



澳門理工學院
Instituto Politécnico de Macau
Macao Polytechnic Institute

School of Applied Sciences
Bachelor of Science in Computing

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

2020/21 Academic Year

Table of Contents

PROPOSED BY REBECCA CHOI.....	4
1. Macao Travel Mode Recommender.....	4
2. Leisure Activity Advisor.....	5
3. Order Management System for Macao WeChat Business.....	6
4. Facial Expression Recognition Terrorist Detector.....	7
PROPOSED BY WILSON HO.....	8
1. E-Learning and Assessment Platform Using Cloud Computing.....	8
PROPOSED BY CORA LAI.....	9
1. Macau m-Police Aid.....	9
2. Elderly Care and Monitoring App.....	9
PROPOSED BY CHAN-TONG LAM.....	10
1. Real-Time Traffic Congestion Detection using Online Videos.....	10
2. Bus Arrival Time Prediction using On-line Bus Locations from Multiple Routes.....	11
3. Parking Space Prediction using Real-Time Parking Information.....	12
4. Channel Estimation Techniques for Uplink Wireless Systems with Massive MIMO.....	13
PROPOSED BY PHILIP LEI.....	14
1. Online Examination Question Paper Generator and Grader.....	14
2. File and Task Tracker in CSCW.....	15
3. A Learner Model Driven App for Beginners to Learn a Foreign Language.....	16
PROPOSED BY YUE LIU.....	17
1. Environment Protection Mobile Application.....	17
2. Second-hand goods exchange, rental, trading system.....	18
3. Traveller Detection at the Border Gate.....	19
4. Spectrum Management in 5G network.....	20
5. Data Visualization for Macao Health Code.....	21
PROPOSED BY AMY LUO.....	22
1. Highway Traffic Flow Prediction.....	22
2. Travel Time Prediction.....	23
3. Map Matching using Object Moving Trajectories.....	24
4. Online Car Rental System.....	25
PROPOSED BY BENJAMIN NG.....	26
1. Social Distance Detector.....	26
2. Flu Prediction and Monitoring in Macao using Neural Network.....	27
3. Spectrum Sensing using Neural Network with a Massive Antenna Array.....	28
4. Virtual-Reality Gaming.....	29
PROPOSED BY JACKY TANG.....	30
1. Paytable for EGM Game.....	30
2. Glass House Controller using Arduino.....	31
3. Portable Navigation Device for Visual Impairment.....	32
PROPOSED BY RITA TSE.....	33
1. Intelligent Battery Management System.....	33
2. Online Weather Station.....	34

3. A Web Based Real-time Data Visualization on 3D Earth Engine	35
4. Real-time 3D Interactive and Collision Detection on Multi-platform	36
5. Android based Bacarrat Dealers Training app.....	37
6. An App to Stimulate Students in Learning Portuguese	38
7. Intelligent Voice Ordering for Restaurant (or grocery)	39
8. Pi Car Autonomous Navigation	40
PROPOSED BY YAPENG WANG	41
1. Portuguese Voice Commands Recognition for Macau Tourism.....	41
2. Improving Positioning Accuracy Using BLE Direction Finding	42
3. Interactive Chatting Robot for MPI Open Day	43
PROPOSED BY XU YANG.....	44
1. Deep Learning Models on Stock Market Prediction.....	44
2. VANET Routing for Vehicle to Vehicle Implementation.....	45
3. Adversarial Attacks and Defenses for Deep Learning Networks	46
4. Deep Reinforcement Learning for Trading	47

PROPOSED BY REBECCA CHOI

rebeccachoi@ipm.edu.mo

1. Macao Travel Mode Recommender

Background

In Macao, there are different transportation vehicles, for the mass transportation, there are bus, taxi and light rapid transit. Other than mass transportation, driving car and motor bike are other options. As Macao is small, sometimes walking is also a good choice. Even though travel modes in Macao are not much comparing with other big cities, it is difficult to choose a correct travel mode. The reason is because Macau is congested, there are traffic jams everywhere, and different vehicles have different routes, a correct traffic vehicle can avoid traffic jam. In addition, parking in Macao is limited and under strain, it is difficult for drivers to find a parking slot, therefore, sometimes mass transportation is better.

