澳 門 理 工 學 院
Instituto Politécnico de Macau
Macao Polytechnic Institute

School of Public Administration

Bachelor of Science in Computing

Proposed Project List (by Teachers) for COMP490 Final Year Project

2019/20 Academic Year

Table of Contents

PROPOSED BY REBECCA CHOI

1. Domestic Helper Matcher Platform

Background

Due to changes of the society, the number of dual-career family increases dramatically in recent decades, and the demand for the domestic helper in doing housework and babysitting raises significantly. In addition, aging population also increases the need for domestic helper to take care of the elderly.

However, the domestic helper agency usually just helps in finding a maid and does not guarantee the maid has good performance. Moreover, the current law in Macau cannot protect the employer of domestic helper, whenever the labour relation with a domestic helper is terminated, no matter what reason it is, the employer needs to be responsible for the domestic helper's transportation cost to return to the place of habitual residence. Therefore, it is desirable that the employer can know the domestic helper and ensure she has good performance before start of the labour relation.

To solve this issue, in this project, student will develop a mobile application that shows the information of the domestic helper. In the application, domestic helper can register their personal information including age, marital status, number of children and working experience, so that their potential employer can know about them through this platform. In addition, their past employers who has used her services can leave comments and give grades. With this mobile application, people who want to hire a domestic helper can easily search the domestic helpers in the application, and know their basic information and past performances.

Project Objectives

In this project, the main objectives are as follows. (i) Develop a mobile application that allows domestic helpers to register their personal information. (ii) Implement the function of searching domestic helper by attributes filtering. (iii) Implement the grading and comment function on domestic helpers' page. (iv) Provide guidelines information for applying overseas domestic helper in Macau.

The student is expected to have good programming skills and basic knowledge about database.

2. Price Comparison and Purchase Suggestion for Supermarkets

Background

Supermarket is a self-service shop that provides wide range of food and household products. It is very common all over the world, especially near a residential area, as it provides convenience to consumers, consumers could buy all the food, including meat, vegetables, and other necessary household products in just one place. Moreover, supermarkets offer convenience of shopping hours, some even open 24 hours.

In recent decades, there is a rapid growth of supermarkets in Macau, consumers have multiple options in choosing supermarket. However, for a given product, most consumers probably would not know which supermarket offers the lowest price. Due to inflation, the prices of goods and services are rising, however, wages of wage earners cannot catch up with inflation. Therefore, it is desirable that consumers could know the prices of the goods in the supermarkets in advance.

To deal with this, in this project, the student will develop a mobile application that shows the prices of the same goods in different supermarkets, so that the consumers can know which supermarket offers the lowest price. In addition, as consumers usually buy more than one commodity at once, hence, the application would allow users to add commodities to their shopping list, and suggest the supermarket the user should purchase from based on the prices and location of the supermarkets.

Project Objectives

The objective of the project is to develop a mobile application that allows consumers to purchase goods in a supermarket with relatively lower prices so as to save money. The main features of the mobile application include: (i) For a given commodity, display its prices in different supermarkets. (ii) Display all nearby supermarkets with a map relevant to the consumer's location. (iii) Allows users to add commodity to their shopping list, and calculate the total amount of money that is needed for the purchase at different supermarkets. (iv) Based on the prices and location of the supermarkets, suggest the supermarket the user should purchase from, so as to reach a compromise between distance and actual spend.

The student is expected to have good programming skills and basic knowledge about database.

3. Facial Expression Recognition Terrorist Detector

Background

In recent years, terrorism happens anywhere all over the world, and terrorists usually carry out attacks in areas with large people flows like in the big events. It is desirable if we can prevent the attacks and catch the terrorists before they carry out the attacks. In fact, in the case of big events, we usually can distinguish the terrorists from others from their facial expression. As the terrorists need to carry out attacks, they usually have serious or cautious looks, unlike others with good mood to join the events. In this project, the student will develop a facial expression (mood) recognition terrorist detector, with a given image, all faces in the image will be analyzed, to recognize the facial expression of all the people in the image, and suspected individuals will be indicated, so that the security guides can monitor their action, to prevent possible attacks.

Project Objectives

In this project, the main objectives are as follows. (i) Self-study the committee neural network under guidance of the supervisor. (ii) Implement the facial expression recognition using committee neural networks. (iii) Train the neural network. (iv) Extend the recognition algorithm and design an algorithm to identify possible terrorists.

The student is expected to have good programming skills and basic knowledge about database.

Reference

Facial expression (mood) recognition from facial images using committee neural networks
https://biomedical-engineering-online.biomedcentral.com/articles/10.1186/1475-925X-8-16

4. Restaurant Online Reservation and Ordering System

Background

As the economy prospers, nowadays more and more people prefer dining outside, thus the restaurants are always full during the dining time. Waiting for more than one hour is very common for dining in restaurants without reservation. To prevent waiting for a long time, it is better to make a reservation for dining in the restaurant in advance rather than walk-in. However, making a reservation through a phone call, not only increases the workload of the waiters and waitresses in the restaurants, some of the customers would also feel inconvenient about it.

In recent years, there are many platforms that offer services for customers to order food online and provide food delivery. This type of platform not only raises the volume of business, but also reduces the workloads of the staffs, as the customers place order and make payment themselves. Therefore, the service of online food ordering is desirable not only for takeaway, it is also beneficial for walk-in customers, as the work of placing order can be left to the customers, so that the waiters and waitresses in the restaurants can be concentrated only on the task of serve meals.

In this project, the student will develop a system that allows customers to make a reservation online for dining in advance in the designated restaurant that have been registered. In the system, customers can also order food and make payments to the restaurant directly by themselves. With the system, it provides convenience for customers in booking seats, and reduces the burden of the waiters and waitresses, as the system reduces the calls for making reservation. In addition, the function of food ordering and payment in the system also reduces the workloads of the waiters and waitresses.

Project Objectives

The objective of the project is to develop a system that allows customers to make online reservation in designated restaurant, place food ordering and make payments. The main features of the system include: (i) Allows restaurant to register an account for adding available seats and food for booking and ordering respectively. (ii) Display the available seats for making reservation in the registered restaurants to the customers. (iii) For registered restaurant, display its menu and allows customers to place order by themselves. (iv) Allows customers to make payment for ordered food through the system.

The student is expected to have good programming skills and basic knowledge about database.

PROPOSED BY WEI KE

1. A Question Database and Frontends for Java Programming

Background. Online e-learning becomes a trend in modern education. We see many instances of e-learning in foreign languages, social sciences and even mathematics. With the popularity of smart phones, online e-learning is getting common to take the new platform. To help students learn Java programming with their favourite smart phones, and to catch up with the e-learning trend, we are going to deploy learning materials online via smart phones to facilitate e-learning of Java programming.

To establish such an e-learning platform, two major tasks are involved. First, a database system must be designed and implemented to collect various types of questions on Java programming. This include the data structures and indexing methods for the storage and retrieval. Second, the frontends must be created to input and manage questions, and to present them on smart phones, specialized for the natures of the devices, such as touch screens and limited display areas.

Project Objectives. The goal of this project is to analyse the structure of the questions for learning Java programming, and create a database of the questions. To facilitate the applications of the question database through mobile platforms, two other tasks must also be accomplished. One is the desktop UI for teachers to input and manage the questions in the database. The other is the mobile UI to present the question to students and enable them to give answers.

In this project, the main objectives are as follows.

1. Review and analyse various types of questions for learning Java programming.
2. Summarize the structure of the questions.
3. Design and create the database to store and retrieve the questions efficiently.
4. Design and implement the desktop UI to input and manage the questions.
5. Input sample questions to test the database.
6. Design and implement the mobile UI to present the questions and get the feedback from the user.

Requirement. The student who chooses this topic should have some interest and clear understanding in database design and implementation. Also, the student is expected to have the following skill set: Java programming, mobile interface programming, and integration of third party class libraries.

2. A Database for GPX files and Its Application in Geotagging

Background. A GPX file records geographical location points obtained from GPS along with the time of each location. During an activity, be it sports or touring, the GPX file tracks the movement of the GPS sensing device carried by the user. There are many activities for a certain user, and the movements are tracked by various GPS devices, such as smart phones and GPS meters. It is very convenient that these GPX files from many sources are collected in a database.

When a user is touring, the user usually takes photos. Photos taken by a smart phone can have geotags recording the locations embedded in the EXIF metadata of the image. However, most cameras, especially those big ones, do not come with GPS sensors, thus they cannot embed geotags for the locations to tell where the images are taken. One very obvious application of the GPX database is to resolve the location of an image by matching the time of the image against the time of the collected GPS geographical points. When exact matches are not found, interpolation is used to calculate the location from the points of the surrounding times. Once the location is resolved, we are able to put it back to the EXIF of the image in the form of a geotag.

