IOT, and medicine.

The prospect of applying 3D cultured osteogenic cell spheroids for surgical procedures in Empty Nose Syndrome.

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- Poster Presentation: Yes
- Oral Presentation:Yes

INTRODUCTION

Empty Nose Syndrome (ENS) arises from excessive nasal turbinate removal, often during turbinate reduction surgery, resulting in altered airflow, mucosal dysfunction, and reduced neural sensation. ENS sufferers endure symptoms like dyspnea, nasal dryness, and paradoxical obstruction, often leading to sleep disorders. Psychological distress and even severe cases of depression and suicidal thoughts can emerge due to cerebral hypoxia and sleep deprivation. Current ENS treatments are inadequate, prompting exploration of cell-based therapies. This study aims to create a bone-like structure using 3D dynamic culturing of mesenchymal stem cells (MSC) and platelet-rich fibrin (PRF) as a surgical implant for ENS turbinate reconstruction. Incorporating neural stem cells (NSC) and endothelial cells (EC) in the MSC 3D dynamic culture can enhance bone regeneration efficiency post-implant surgery.

METHODS

According to several studies, the growth factors secreted by NSC show a positive effect on MSC in osteogenesis. By introducing this co-culture system into the 3D dynamic MSC culturing, we expect that the bone regeneration efficiency for the damaged turbinate tissue would be increase after the implant surgery. The three types of cells will first be seeded inside the scaffolds separately and apply to the bioreactor system in our lab. After 21 days of culturing, the MSC cell clumps will be separated from the alginate scaffold and combine with PRF to generate the bone-like structure.

RESULTS AND DISCUSSION

The result of current experiment indicates that MSC co-cultured with NSC and EC display a better outcome in live and dead staining. Moreover, the cell cluster in both dynamic groups seems to be more condense than in the static group. Which suggest that a dynamic culture environment might be beneficial for cell cluster forming However, the mineral deposition ability of the co-culture group does not seem to be as significant as the control group.
Further application in combination of cell spheroids and biomaterial on ENS clinical treatment is to be observed.

NOVEL ASPECT

This study applies the co-culture system of NSC and EC into the 3D dynamic MSC culturing to create a better osteogenesis environment for MSC

Prior Featurized Topological Encoder Neural Network

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- Poster Presentation: Yes
- Oral Presentation:No

INTRODUCTION

Cell recognition, tracking, and segmentation techniques play a crucial role in biomedical research. They aid scholars in studying diverse cellular activities, interactions, and affinities, while also investigating the invasiveness and life cycle of cancer cells within different substrates. Additionally, these techniques allow analysis of cell morphology and interactions, making them a pivotal junction between artificial intelligence and medical research. This study introduces the Prior Featurized Topological Encoder Neural Network(i.e. PFTE-net), aiming to overcome challenges faced by AI models in cell segmentation.

METHODS

The research approach consists of two steps: preprocessing and network architecture.
In preprocessing, Affine Transformation techniques from the U-net paper are applied to enlarge the dataset and display the varied morphology of biological cells, aiming to boost model learning and accuracy. Following this, the lab's developed fast Data Density Functional Transform is used for advanced image feature extraction and enhancement. Additionally, The proposed PFTE-net, derived from CE-net, merges GCN and fDFFT features. Similar to the U-net design, each layer holds three GCN layers, succeeded by downsampling and max-pooling, repeated thrice. Results are sent to the Context Extractor module and then upsampled to regain image dimensions.

RESULTS AND DISCUSSION

The experiment has successfully integrated two distinct network architectures, GCN and fDDFT. Additionally, we transformed the graph structure of GCN into the point-wise structure of fDDFT. We plan to attempt submission to an IEEE journal. We intend to introduce Bayesian probabilistic inference mathematically to establish a Gaussian mixture model constrained by covariance. The theoretical approach will use the mean-covariance matrix of each complete individual cell in the image as a constraint target. This is to capture overlapped cells using constrained covariance matrices during recognition tasks, resulting in a Variational Likelihood density distribution. In engineering applications (and based on experience), these can be assumed as Dirichlet, Gaussian, and Wishart distributions. The shape of the covariance matrix generated by a single cell will serve as a reference blueprint for overlapping clusters of other cells. Following the sampling process outlined above, we calculate the potential number of cells in each overlapping cluster and use the shape of the covariance matrix as a template for each potential cell. Simultaneously, we determine its centroid position to facilitate tracking. This study aims to leverage the strengths of GCN, fDDFT, and CE-net to propose PFTE-net, which has been proven in preliminary research to enhance cell segmentation accuracy. This includes non-Euclidean feature extraction techniques in geometric deep learning and optimal design of network models. Anticipated outcomes of this research encompass its application in various cell recognition and tracking tasks, aiding researchers in observing morphological changes, displacements, and invasiveness of cancer cells. It can also be used in engineering research to efficiently observe cell crawling and growth, achieving the goals pursued by medical image segmentation techniques: optimized high accuracy, sensitivity, and specificity.

NOVEL ASPECT

This study innovatively combines strengths of various networks on a rigorous mathematical foundation to propose a new deep learning architecture.

Integrative analysis of breast cancer in TCGA for identification of potential microRNA diagnostic panels and uncovering oncogenic role in breast cancer

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- Poster Presentation: Yes
- Oral Presentation:Yes

INTRODUCTION

Breast cancer is prevalent cancer among woman . In the past, we used mammography to detect whether patients have breast cancer or not. However , it has problems such as false positive diagnosis ,unnecessary biopsy , psychological burden and radian exposure. Therefore , we use miRNAs to detect breast cancer nowadays. It has been recognized as powerful biomarkers in a variety of cancer .

METHODS

R,Python,Deseq2,PCA,Random Forest

RESULTS AND DISCUSSION

I found 24 significant up-regulation miRNAs and 31 significant down-regulation miRNAs in tumor versus normal tissues .Using PCA and random forest to have a confusion matrix, ROC curve and extract feature importance .Through cross-validation to have an accuracy of 82%, a precision of 84%,a recall of 95% ,an AUC score of 66% .Finally, making correlation heatmaps between miRNA and mRNA for visualization. Furthermore, I also analyzed breast cancer patients with 9 primary tumor versus 7 metastasis tissue using same system to get corresponding results.

NOVEL ASPECT

Using miRNAs for detecting breast cancer by analysis of BC data in TCGA database