To solve this issue, in this project, student will develop a mobile application that recommends a suitable travel mode and route based on the road situation and parking availability. In the application, users can set the starting point and the destination, a travel mode and route will then be recommended depending on the estimated duration for different travel modes. With this mobile application, people would probably reach the destination in a more efficient manner and save travelling time.

Project Objectives

In this project, the main objectives are as follows. (i) Develop a mobile application that provides a user-friendly interface for users to set the starting point and destination for the travel. (ii) Estimates the travelling time for different travel modes based on the road situation. (iii) Adjust the travelling time for driving car by considering the parking issue. (iv) Recommends suitable travel mode and route for the user based on the travelling duration.

The student is expected to have good programming skills.

2. Leisure Activity Advisor

Background

In today's society, everyone are busy with work and school, when there is spare time, it is good to go out to have some leisure activities to relax after work and during vocation. However, there are few spots to hang around in Macao, sometimes we may have no ideas where to go. In addition, activity that can be done is often restricted by different factors, just like weather, time, duration available, etc. For example, outdoor activity is obviously not a good suggestion when it is raining; hiking is also not recommended at night; and if there is not much available time, a location that is close would be preferred.

To deal with this, in this project, student will develop an application which recommends leisure activities. Based on the current user location, time, leisure duration, user group and weather, leisure activities will be suggested. In order to improve the suggestion, data is collected from users regarding the options they chose. With the application, it is expected that users can enjoy their spare time with the suggested interesting activity and have a good time.

Project Objectives

In this project, the main objectives are as follows. (i) Develop an application that provides a user-friendly interface for users to set the attributes like current location, time and weather, preferably with the help of Google Map. (ii) Retrieve weather information for generating leisure activity suggestion. (iii) Recommends some leisure activity options with the given parameters for the users. (iv) Provide means to collect data from the users regarding their chosen options. The goal is to improve the suggestion with users' feedback.

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

3. Order Management System for Macao WeChat Business

Background

Nowadays, there are many instant messaging apps, like WhatsApp, WeChat, Line. Among them, WeChat becomes more and more popular in recent years. WeChat is a multi-purpose messaging and social media mobile app. Recently, more and more people are doing business with WeChat, hence gives rise WeChat business.

WeChat business is a mobile business model, it utilizes the friendships to maintain the customer relationships, and sellers promote their products with WeChat Moments. One of the reasons for its arising is because of low cost and easy start, which attracts lots of small merchants to join in WeChat business. Small merchants usually do not have much capitals and do not have their own order system. However, placing order with messages is not efficient and unable to generate statistics for decision making.

In this project, the student will develop an order management system for Macao WeChat business. With the system, customers can place orders their own in WeChat, merchants can post goods and manage orders. In addition, sales statistics will also be provided, so it is easier for merchants to make a correct business decision.

Project Objectives

The main features of the system include: (i) Merchants can add and edit commodities for sales. (ii) Customers can view the commodities of the merchants and place order by themselves. (iii) Merchants can manage the placed orders. (iv) Provides different types of sales statistics to the merchants for business decision making.

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

4. 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>

PROPOSED BY WILSON HO

kcho@ipm.edu.mo

1. E-Learning and Assessment Platform Using Cloud Computing

Background

Due to the COVID-19 pandemic, it has resulted in schools shut all across the world. Education has changed dramatically as schools shut. Teaching is undertaken remotely and on digital platform with the help of e-learning technology.

Getting students to do the readings is one of the problems of e-learning. In addition, how to reduce the risk of cheating in online tests and examinations is another headache for teachers while doing the online assessment.

In this project, the student will develop an E-learning and assessment platform (LMS) for secondary & primary schools in Macao. With the help of online facial recognition technology, teachers can find out the time spent on readings of a student on a weekly or daily basis and thus keep good track of student's learning progress. The platform can also provide online test and exam monitoring in order to assist teachers to monitor their students.

Project Objectives

The student is required to:

1. do literature review on facial recognition technology
2. learn about application development using Cloud computing
3. design the system architecture and the functions of the E-learning and assessment platform
4. implement a function of online reading record keeping and monitoring
5. implement a function of online test and exam monitoring
6. compose a final project report.