A very important reason to have a database is that we can match the time across all the traces, enabling batch processing. For example, when a user travels for a couple of days, the user may have several GPX files for all the tours, and may take thousands of photos. Therefore, the application must be able to handle many GPX files and image files all at once, hence high efficiency must be considered.

Project Objectives. We are to develop a database for storing GPS points imported from GPX files. Based on the data in the database, we are going to build an application to resolve the geotag of an image with EXIF metadata, by finding the GPS points with similar time to the time of the image. Interpolation must be used to calculate the geotag, and finally, the obtained geotag is written back to the EXIF of the image. The application must support batch mode to process a large amount of file at once.

In this project, the main objectives are as follows.

1. Study and analyze the EXIF specification for geotags and date-taken tags.
2. Study and analyze the GPX file format.
3. Develop the database for storing GPX files, to carry out approximate time searching as efficient as possible.
4. Design and implement the application to import GPX files to the database in batch mode.
5. Design the algorithm to resolve geographical points of images based on the GPX database by time matching.
6. Design and implement the application to amend geotags for images in batch mode.
7. Evaluate the applications to see how effective they work.

Requirement. The student is expected to have good programming skills and knowledge about database design, algorithm design and integration of third party class libraries.

3. A Single-file Virtual File System with Versioning

Background. Sometimes a program needs to handle several data streams, and these data streams are closely related and should not be separately stored. For example, an EPUB e-book file contains multiple HTML files, each for a chapter. Once these data streams are stored as normal files in a file system, they are exposed to separate modification and deletion, damaging the integrity of the data streams. One solution is to store these data streams in a single physical file, while providing file read/write functions for each individual data stream to the program.

Versioning is another important feature that allows the file system to keep older versions of the files stored. Not only the data can be rolled back, one can also open an older version of a file and modify it to make a branch.

Since it's possible to read/write the data streams in the file alternately in an arbitrary way, the structure of the physical file holding the streams must follow the structure of a real file system, supporting both efficient space usage and efficient random and sequential read/write. As a virtual file system, new streams must be allowed to create, and old streams to delete.

There are many standard structures for file systems, such as FAT and EXT2. They are all based on disk partitions of fixed sizes. The single file VFS is based on a file whose size can extend and shrink. The development can based the structure of an existing file system and take into the consideration of flexible sizes.

Project Objectives. We are to design and implement a C# class library to support a single-file VFS for .NET programs. The structure of the single-file VFS must be based on a red-black tree. The class library must provide the functions to create, delete, read and write files. Nested directories must also be supported. Versioning is achieved by making the tree structure immutable, while sharing unmodified data items among different versions to improve space efficiency. A standalone toolset must be implemented to list/explode the data streams from the VFS file, and implode external files into a VFS file, just like what zip/unzip programs do.

In this project, the main objectives are as follows.

1. Study the previous implementation of the single file VFS, the FAT file system structure, the Microsoft Compound Document File Format, and the red-black tree data structure.
2. Design the structure and allocation scheme for multiple data streams based on nodes.
3. Design the indexing scheme and how to store the index data as one of the streams based on the above design.
4. Design and implement the class library.
5. Write the toolset using the class library.
6. Evaluate the performance of the class library.

Requirement. The student is expected to have solid understanding of computer operating systems and data structures. Good C# programming and algorithm design skills are also essential.

4. A Camera-Based Book Digitizer with Laser-guided Distortion Correction

Background. Legacy books often have only printed versions and do not have digital versions. This makes them hard to preserve and distribute. To digitize a printed book, an effective way is to unpack the book and feed it into a scanner with an automatic feeder. To scan the pages without unpacking them requires special borderless scanner and manual operations. To make digitization work efficiently without destroying the book, one idea is to use a digital camera to shoot the pages opened from the book in the overhead position. However, the pages in an opened book are not flat, the resulted distortion must be corrected by computer algorithms.

To help identify the distortion, straight lines printed on the opened pages are very useful. Instead of permanently printing the lines on the pages, we can use laser beams to project the lines and have a shot, then turn off the beams to have another shot. The second shot can be corrected based on the distorted laser lines from the first shot. Therefore, the distortion correction based on the guiding lines is the critical part of the digitization.

Project Objectives. We are to develop an image transformation algorithm to correct the distortion of the pages appeared in an opened book, based on the guiding lines projected by laser beams. The algorithm must be able to recognize the lines and find out the transformation needed to perform the correction.

In this project, the main objectives are as follows.

1. Study the image processing algorithms to normalize pages captured by a digital camera.
2. Study the algorithms to extract the guiding lines.
3. Find and derive the algorithm to correct the guiding lines.
4. Design the distribution of the guiding lines so that the correction covers all the needed directions.
5. Integrate and implement the image transformation algorithms to flatten a distorted page from an opened book.
6. (Optional) Design and construct the mechanism to practice then method.

Requirement. The student is expected to have knowledge on the principles of image processing, good programming skills (preferably in Python and Matlab), knowledge about integration of third party class libraries.

PROPOSED BY CORA LAI

1. An initial Prototype of a Casino Customer Relationship Management System driven by Face Recognition Technology

On the one hand, the Casino business has an eminent need to identify the characteristics of its customer especially the high pay off ones for marketing purpose. On the other, Face Recognition Technology, in recent years, has become more and more popular and mature. This project serves as an initial prototype of a Casino Customer Relationship Management (CRM) System that makes use the face recognition technology to keep track of a customer's characteristics. Hopefully the idea can be expanded to capture a customer's data in the Casino & its affiliated. In the long run, some smart marketing efforts can be made based on captured customer characteristics, habits and preferences, and customer lifetime value can be built.

Major tasks that are involved:

- Create a Face recognition server and database server;
- Create a web-based Casino customer profiling system that captures a customer's basic information plus the profile picture (using camera mounted on the computer);
- The system can
    - detect face from photos (and video better still)
    - identify face – search face matches and identify the customer
    - detect a customer's age group
    - detect a customer's gender
    - [Optional] customize the (paper based) Loyalty Card using the facial feature of the customer.

Possible technologies:

- PHP , python, or JavaScript development;
- MySQL Database server;
- Face Recognition server using Face Recognition API
  e.g. Kairos https://www.kairos.com/docs/

2. A Fun class Attendance, Assessment and Participation Tracking System driven by Face Recognition Technology

To make it fun to go to class, this project leverages the maturing Face Recognition Technology to take student attendance, and attempts to engage students in lecture and in assessment using game-based interface.

Major tasks that are involved:

- Create a Face recognition server and database server;
- A. The web-based attendance part of the system
  - For setting up,
    - The teacher can generate the student file based on an imported excel spreadsheet;
    - The students are required to take the profile picture using the camera mounted on the computer and it is then stored in the student file;
    - The students are allowed to choose a nick name and a profile picture of their choice.
  - The attendance is taken when the student stands in front of the camera and thru the Face recognition server
    - can detect face from photos and identify face – search face matches the data in the student database
    - provides Anti-Spoofing Mechanisms. That is, some intelligence must be built/designed that no one can use a photo, video, a mask or a different substitute for an authorized student's face.
- B. The web-based assessment and participation tracking part,
  - The system is expected to have a mobile sensitive, playful, creative & user-friendly interface (better still with sound) like kahoot https://kahoot.com/how-to-play-kahoot/;
  - Teachers can involve students in multiple choice questions in a number of easy-to-organize ways (e.g. individual competition, small groups / big group competition) for assessment and participation tracking;
    - Teachers are provided an easy-to-use way to input multiple choice questions in word/Excel formats into the course content file effectively;
    - The assessment results of students will be recorded in the student file respectively;
    - Teachers can view the student information and performance (in terms of participation and assessment result) on-line;
    - Students can login to participate in the exercise/assessment prepared by the teacher.
  - An interesting and engaging discussion platform among teachers & students is provided.

Possible technologies:

- python, or JavaScript development;
- MySQL Database server;
- Face Recognition server using Face Recognition API
- e.g. Kairos https://www.kairos.com/docs/

3. Macau Parkinson Buddies

Parkinson disease (PD) is a common progressive neurodegenerative disease. The typical PD symptoms include limb stiffness or slowness of movement, loss of ability of movement, tremor, (especially in finger, hand or foot), rigidity of the arms (thus causing handwriting difficulty), and problems with balance and falling. The project aims at providing PD patients some technology enabled support for their daily living.