References

- <https://azure.microsoft.com/en-us/services/cognitive-services/face/>
- <https://techbusinessguide.com/face-recognition-online-tools-ready-to-use-with-your-apps-and-products/>

PROPOSED BY CORA LAI

coralai322@gmail.com

1. Macau m-Police Aid

Since the Macau SAR government would like to promote more e-services to enhance the efficiency of the local government and Police contributes a major task forces in Macau, an integrated mobile app is designed for police's tasks automation.

The integrated app enables a policeman to perform the following tasks:

- Basic function 1: An Optical Character Reader (OCR) server is setup to perform the OCR functions.
- Basic function 2: to easily document data (voice, video text data, plus GPS, date & time stamps) & store them in encryption
- To record illegal parking incidence - To take a picture of a car's license plate and upload it for OCR – to retrieve the license number that is used to check the Registered Vehicle database. Upload the Illegal parking record to the database as well.
- For suspected ID card - To take a picture of an ID card and upload it for OCR – to retrieve the card number & the photo of the original card from the ID card database. Upload the ID problem record to the database if there is any.
- To Maintain *beat* record (with GPS, date and time stamps) for police patrol assuming QRCode is equipped at each point of monitoring

Possible technologies to be used:

- Abby cloud OCR SDK for Chinese OCR
- mobile development environment: Google Flutter / Microsoft-Xamarin / React-Native/Native Android Framework/ or IOS development

2. Elderly Care and Monitoring App

The Covid19 has made it difficult for care professionals and family members to take care and monitor an elderly in person. The mobile-apps is designed to make it possible for caregivers to monitor the activities of an elderly at home with the following functions:

- live streaming the elderly's sports activity (for physio and family members' monitoring)
- Sports reminder
- Take blood pressure
- Medication reminder
- Take medication (with time-stamped photo-taken)
- Fast track to contact registered caregiver(s)

(This app is to be used by an elderly who or a helper at home can work with a smartphone.)

Possible technologies to be used:

- Dailymotion live stream API
- SWIFT sdk or AngularJs
- Apple careKit API

PROPOSED BY CHAN-TONG LAM

ctlam@ipm.edu.mo

1. Real-Time Traffic Congestion Detection using Online Videos

Introduction

The Macao government provides instant traffic videos at different locations /intersections through the following website: <http://www.dsat.gov.mo/dsat/realtime.aspx>. The 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 traffic congestion detection system when they are on the road or planning for the trip. Different techniques can be used to detect traffic congestion. In [1], multiple Intersection over Union (mIOU) is used to estimate the traffic level, along with the estimation of the number of vehicles using the generic object detector YOLOv3 [2]. The method requires calibration of parameters for different images taken at different locations. In this project, the goal is to investigate a more generic method of detecting traffic congestion using existing generic object detector YOLOv4 [3] and a simple 2nd stage neural network. The inputs to the 2nd stage neural network are mIOU, number of vehicles and movement of the vehicles in the videos for a short period of time [4]. The other goal is to create a useful dataset for training, validation and testing of traffic congestion detection in Macao.

Objectives

Students are expected to achieve the following objectives:

- Obtain on-line videos continuously taken from different locations and angles.
- Detect number of vehicles from on-line videos using YOLOv4
- Detect movement of vehicles in the video for the purpose of congestion detection
- Establish a dataset for training, validation and testing of traffic congestion in Macao

Deliverables

- A real-time traffic congestion system using on-line videos
- A traffic detection dataset using on-line videos from DSAT of Macao

Basic skills/knowledge

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

References

- [1] C. T. Lam, B. Ng and C. W. Chan “Real-Time Traffic Status Detection from on-Line Images Using Generic Object Detection System with Deep Learning” Proc. of the 2019 International Conference on Communication Technology (ICCT 2019), Xian, China, 2019.
- [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, 2020]
- [3] A. Bochkovskiy, C.-Y. Wang, H.-Y. Mark Liao, “YOLOv4: Optimal Speed and Accuracy of Object Detection,” [Online]. Available: <https://arxiv.org/pdf/2004.10934.pdf>
- [4] G. Oltean, C. Florea, R. Orghidan and V. Oltean “Towards Real Time Vehicle Counting using YOLO-Tiny and Fast Motion Estimation” Proc. of the 2019 IEEE 25th International Symposium for Design and Technology in Electronic Packaging (SIITME), 2019.