Major tasks that are involved:

- Besides the web server, there are two possible options for this project:
  - I. Create a web-based system having an interface that is mobile sensitive and suitable for Parkinson patients with functions listed far below.
    interface Guideline is shown below:
    - https://ieeexplore.ieee.org/abstract/document/5109223
    - http://mural.maynoothuniversity.ie/6621/1/PAS_user%20interface%202015.pdf
  - II. Create an Android App with functions listed far below.
    interface Guideline is shown below:
    - http://mural.maynoothuniversity.ie/6621/1/PAS_user%20interface%202015.pdf
- A. Web content generation for the web administrator:
  - Change of website theme;
  - Activities:
    - to easily publish some activities information and with option to invite registration;
    - provide a calendar view of activities of Buddies Group.
  - PD Resources: an easy to use interface is provided to publish some PD related information or link to social resources (in PDF, word, jpg, html format) on topics like PD related information, caring for PD patients, Sharing etc.
- B. Support functions for PD patient or their career (with a local database):
  - Easy phone access – with a simple interface (Android)
    - Simply press one button where photos can be placed, the user can automatically dial to immediate family member, ambulance, disabled taxi, taxi, Caritas car etc. for help or emergency
  - Metronome function: to remind them when to raise each foot when walking (Android / Web)
    - Using a simple interface, users can choose the exercise duration and their walking tempo (the speed that is adjustable);
    - Like a Metronome, the user is reminded “left” and “right” when to raise each foot when walking at the chosen speed during the selected time.
  - Weekly planner & health journal (to be reported to the doctor) (Android / Web)
    - The planner can be scheduled to remind with sound the patient to doctor’s appointment, exercise or take medication;
    - For medication reminder - The user can input all the medication and their usage frequency;
    - The user and/or career will be reminded all their activities/medication reminder (as an iCal event);
    - A calendar view of the user’s schedule and actual activities can be shown respectively;
    - Then the user/career can confirm the activities - to be recorded down on their health journal.

4. Macau Cancer Support Group

Since Cancer is a leading cause of death in Macau and worldwide. The project aims at providing Cancer patients in Macau a community and a technology enabled support for their daily living.

Besides the web page, there are two possible options for this project:

- I. Create a web-based system having an interface that is mobile sensitive and suitable for elderly people (the user can adjust the font at wish)
- II. Create an Android/IOS App with functions listed below.

A. Server functions: Service and Community Functions:

- Referral/ Self referral
  - For phone counseling
  - For home visit
  - Work flow explanation
- Group chat platform – initiate an individual/group (limit 50) audio call/video call on skype
  - https://docs.microsoft.com/en-us/skype-sdk/skypeuris/skypeuriapireference
- Other Web Functions
  - Allow newsletter Subscription (thru email)
  - Allow Volunteer enrollment (thru email)
  - Donation page

B. Client functions: Support for a cancer patient or their career

- Weekly planner & health journal (to be reported to the doctor)
  - The planner can be scheduled to reminder the patient for doctor's appointment, exercise and to take Medication;
  - For medication reminder - The user can input all the medication and its usage frequency;
  - The user and/or career will be reminded all their activities/medication reminder (as an iCal event);
  - A calendar view of the user's schedule can be shown;
  - Then the user/career can confirm the activities - to be recorded down on their health journal.
- Favorite picture slideshow
  - Allow the user to put photo in a specified folder
  - The user can choose the display duration (with a default 5 min.).
  - During the selected time, the photos in the specified folder will be displayed continuously

Possible technologies:

- JavaScript/Android Studio development;
- MySQL/SQLite Database;
- Skype API

PROPOSED BY CHAN-TONG LAM

1. Real-Time Automatic Traffic Congestion Alert System with YOLO

Introduction

The Macao government provides instant traffic images/videos at different locations /intersections through the following website: http://www.dsat.gov.mo/dsat/realtime.aspx. The images/videos are taken from various angles and different distances. Road users need to access the instant traffic information in order to know the status of the traffic conditions. It would be convenient for the road users to have a real-time automatic alert system showing traffic conditions in the proximity of their current locations. Different techniques can be used to detect traffic status from on-line information, such as real-time generic objection detection YOLOv3 [1] [2]. YOLOv3 is based on YOLO [3]. It is a simple, fast yet accurate real-time object detection deep learning system. There are two main parts in this project. First, students are expected to detect traffic congestion level using YOLOv3. Second, the congestion level will then be visualized on a map showing current user location. A mobile application program will be developed for showing the tra

Objectives

Students are expected to achieve the following objectives:

- Obtain on-line images/videos continuously taken from different locations and angles.
- Detect congestion level from on-line images/videos using YOLOv3
- Track user location using GPS
- Visualize the traffic congestion level on a map

Deliverables

- A real-time traffic congestion alert system using on-line images/videos

Basic ***skills***/knowledge

Students should be proficient in C/C++/C#/Java/Matlab/Python programming skills, familiar with OpenCV library and have basic image processing knowledge.

References

[1] S. Luo, C. Xu and H. Li, “An Application of Object Detection Based on YOLOv2 in Traffic” Proc. of the 2019 International Conference on Image, Video and Signal Processing (IVSP 2019), Feb. 2019, pp. 68-72, DOI: 10.1145/3317640.3317657.

[2] PJREDDIE.com, J. Redmon and A. Farhadi, 'YOLOv3: An Incremental Improvement', Technical Report 2018. [Online]. Available: https://pjreddie.com/media/files/papers /YOLOv3.pdf **[Jul. 24, 2019]**

[3] J. Redmon, S. Divvala, R. Girshick and A. Farhadi, “You Only Look Once: Unified, Real-Time Objection Detection, ” Proc. of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR 2016), Jun. 2016, pp. I-511-518, DOI: 10.1109/CVPR.2001.990517.

2. Bus Arrival Time Prediction using Deep Learning Networks

Introduction

In order for the passenger's convenience, the Macao Government provides real-time information on discrete bus locations for all 85 bus routes through the following link: http://www.dsat.gov.mo/bus/site/busstopwaiting.aspx?lang=tc or through a "Bus Traveling System" App. However, the exact bus arrival time is not available through the website or the APP. It would be convenient to provide the passengers with accurate arrival time for their final stop. This project is intended to improve the performance of the methodologies proposed in [1].

There are two ways to improve the performance of the estimation. One is to provide more side information, such as the traffic status, in addition to the weather conditions. Another one is to improve the performance of the estimator. In this project, different deep learning networks will be evaluated to improve the performance. The first deep neural network to be evaluated will be the multi-layered neural network [2], while the other more advanced neural networks include Recursive Neural Network (RNN) [3]. Students are expected to obtain data for training and evaluation as well as application of the proposed deep neural networks for bus arrival time prediction.

Objectives

Students are expected to achieve the following objectives:

- Obtain real-time arrival time at each bus stop along selected routes
- Obtain weather condition and traffic status for training of deep learning networks
- Train and evaluate suitable deep learning networks
- Compare the performance of different estimation techniques for bus arrival time
- Predict bus arrival time using the best selected technique

Deliverables

- A bus arrival time prediction model using deep learning networks for Macao
- An application program for providing real-time bus arrival time prediction

Basic skills/knowledge

Students should be proficient in C/C++/C#/Java/Matlab/Python programming skills, familiar with OpenCV library and have basic image processing knowledge.

References

[1] Ben Leong, "Prediction of Bus Arrival Time using Real-Time Bus Location", Final Year Project Report, Macao Polytechnic Institute, April 2019.

[2] W. Treethidtaphat, W. Pattara-Aitkom and S. Khaimook, "Bus Arrival Time Prediction at Any Distance of Bus Route" Proc. of the 2017 International Conference on Intelligent Transportation Systems (ITSC), Oct. 2017, pp. 68-72, DOI: 10.1109/ITSC.2017.8317891.

[3] J. Pang, J. Huang, Y. Du and Q. Huang, "Learning to Predict Bus Arrival Time From Heterogeneous Measurements via Recurrent Neural Network," in IEEE Transactions on Intelligent Transportation Systems, Early Access, Oct. 2018, pp. 1-11, DOI: 10.1109/TITS.2018.2873747.

3. Automatic Grouping of Natural Vehicle Images using Generic Object Detection Systems

Introduction

The Macao Transport Bureau is responsible for new vehicle inspection [1], in which pictures of the new vehicle will be taken. These natural images include license plate, interior and exterior of the vehicle. It would be convenient to have an automatic grouping system for all the pictures taken for all the new vehicle. Automatic grouping of images/pictures using deep neural network is available in Google Photos [2]. The service can group related images from thousands of images into a separated category. For example, photos taken at the same place and the pictures of the same person taken at different locations can be grouped into a specific category. However, it is not directly applicable for the natural vehicle images due to the variations of the available features. In this project, students are expected to design an algorithm for automatic grouping of natural vehicle images using generic object detection systems. The key to the algorithm is the automatic recognition of the license plate from the nature images [3]. Moreover, the students are expected to design and implement an automatic grouping system, given the natural vehicle images provided by Macao Transport Bureau.

Objectives

Students are expected to achieve the following objectives:

- Extract license plate number from the images using generic object detection system
- Design an automatic grouping algorithm using the license plate number obtained and time stamp of the pictures
- Evaluate the performance of the algorithm
- Implement an automatic grouping system

Deliverables

- An automatic grouping system for grouping of natural vehicle images

Basic skills/knowledge

Students should be proficient in Java/JavaScript/Matlab/Python programming skills and have basic data visualization knowledge.

References

[1] DSAT.gov.mo, 'Instant Traffic Status', 2019. [Online].
Available: http://www.dsat.gov.mo/dsat/subpage.aspx?a_id=1443512180# [Accessed: 06-July- 2019].

[2] The New Google Photos App Will Automatically Group Your Images by Faces And Recognized Objects Like Cars, Skylines, and Food, https://www.androidpolice.com/2015/05/25/the-new-google-photos-app-will-automatically-group-your-images-by-faces-and-recognized-objects-like-cars-skylines-and-food/ **[July 05, 2019]**

[3] R. Laroca, E. Severo, L. Zanlorensi, L. Oliveira, G. Gonçalves, W. Schwartz and D. Menotti, “A Robust Real-Time Automatic License Plate Recognition Based on the YOLO Detector” Proc. of 2018 International Joint Conference on Neural Networks (IJCNN) , Oct. 2018, pp. 1-10, DOI: 10.1109/IJCNN.2018.8489629.

4. Channel Estimation Techniques for Uplink Wireless Systems with Massive MIMO

Introduction

Massive Multiple-input multiple-out (MIMO) [1] will be one of the key enabling technologies for the future mobile communication systems [2], which is called "5G" mobile communication system. It is expected that 5G mobile communication systems will be available in 2020 [3]. The potential benefits of massive MIMO includes a ten-fold capacity increase and hundred-fold energy efficiency improvement, the reduction of per-antenna power, simplified RF cabling, and a simplified MAC layer [4]. Channel estimation in the uplink (UL) plays an important role on its capacity and the performance of a communication with massive MIMO [1]. In order to have a better understanding of the potential technologies used in 5G systems, it would be useful to compare the performance of different techniques used for the channel estimation in the UL of a massive MIMO system [5][6][7].

Objectives

Students are expected to achieve the following objectives

- simulate a communication system with massive MIMO
- simulate different channel estimators for uplink massive MIMO systems
- evaluate and compare the performance of different channel estimators

Deliverables

- A simulation program for massive MIMO
- Simulation results for different channel estimators

Basic skills/knowledge

Students should be proficient in C/C++/C#/Java/Matlab/Python programming skills and have strong data communication knowledge.

References

[1] T. L. Marzetta, "Noncooperative Cellular Wireless with Unlimited Numbers of Base Station Antennas," *IEEE Transactions on Wireless Communications*, vol. 9, no. 11, pp. 3590-3600, November 2010.

[2] F. Rusek, D. Persson, B. K. Lau, E. G. Larsson, T. L. Marzetta, O. Edfors, and F. Tufvesson, "Scaling up MIMO: Opportunities and Challenges with Very Large Arrays," *IEEE Signal Processing Magazine*, vol. 30, no. 1, pp. 40-46, January 2013.

[3] GSMA Intelligence, "Understanding 5G: Perspectives on Future Technological Advancements in Mobile", December 2014.

[4] F. Rusek, D. Persson, B. K. Lau, E. G. Larsson, T. L. Marzetta, O. Edfors, and F. Tufvesson, "Scaling up MIMO: Opportunities and Challenges with Very Large Arrays**,"** *IEEE Signal Processing Magazine*, vol. 30, no. 1, pp. 40-46, January 2013.

[5] H. Ngo and E. Larsson, "EVD-based channel estimation in multicell multiuser MIMO system with very large antenna arrays," *IEEE Transactions on Wireless Communications*, vol. 9, no. 11, pp. 3590-3600, November 2010.

[6] Y. Nan and X. Sun and L. Zhang, "Decision Aided Uplink Compressive Channel Estimation for Massive MIMO Systems", *Wireless Personal Communications*, vol. 96, issue 1, pp 153-162, 2017.

[7] F. Li, H. Wang, M. Ying and W. Zhang, “Channel Estimation using Superimposed Pilots and Second-Order Statistics for Massive MIMO Networks”, in Proceeding of IEEE 18th International Workshop on Signal Processing Advances in Wireless Communications, December 2017.

PROPOSED BY PHILIP LEI

1. Predictive Analytics on Transportation Resources

Public resources related to transportation are usually scarce in a crowded city like Macao. By analysing the usage of these resources, one can study the dynamics of demand and discover insights to better support city development. This project aims to examine the traffic situation of Macao by applying data analytics to publicly available traffic-related metrics from the Government websites. It has the following objectives:

- Collect data from public web sites, e.g. available parking spaces in public car parks, bus circulation data, road condition
- Identify factors that affect / reflect the traffic condition
- Build time series models of the traffic data
- Apply suitable data analytics algorithms to reveal the patterns and dynamics of the traffic data
- Develop a user interface to present the analysis result

Related technologies:

- Collecting data by crawling web sites
- Data modeling and storage
- Data analytics algorithms, e.g. time series prediction
- Web application development

Reference:

- Information of parking spaces in car parks: http://www.dsat.gov.mo/dsat/carpark_realtime.aspx
- Bus location: http://www.dsat.gov.mo/bus/site/busstopwaiting.aspx?lang=en

2. Curriculum Design Tools for Outcome-based Education

In outcome-based education, teachers prepare teaching material and assessment methods based on pre-designated overall learning outcomes that students should achieve at the end of the curriculum. Usually, the teachers have to design the multi-year curriculum to achieve some standards, e.g. Basic Academic Attainments for primary and secondary education from Macao Government [1], or the AHEP learning outcomes for tertiary education [2].

The curriculum consists of several modules / subjects delivered through 3 – 6 years, and each module (e.g. Information Technology in secondary education) covers different topics (e.g. basic operation of computers, word processing, graphics and multimedia authoring). The teachers may choose between adopting ready-to-use textbooks from publishers, or developing school-based teaching material to enrich content on some topics that are not covered sufficiently by the textbooks. Since many teachers are involved in teaching the modules, it becomes a big challenge to develop the curriculum to match the overall learning outcomes, arrange the topics into modules in a coherent order, and monitoring the effectiveness of teaching in different modules throughout the years of the curriculum.

In this project, students will design and develop an application to assist teachers to design a multi-year curriculum for outcome-based education. The project as the following objectives:

- Study standard learning outcomes for a curriculum, e.g. [1] and [2]
- Survey the current practice in curriculum design, and identify major challenges that may be tackled with assistance from computer applications.
- Design and develop an application for users to
    - Map topics in modules to learning outcomes of the whole curriculum
    - Examine whether various topics are covered in a coherent, complete and well-paced manner throughout the 3-6 years of the curriculum
    - Support both textbooks, school-based teaching material, and other learning activities, e.g. interest groups, projects

Skills required: web development

References:

1. Basic Academic Attainment from the Education Bureau of Macao Government: http://www.dsej.gov.mo/crdc/edu/requirements-e.html
2. Guidelines on meeting AHEP learning outcomes: https://www.theiet.org/media/1777/guidance-on-meeting-ahep-learning-outcomes.pdf

3. A Case Study of Data Science in the Domain of Gaming

The emerging gaming networking protocol G2S (Game-to-System) supports a large number of event messages that a slot machine may send to a gaming information system to inform the change of status, meters and activities at the slot machine. This provides a valuable data source for data mining and can uncover patron gaming behavior, preferences and trend. Nonetheless, in order to harness the large amount of data, Big Data technologies are necessary in data collection, transformation, analysis and presentation.

This project aims to develop a data analysis system for slot machines in a gaming network. Some objectives are:

- Examine the different events that casino operation may generate.
- Identify common KPIs (Key Performance Indicators) in casino management.
- Study Big Data technologies for data collection, transformation, analysis and presentation.
- Design and implement algorithms to compute the KPIs using Big Data tools

Skills and knowledge required: slot machine operation and gaming networks, data science tools

4. Postal Address Sorting System

Background
Traditionally, mails are sorted by hands in the post office. In recent years, post office begins taking advantage of new mail-sorting machine which has many high-speed cameras to capture the envelope images in the mail stream. The mail-sorting machine can detect the stamp and seek the address area on the envelope. We can develop a software system to recognize the address on envelop by using OCR technology. In addition, we can make use of machine learning to raise the OCR accuracy so as to increase the operational efficiency of post office. When delivering the letters, postmen can be benefited by efficient route planning according to the destination outputs by the system.

Major tasks involved:
This project aims to develop a software system to improve the efficiency of mail-sorting in the post office. The system should provide the following functions:

- The system can capture the mail address on envelope and save it in the database.
- The system contains a standard Macau address database. In order to raise the accuracy, it should be used to compare with the captured address.
- If the captured address cannot match any standard address in the Macau address database, the system should recommend the most likely correct one.
- In order to help postmen to deliver letters more efficiently, the system will add destinations in Google Map according to all captured addresses.
- (Optional) The system can recognize handwriting addresses on envelopes.

Possible technologies:
Web programming (e.g. JavaScript or PHP), Web API, database design.

5. A User-friendly Mindfulness App : EasyRelax

Background

The recent economic boom in Macau grew tensions in its labor market, generating a working population with higher pressure. Learning how to relax will help employees remain calm in a stressful working environment. Proper relaxation has been proved to be an effective way for reducing stress, improving emotional balance, and working more effectively.

This project aims to design and develop an Android mobile app (EasyRelax) to help Macau employees learn how to practice relaxation. EasyRelax helps users understand and adopt a simple relaxing practice, and provides a self-guided breathing exercise to users. Making use of the wearable device or mobile phone's camera, it is possible to keep track of users' practices and provide critical information to users, such as heart beat and blood pressure data.

Major tasks involved:

- To create a database for collecting and storing users' practice data in Mobile Phone.
- To generate assessment reports helping users to track their relaxation exercises over time.
- To provide a customizable reminder for users.
- (Optional) to use wearable device or mobile phone to monitor heart beat during the relaxation practice.

Possible technologies:

- Java programming in Android.
- Google Flutter Mobile UI framework.
- (Optional) Android smart watch API.

PROPOSED BY YUE LIU

1. Waste Sorting Application

Waste sorting and recycling is not a new topic worldwide over years. In Vancouver Canada, waste sorting rules has been applied for years. People need to clean and sort their rubbish properly under waste sorting rules otherwise they will be punished not only financially but also in action (the waste collecting company will stop collecting their waste.). On 1st July 2019, Shanghai as a pioneer, which will be followed by another 45 main cities in China, starts executing their extremely strict waste sorting rules. The waste is classified into 4 categories: recyclable waste, hazardous waste, dry waste and wet waste. If the waste is wrongly classified, the owner of the waste will be fined 50-200 RMB. Sorting thousands variety of waste into several categories becomes such a crucial and difficult daily task for citizens in Shanghai.

It is not difficult to guess, sooner or later, Macao will also follow the trend of waste sorting and recycling in order to protect the living environment. It is necessary to use technology to help people recognize different types of wastes and even more to classify their waste into different categories. The aim of this project is to develop a mobile application which helps with waste sorting and classification.

Project objectives
The student requires to:

1. Do literature review on image classification
2. Learn about mobile application development.
3. Design overall architecture and the functions of the application.
4. Implement a function of delivering common knowledge of waste sorting.
5. Implement a function of sorting wastes.
6. Compose a final project report.

Programming language/tool: Android Studio, Java, JavaScript, C++

Reference Reading

1. YOLO object detection: https://pjreddie.com/darknet/yolo/
2. Object classification: https://paperswithcode.com/task/object-classification
3. Documentation of Android Studio: https://developer.android.com/training/basics/firstapp
4. TensorFlow, tutorial and examples: https://www.tensorflow.org/overview/
5. Keras, doucumentation, https://keras.io/

2. Smart Parking Agent

In Macao, problems related to vehicles are avoidable. Parking is one of them which always causes troubles for drivers in Macao. Although DSAT releases some information of local parking lots to assist drivers to make better decision on parking their cars, e.g the stall vacancy for cars and motorcycles (http://www.dsat.gov.mo/dsat/carpark_realtime.aspx). The inconvenient and user-unfriendly interface of the website make it hard for the drivers to use, especially when they are holding the steering wheels.

The aim of the project is to develop a mobile application named Smart Parking Agent to assist drivers to find the stalls conveniently and give parking suggestions to drivers. The parking data should be retrieved in real time from DSAT and visualized in a user-friendly way (e.g. on a map) in the application. Furthermore, by collecting historical statistics, certain analysis should be made for the better parking coordination in the future.

Project objectives

The student requires to:

1. Investigate parking applications in the market and analyze their pros and cons.
2. Design architecture of the application.
3. Retrieve real-time parking data from DSAT website.
4. Visualize the parking information in a user-friendly way.
5. Analyse based on the statistics of the vacancy of parking lots.
6. Compose a final project report.

Programming language: Java, C++ or Python etc.

Reference Reading

1. DSAT website: https://www.dsat.gov.mo/dsat/carpark_realtime.aspx
2. Easy Parking mobile app by Shenzhen road traffic management centre: https://www.szrtc.cn/MobileApp/Index On 1st July 2019, Shanghai as a pioneer which will be followed by another 45 main cities in China starts executing their extremely strict waste sorting rules.
3. Android studio, https://developer.android.com/

3. Translation Assignment Marking System

With the rapid development of Machine Translation, machine can now give translation with fairly good quality. It provides convenience to people who knows little about another language. Portable simultaneous translation devices embedded with machine translation and speech recognition technology are also available in the market with the ability of real-time translation between people speaking different languages.

However, improved translation quality of machine translation engines may cause a headache for language teachers and translation companies. Some students rely on google and baidu translate so much when doing their homework and some translators may simply hand their translation work to Google translate without putting much effort on refining it. How to check & define that a piece of assignment “borrows” too much from machine translation is a new problem raised.

The aim of this project is to develop a translation assignment management system which allows language teachers or supervisors to know the similarities between the assignments and machine translation so that they can mark the assignments properly.

Project objectives

The student requires to:

1. Do literature review on Machine translation APIs and website development.
2. Design overall architecture and the functions of the system.
3. Implement a function of similarity checking.
4. Implement a function of marking.
5. Generate a similarity report.
6. Compose a final project report.

Programming language: PHP, JavaScript or Python etc.

Reference Reading

1. Turnitin similarity checking system: http://www.turnitinuk.com/
2. Canvas marking system: https://canvas.ipm.edu.mo/
3. Google translate API: https://cloud.google.com/translate/

4. Spectrum Management in 5G network

Recently China has officially entered 5G telecommunication era by announcing that the four companies, China Telecom, China Mobile, China Unicom and China Broadcasting Network have been awarded with 5G licenses for commercial use. The 5G network aims to support 3 main categories of communication scenarios: eMBB (enhanced Mobile Broadband) to provide enhanced mobile connections for existing mobile services; URLLC (Ultra Reliable Low Latency Communications) to support ultra-low latency for mission-critical communication tasks and mMTC (massive Machine Type Communications) to support connections of massive IoT devices. OFDMA (Orthogonal Frequency Division Multi-Access) is adopted for eMBB and URLLC.

Managing the spectrum is crucial to network operators and their subscribers. It has great impact on user experience and the profit of the operators. When it comes to allocate spectrum in a 5G OFDMA network, several transmission impairments must be considered together with the co-channel interference between users. The aim of the project is to build a simulator to manage the spectrum in 5G band and analyses the simulation results.

The project objectives

In this project, the student is required to:

1. Do Literature review on spectrum allocation and OFDMA
2. Understand the basics of co-channel interference.
3. Implement a network scenario.
4. Allocate the spectrum to users.
5. Analyse the simulation results.
6. Compose a final project report.

Programming language: Matlab, Java or any other programming tools which the students are familiar with.

Reference Reading

1. OFDMA: https://en.wikipedia.org/wiki/Orthogonal_frequency-division_multiple_access
2. W. Rhee and J.M. Cioffi, Increase in capacity of multiuser OFDM system using dynamic subchannel allocation, VTC2000-Spring. 2000 IEEE 51st Vehicular Technology Conference Proceedings, 2000

PROPOSED BY BENJAMIN NG

1. Macao Transportation-all-in-one App

Background

In Macao, public bus and taxi are the most convenient means to commute. As the foreign visitors rely on public transport options such as bus or taxi to travel around, they may often want to weight their options as to which is more expensive and time-saving. This app will help to estimate both the bus fare and taxi fare as well as the corresponding time required to reach their destinations by both means. The users simply enter, via text or map, their starting points and destinations, it will return the approximate cost and time of taking either the taxi or bus, followed by suggesting the best alternative. Furthermore, this app may also have the capability of taking the traffic into account in the estimation of the taxi fare and time required for both options. Finally this app will help to collect user data, facilitating data analysis in predicting the travel behavior in Macau.

Objectives

There are three objectives in this project. First, an app with a user-friendly user-interface allowing the users to enter their locations and destinations, preferably with the help of google map. Second, estimate the taxi fare, bus fare based on the distance required, with the possibility of taking into account the current traffic conditions. Third, provide means to collect data from the users regarding their travel behavior. The goal is to allow predictive analysis on the collected data, so as to predict the traffic jam and congested spots during peak hours or festive seasons.

The student is expected to have (or to learn) the following skill sets: programming languages such as JAVA and knowledge using google API. Student is also expected to develop the apps for Android. Also, this idea is innovative and can be further polished to become a real working product.

2. Flu prediction and monitoring in Macao using neural network

Background

Tracking the flu outbreaks has become one of the most important tasks in any modern safe society. In Macao, tens of thousands of people are infected every year, some have contracted the disease more than one time, and this situation has worsen due to the increasing population and rising number of tourists visiting Macao each year. Big Data system plays a key role in tracking or even predicting the outbreak of the disease. A prominent example is Google Flu Trends, developed by Google Inc. using the data collected from the search queries. In this project, the student is expected to identify a number of factors that might influence the flu outbreaks, such as the temperature, the time of year, the lifestyle or habits of people. And a neural network is to be developed in order to help determine the probability of catching a flu.

Objectives

There are three main objectives in the project. First, build an application (desktop/mobile) with an interface allowing users to enter the information relating to personal habits/lifestyle (e.g. number of exercises per week, medical history, etc.), the environment (e.g. temperature, humidity, etc.). Second, collect data (e.g. online, questionnaire) that relate the aforementioned information to the flu occurrences. Third, build a neural network which accepts the input parameters and produces an estimation of the probability of flu occurrence. This project's expected result is mainly a proof-of-concept prototype, and as such, the estimation needs not be very accurate and may be subject to modification in the future once more data is available to train the neural network.

The student is expected to have (or to learn) the following skill sets: programming languages and internet programming. This can be an exciting project as the student will explore new knowledge in Big Data and neural network. Also, this idea is innovative and can be further polished to become a real working product.

3. Spectrum Sensing using neural network with a massive antenna array

Background

According to Wikipedia, Cognitive Radio is "a transceiver which automatically detects available channels in wireless spectrum and accordingly changes its transmission or reception parameters so more wireless communications may run concurrently in a given spectrum band at a place". Frequency spectrum band, which is a scarce resource, is normally shared by wireless (TV or phone) service providers who pay a high licensed fee. Yet, these licensed frequency bands utilization percentage can be small sometimes since the wireless services may have idle periods in which no signals are sent or received. The motivation of cognitive radio is to allow more users to use the licensed band for free during these idle periods or periods with less interference. And the job of *spectrum sensing* is to let the secondary users, who seek to opportunistically use the channels unoccupied by their legal owners, decide whether the channels of interest are idle.

The use of massive antenna/sensor system in spectrum sensing is a relatively new concept. As IoT becomes more popular, it is foreseen that one can deploy many sensors to perform the work of spectrum sensing. This is the motivation of this project.

Objectives

In this project, the main objectives are two-fold: (i) implementation of spectrum sensing algorithm based on neural network, using Matlab or JAVA. (ii) extend the algorithm for massive antenna/sensor system. This project shall lead to a conference paper publication.

In this project, the student is expected to have some programming skills and basic knowledge about wireless data communications. This can be an exciting project as the student will explore new knowledge in Big Data and neural network

4. Virtual-Reality Gaming

Background

This project is very interesting for those who love gaming and VR. The idea is to develop a simple VR game that focuses on one of the following purposes: (1) fitness –facilitate bodily exercise, (2) design concept visualization – help visualize the design concept using VR, for example, the interior design of a bedroom, a dining room and so on, (3) education, and (4) flight simulation. Student will need to develop codes using the library functions (API, SDK) of some VR devices (such as Oculus) and to develop 3D scenes using unity3D or sketchUp.

Objectives

The main objectives of this project are as follows: (1) design the VR game that achieves a specific purpose, (2) develop the 3D scenes for the game, (3) implement the game using SDK provided by the VR device.

The student is expected to have good programming skills and passion to learn about VR technologies. He/She is responsible to learn how to use the API/SDK of the VR device and overcome the challenges encountered during the course of self-learning new knowledge.

5. Is the bus crowded?

Background

With the recent launch of “Macau bus arrival apps”, the passengers in Macau may now check the arrival time of the next bus at a designated bus stop. However, very often, the worried passengers are also concerned about whether the arriving bus is full or not. This usually occurs during the peak hours and passengers may not be able to get on the bus even it arrives on time. It would be convenient if passengers can also be informed whether the bus is packed beforehand and may resort to other travel means if necessary.

Objectives

In this project, student is expected to develop a program to process image taken inside the bus (either from CCTV in the bus or smartphone’s photos). Using image processing algorithms, the program may be able to assess the situation in the bus, such as whether the bus is crowded or not. Student is expected to carry out literature review on different objects recognition algorithms applied to images and determine the suitable one for this project.
Furthermore, it is expected that the student should complete a client-server system which collects real-time data including these images, decisions and timing info so as to allow predictive analysis on the Macau bus system.

The student who chooses this topic should have some interests in the image processing technologies and working with images. He/she is expected to have the following skill sets: programming languages such as JAVA or C or Matlab.

PROPOSED BY JACKY TANG

1. Team Building Game for Kids

Background

Team building activities are good work for kids, which encourage them to find ways to work with others in harmony, achieving a common goal efficiently and effectively. Whether at home or school, kids should learn to be a part of a team made up of different people. There are many games or exercises that would be able to teach or train them about teamwork.

In this project, as smartphone and tablet are common nowadays, you are required to implement a network game for kids that can build their team spirit. Any games that can meet the objective may be selected (NO need to design new game). It is important to include the Key Performance Indicator (KPI) that assist parents to evaluate the level of team spirit the kids develop. The evaluation result should be illustrated.

Deliverables

Students are required to implement a game for team building. Levels of achievement would be expected and the grade is considered in reference to the achievement, as listed below.

a) Correctly implement and demonstrate a network application playing a team building game;
b) Correctly collect the data generated from game play and store in the backend;
c) Correctly develop and implement the KPI for the evaluation of the game;
d) Correctly illustrate the evaluation in graphical user-friendly interface.

Technical Skills Required

To complete the development of this project, students are suggested to possess the following skills.

- Network programming skill
- Education background

2. Design of the Paytable in EGM Game

Background

Electronic Gaming Machine (EGM) is popular in casinos in Macau and the number of EGMs increases gradually every year, likely creating a force to push up the share of the gaming revenue. There are a number of EGM games available in casinos, which can be categorized into slot game and electronic table game.

In this project, you are required to design the paytable of an EGM game. A paytable is a table listing out the payouts for all possible combinations on a slot game. To verify the correctness of the paytable, a simulation will be conducted. In the simulation, the key performance indicator will be analyzed. The result of the analysis will be illustrated.

Deliverables

In this project, students are required to develop an EGM game for intensive simulation. Different scenarios will be setup in the simulation for comparison. The result will be illustrated and justified. Levels of achievement would be expected and the grade is considered in reference to the achievement.

a) Correctly implement and demonstrate an application simulating game playing in EGM;
b) Correctly collect and illustrate the data of one EGM for the analysis;
c) Correctly connect more than one EGMs remotely and perform the analysis using G2S protocol.
d) Correctly illustrate the analysis in graphical user-friendly interface using a slot floor map.

Technical Skills Required

To complete the development of this project, students are suggested to possess the following skills.

- Gaming standards for EGM.
- G2S protocol.

3. Glass House Controller using Arduino

Background

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs from a temperature sensor, or a button, and turn it into an output - activating a motor, turning on an LED. You can program your Arduino board using the Arduino programming language, and the Arduino Software (IDE) to achieve your goal.

In this project, your goal is to implement a glass house for a particular plant so that it can grow in the best environment. An Arduino broad will be installed with sensors inside a glass house to maintain the best growing environment by controlling the indoor temperature and humidity. A LED display is used to show the environment in the glass house.

Deliverables

In this project, students are required to design and implement the glass house for demonstration. Levels of achievement would be expected and the grade is considered in reference to the achievement.

a) Correctly design and implement the glass house for demonstration;
b) Correctly design and implement the Arduino with relevant sensors in the glass house;
c) Correctly demonstrate the operation of the controller in the glass house;
d) Correctly store the data at a local database server.

Technical Skills Required

To complete the development of this project, students are suggested to possess the following skills.

- Programming in Arduino.
- Basic electric background

4. General EDGE Server for IoT System

Background

EDGE computing refers to data being processed at the edge of a network, instead of doing all of that processing in a big central cloud. It happens as a lot of data from the internet of things (IoT) devices may create bulk of processing work on the cloud, causing the performance issue. Processing the data at the edge of network before sending it across long routes to the cloud becomes crucial, as it allows analysing important data at near real-time.

In this project, an Arduino client with sensors will continuously send data to your EDGE server for processing. Processed data will then be provided by a Web server. To read the data, a web browser is needed.

Deliverables

In this project, students are required to design and implement the Arduino client, EDGE server and Web server. Levels of achievement would be expected and the grade is considered in reference to the achievement.

a) Correctly design and implement the Arduino client;
b) Correctly design and implement the EDGE server communicating with the clients;
c) Correctly process the data in the EDGE server;
d) Correctly provide the processed data in the Web server and demonstrate it using a web browser;

Technical Skills Required

To complete the development of this project, students are suggested to possess the following skills.

- Programming in Arduino
- Network programming
- JavaScript

PROPOSED BY RITA TSE

1. Evaluating Air Quality sensors along popular walks in Macao

The raising levels of life standards and the increased rate of industrialization are posing threat to the planet ecosystem and our health and the human species survival. The scientific community is studying the global warming problem assess risks and find solutions that will safeguard the level of and quality of our lives.

In this project we propose to analyze the data collected by an urban sensing platform in search of possible cause-effect phenomena in the outdoor environmental quality levels using a low cost and a high cost sensor.

This project requires the student to collect and create a database to provide air quality of popular walks in Macao. The key concept is to explore the time-spatial relationships between the environment quality. The student needs to classify the data set both by time and geographical location and able to apply statistical techniques to identify potential correlations and clustering. For example:

- Classifying the samples by day of the week and time window.
- Counting the number of samples at similar times (i.e. every Monday from 8-10), etc.
- Identifying correlations across samples

The data are as follows:

- temperature
- humidity
- pressure
- PM

References

[1] Rita Tse, Yubin Xiao, "A Portable Wireless Sensor Network System for Real-Time Environmental Monitoring", to be presented in the Seventeenth International Symposium on a World of Wireless, Mobile and Multimedia Networks, Coimbra, Portugal, June 2016.

2. Online Weather Station

Weather information is important in our daily lives. Farmers need weather information to help them planting or harvesting. Airlines need local weather information to schedule flights. Accurate weather forecast is important in planning our daily activities.

The aim of this project is to develop an Android mobile application that delivers real time weather information and forecast to users, alerting them when there is severe weather condition. It requires student to collect weather information through APIs [1], create the necessary database and provide visualize the collected weather data.

This project has the following objectives:

- Request data from the Cloud.
- Store data in local database.
- Visualize the data.
- Evaluate the data.

References

[1] Open Weather Map, https://openweathermap.org/api.

3. A web based real-time data visualization on 3D Earth engine

Earth engine is a three-dimensional (3D) software model or representation of the Earth simulation. It provides the user with the ability to freely move around in the virtual environment by changing the viewing angle and position. Compared to a conventional globe, virtual globes have the additional capability of representing many different views on the surface of the Earth. These views may be of geographical features, man-made features such as roads and buildings, or abstract representations of demographic quantities such as population.

3D web programming requires the mastery of many different aspects of 3D production. It also requires the use of highly specialized software tools to generate the proper data. The organization information and analyzing of virtual scene resources based on geometrical information systems. Realistic real-time rendering methods for complex scenes by shading language; Calculation methods for realistic light effects; Calculation and rendering methods for special effects of natural scenes. This project contains the following objectives:

- Real-time rendering
- Data visualization and analysis
- Graphic programming
- JavaScript programming

References:

[1] Analytical Graphics, CesiumJS, https://cesiumjs.org/
[2] Silicon Graphics Inc. OpenGL, https://www.opengl.org/
[3] Mozilla Foundation, WebGL Working Group, WebGl, https://www.khronos.org/webgl/
[4] Autodesk, Inc., 3ds Max, http://usa.autodesk.com/3ds-max/
[5] Adobe Systems Incorporated, Model Construction, http://www.adobe.com/

4. Real-time 3D interactive and collision detection on multi-platform

Real-time 3D interactive is further to allow users to freely surround the virtual entertainment. Interactions allow users to feel reality and intent more interested. Virtual environments can be used to further enhance existing cultural heritage and casinos.

The object of this project is to implement a computer-generated graphics in real-time for interactive application. 3D application requires the mastery of many different aspects of 3D production and interactive design such an object beyond the limits of current graphics skill, but the scripting language can significantly achieve the status. The collision detection must contain the up and down stairs with gravity effect in a complex scene. More interactive action include the switch on/off of the light, small object picking and etc. This project contains the following objectives:

- Create a virtual 3D world by using Virtual Reality
- Scene rendering
- Real-time interactive
- Game Implementation

References:

[1] Autodesk, Inc., 3ds Max, http://usa.autodesk.com/3ds-max/

[2] Blender Foundation, Blender, http://www.blender.org/

[3] Unity Technologies, Unity, https://unity3d.com/

[4] Real-Time Physics Library, Bullet, http://bulletphysics.org/wordpress/

[5] Microsoft, DirectX, http://www.microsoft.com/windows/directx/

[6] Silicon Graphics Inc. OpenGL, https://www.opengl.org/

[7] Adobe Systems Incorporated, Model Construction, http://www.adobe.com/

5. Training System for Baccarat Dealers in Android

Background

Gambling tourism is Macau's biggest source of revenue, making up about 50% of the economy. Visitors are made up largely of Chinese nationals from the mainland and Hong Kong [1]. The gross gaming revenue in 2018 is US 37.59 billion [2].

In Macao, Baccarat is extremely dominant [3]. Baccarat[4] is a card game played at casinos. Baccarat is a comparing card game played between two hands, the "player" and the "banker." Each baccarat coup has three possible outcomes: "player" (player has the higher score), "banker," and "tie."

Project Description and Objectives

This project will design and build a training practice system for the Baccarat dealers. User requirement and human computer interface design must be considered.

This project may have the following modules:

1. Rules and Procedure of the Game
2. Card placement
3. Handle wagers and payouts, along with a full understanding of commissions
4. Game playing
5. Practice in Mathematics for Dealer

References:

[1] http://en.wikipedia.org/wiki/Gambling_in_Macau
[2] https://www.statista.com/statistics/253755/gross-revenue-from-gaming-and-gambling-in-macao/
[3] http://wizardofodds.com/games/baccarat/
[4] http://en.wikipedia.org/wiki/Baccarat

6. An Android tool to stimulate students in learning Portuguese

How to learn a foreign language effectively? Learning a foreign language through online courses [1] can have many benefits such as using multimedia, repetition, different learning methods, accessibility and autonomy. Nowadays, multimedia features applied to learn in e-learning such as videos, audio, chat rooms, webcams, online web page and even mobile apps. However, technology innovation cannot make to learn a foreign language easier. Mostly, learning a new language will need a perpetuated period of study, patience and time, not many people pick up new language lessons on their first attempt, indeed, repetition and exercise practicing will help students to master a new language. Moreover, students can learn at their own pace through e-learning which provides a solid and comprehensive education at any time of their own.

We can find several web tools that are really helpful in learning vocabulary [2]. Learn Portuguese vocabulary online can have fun too [3, 4]. Following the course step-by-step students can quickly gain improve and train their vocabulary.
This project has the following objectives:

- Design a user-friendly interface
- Design different levels of learning
- Build up a vocabulary database
- And Implement the system

References:

[1] Benefits of Learning Foreign Language Online, https://elearningindustry.com/5-essential-benefits-of-learning-foreign-languages-online
[2] Learning Vocabulary online, https://www.learning-english-online.net/vocabulary/
[3] Babbel, https://www.babbel.com/learn-portuguese-online
[4] Portuguese Language Lesson, http://ielanguages.com/portuguese.html

7. Voice-activated Food Ordering System for Android

The rapid development of the computer technologies has changed the way we interact with computers. Hardware like touch-screen devices and laptop track pads; software like predictive text or speech recognition are all innovations that improve the way we interact with the computer systems.

This project is an Android based mobile application. Despite of the traditional text input form, this system will use the speech recognition technology to enhance the system's ordering system. The objective is to allow the users to make their order process with speech, in the form of chat bot. The system then converts the speech into text and archive in the server database. Multi-languages input can be considered.

For the architecture, a simple client server model is sufficient. A web server and a database should be setup in the server and the programming language is your choice. The Voice to Text system used webkitSpeechRecognition API [1] and ResponsiveVoice.JS [2] for speech to text and text to voice will be used in this project, whereas Dialogflow [3] can be used for the chat bot.

This project has the following objectives:

- Design a user-friendly interface
- Build the voice functions
- Implement the mobile application

References:

[1] Web Speech API, https://developer.mozilla.org/en-US/docs/Web/API/Web_Speech_API.

[2] ResponsiveVoice Text To Speech API, https://responsivevoice.org/api/.

[3] Dialogflow, https://dialogflow.com/.

PROPOSED BY YAPENG WANG

1. Voice navigated Android App for MPI Open day

Background
Voice recognition has been widely used in mobile phones and personal computers. There are many apps that can take advantage of voice recognition for human interactions such as search engine, voice interaction on map app, chatting bots etc. however, currently most apps use APIs to call service provided by technology giants such as Google, Xunfei etc. The core technology is not locally available. This will lead to issues like privacy issue, service interruption by political reasons (such as the latest Huawei incident). Therefore, a local voice recognition engine will be preferred for some project.

In this project, the student will use the current available voice recognition platform to build a voice recognition engine for an Android App. The project will focus on MPI open day as many guests will visit the campus to see the facilities and prospective courses. The Voice recognition engine will be trained specially for MPI open day navigation, therefore the voice collected for training will be limited to MPI open day. The android app will connect to the engine server for voice recognition and the server will reply with the recognized text. The App will let the visitors to check all interesting facilities and show cases of the open day.

Objectives
In this project, the student is expected to achieve:

- Learn the relevant knowledge of voice recognition platform.
- Find a suitable platform, and build a voice recognition engine.
- Train the voice recognition engine with collected or openly available voice-text corpus.
- Build an Android App that will interact with the voice recognition engine.
- Test and refine the whole system.
- Compose a final project report.

2. Indoor positioning using BLE direction finding

Background

As traditional GPS based positioning is not working in indoor environment, various indoor wireless positioning technologies have been developed such as the WiFi based positioning. However, WiFi based positioning has the limitation of high hardware cost (WiFi Access Points), the low number of reference points, and low scanning speed, and all of these are affecting the positioning accuracy and speed of positioning updates. In recently years, Bluetooth Low Energy (BLE) technology has been developed and wildly used. BLE has the advantage of low cost, low energy requirement and fast scanning speed compares to WiFi. All of these features make the BLE a very suitable technology for indoor positioning.

In version 5.1 of the Bluetooth Core Specification which is just released in 2019, Bluetooth added an optional direction finding capability. Using this new feature, a Bluetooth device can determine the direction of a signal being transmitted from another Bluetooth device. This seemingly basic capability has the potential to significantly enhance Bluetooth location services solutions [1].

In this project, the student will explore this new feature and build an indoor positioning system using BLE direction finding technology.

Objectives

In this project, the student is expected to achieve:

- Learn the relevant knowledge of BLE direction finding.
- Study the BLE direction finding development toolkit (will be provided).
- Build a positioning server that can read the directions measured by BLE base stations
- Propose an algorithm to use the direction finding data to locate user and reduce error.
- Collecting and comparing results with other approaches.
- Compose a final project report.

Reference

[1] Dave Hollander, How AoA & AoD Changed the Direction of Bluetooth Location Services, available: https://www.bluetooth.com/blog/new-aoa-aod-bluetooth-capabilities/

PROPOSED BY XU YANG

1. Comparative Study of Artificial Neural Networks on Gold Price Prediction

Background

Gold is the major commodity in the economic and monetary market. Soft Computing techniques like Neural Networks can be used to forecast the gold price. Artificial Neural Networks are very accurate and predicts the future very well. ANNs have proven particularly useful as forecasting tools in the physical and natural sciences. If there are any non-linearities between variables, then neural networks can exploit them to provide more accurate forecasts. The main problem in using ANN is parameter tuning, because there is no definite and explicit method to select optimal parameters for the ANN parameters to solve different practical problems.

NEAT is a method for evolving appropriate artificial neural networks with a genetic algorithm. This process of evolution allows finding appropriate neural network topologies to solve different practical problems. However, until now there is few papers to use NEAT to solve forecasting problems.

Objectives

In this project, the student will use different neural networks to predict Gold Price and perform the comparative study. The student is expected to achieve:

- Learn the relevant knowledge of forecasting, artificial neural networks including back propagation neural network (BP), elman network (ELMAN), radical basis neural network (RBF), NEAT, etc.
- Do the literature review on gold price prediction
- Learn how to use Neural Network toolbox.
- Collect and analyze data of gold price.
- Design and implement the training system.
- Through experiments to find the appropriate parameters.
- Compare and analyze the experiments' results.
- Compose a final project report.

Technologies:

Artificial neural network, back propagation neural network, elman network, Radical basis neural network, NeuroEvolution of Augmenting Topologies, prediction.

Languages: Java (or any other language suitable).

2. Bone X-Ray Image Classification Using an Ensemble Model Based on Deep Learning

Background

Musculoskeletal conditions affect more than 1.7 billion people worldwide, and are the most common cause of severe, long-term pain and disability, with 30 million emergency department visits annually and increasingly.
Stanford ML Group released a dataset MURA (musculoskeletal radiographs, https://stanfordmlgroup.github.io/competitions/mura/) for competition, which is a large dataset of bones X-rays consisting of 14,863 studies from 12,173 patients, with a total of 40,561 multi-view radiographic images. Each belongs to one of seven standard upper extremity radiographic study types: elbow, finger, forearm, hand, humerus, shoulder, and wrist. Each study was manually labelled as normal or abnormal by board-certified radiologists from the Stanford Hospital at the time of clinical radiographic interpretation in the diagnostic radiology environment between 2001 and 2012.
Deep learning is part of a broader family of machine learning methods based on the layers used in artificial neural networks, which have been applied to fields including computer vision, speech recognition, natural language processing, translation, medical image analysis, etc. where they have produced results comparable to and in some cases superior to human experts.

Objectives

In this project, the student is expected to train different deep learning neural networks (for example, Coevolutionary Neural Network (CNN)) with MURA dataset to automatically determine whether a Bone X-Ray image is normal or abnormal, then perform comparative study, and finally build up an ensemble model to combine the predictions from different models to improve classification accuracy.

The objectives of this project are listed below:

- Learn the relevant knowledge of deep learning, convolutional neural networks, and image classification.
- Learn how to use Keras, which is a platform to run deep learning algorithms [3] , to build up deep learning neural networks.
- Learn how to do image augmentation to enlarge the dataset.
- Do literature review.
- Design and build up suitable CNNs to do the X-ray image classification based on Keras.
- Through experiments to tune the hyper parameters.
- Buildup the final ensemble model.
- Compare and analyse the experiments' results.
- Compose a final project report.

3. Adversarial Attacks on Deep Learning Networks

Background

Deep neural networks (deep learning) have made significant progresses in a wide domain of machine learning: image classification, object detection, speech recognition, language translation, etc. However, deep neural networks have been recently found vulnerable to well-designed input samples. small perturbations on the images for image classification problem and fooled state-of the-art deep neural networks with high probability. These misclassified samples were named as ***Adversarial Examples***. The vulnerability to adversarial examples becomes one of the major risks for applying deep neural networks in safety-critical scenarios. Therefore, the attacks and defenses on adversarial examples draw great attention.

Recent advances in deep learning revolve around supervised learning, especially in the field of computer vision task. Therefore, most of adversarial examples are generated against computer vision models.

Countermeasures for adversarial examples have two main types of defense strategies: 1) reactive: detect adversarial examples after deep neural networks are built; 2) proactive: make deep neural networks more robust before adversaries generate adversarial examples.

Objectives

In this project, the student is expected to study different countermeasures for adversarial examples on deep learning networks (for example, Coevolutionary Neural Network (CNN)) with a dataset, then perform comparative study.
The objectives of this project are listed below:

- Learn the relevant knowledge of deep learning, adversarial examples, defense strategies and countermeasures.
- Learn how to use Keras, which is a platform to run deep learning algorithms.
- Do literature review on adversarial examples, defense strategies and countermeasures.
- Find a suitable dataset and create adversarial examples with existing tool kit.
- Implement at least one defense method to reduce the impact of adversarial noise on one deep neural model.
- Results evaluation, comparison and discussion.
- Compose a final project report.

4. Data cleaning in Mobile Wireless Sensor Networks

Background

Mobile wireless sensor network (MWSN) can simply be defined as a wireless sensor network (WSN) in which the sensor nodes are mobile. MWSNs are much more versatile than static sensor networks as they can be deployed in any scenario and cope with rapid topology changes.

Quality of collected data in Wireless Sensor Networks (WSNs) is one of the major concerns for many applications. The data quality may drop due to various reasons including the existence of missing data or incorrect values (also known as noisy or corrupt values) that can be caused by factors such as interference, low energy levels, or not well-controlled environments. A drop in data quality may seriously impact the performance of decision support systems. Thus, it is crucial to clean the data before using them.

Objectives

In this project, the student is expected to achieve:

- Learn the relevant knowledge of mobile wireless sensor network, data collection, noise impact on the data clustering and data analysis, and different data cleaning methods.
- Do the literature review.
- Find a suitable dataset, create invalid or missing data.
- Learn how to use the data clustering platforms (such as WEKA).
- Implement at least one data cleaning method.
- Results evaluation, comparison and discussion.
- Compose a final project report.