2. Bus Arrival Time Prediction using On-line Bus Locations from Multiple Routes

Introduction

In order for the passenger's convenience, the Macao Government provides real-time information on discrete bus locations for all 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. In [1], we proposed to use link times from different buses serving the same route to predict bus arrival time. This project is intended to improve the performance of the methodologies proposed in [1], by using the link times from different buses serving different routes. Bus arrival time prediction using multiple routes has been studied in [2] and [3]. However, in this project, we would like to use the on-line locations provided by DSAT to further improve the accuracy of prediction. Students are expected to obtain real-time bus locations from the above website and create a dataset for training of neural network models.

Objectives

Students are expected to achieve the following objectives:

- Obtain real-time bus arrival time for buses serving different routes for the same bus stops;
- Obtain weather condition and traffic status for training of neural networks
- Create a dataset for bus arrival time prediction in Macao
- Evaluate and compare the performance of proposed prediction models

Deliverables

- A dataset for bus arrival time prediction in Macao
- A bus arrival time prediction model using real-time bus locations from multiple routes

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] C.-T. Lam, B. Ng and S.-H. Leong, "Prediction of Bus Arrival Time using Real-Time on-Line Bus Locations", Proc. of the 19th IEEE international Conference on Communication Technology (ICCT), Xi'an, China, 2019.
- [2] X. Hua, W. Wang, Yinhai Wang and M. Ren, "Bus Arrival Time Prediction using Mixed Multi-route Arrival Time Data at Previous Stop," in Transport, Vol 33(2), pp. 543-554, 2018.
- [3] T. Yin, G. Zhong, J. Zhang, S. He and B. Ran", Proc. of World Conference on Transport Research – WCTR 2016, Shanghai, China, 2016.

3. Parking Space Prediction using Real-Time Parking Information

Introduction

Macao is a small city with the densest vehicle in the world. In order to further enhance the services to the public road users, the Macao Transport Bureau provides real-time parking information, including parking meter and information of parking spaces in parking facilities, through its public website [1]. For parking meter, the number of available parking meters within a certain area are shown in the map, while the number of available spaces is shown in a table for all the parking facilities in Macao. In [2], we analyse the traffic status using on-line traffic maps and real-time information of parking spaces. This is useful to estimate the traffic status given the parking spaces in a particular facility. However, it can take a long time to cruise around the busy area for a parking space, being either parking meter or in a parking facility. Recently, [3] proposed a deep learning approach to real-time parking occupancy prediction for road users, using parking meter transactions, traffic speed, and weather conditions. In [1], we have the exact information on parking meter and available space for parking facilities. In this project, we want to use the real-time parking information provided by DSAT and the traffic information from the on-line maps, e.g. Google, as well as the weather information to predict the available parking spaces in Macao.

Objectives

Students are expected to achieve the following objectives:

- Obtain and store on-line parking information from the DSAT website;
- Obtain traffic status from Google maps and weather information from SMG website;
- Design and implement prediction models to predict the available parking space;
- Evaluate the performance of the models

Deliverables

- A prediction model for the prediction of available parking spaces in Macao

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] Real-Time Parking Information of Macao, http://www.dsat.gov.mo/dsat/subpage.aspx?a_id=1579511645#. [Aug. 04, 2020]
- [2] C.-T. Lam, B. Ng and I. Pun, "Analysis of Traffic Status Using On-line Traffic Maps and Real-time Information of Parking Spaces", Proc. Of 18th IEEE international Conference on Communication Technology (ICCT), Chongqing, China, 2018.
- [3] S. Yang, W. Ma, X. Pi and S. Qian, "A deep learning approach to real-time parking occupancy prediction in transportation networks incorporating multiple spatio-temporal data sources," in Transportation Research Part C: Emerging Technologies, Oct. 2019, vol. 107, pp. 284-265, DOI: 10.1016/j.trc.2019.08.010.

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], for example "5G" or "6G" 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

philiplei@ipm.edu.mo

1. Online Examination Question Paper Generator and Grader

The robustness of many assessment types is based on timed closed book examination with invigilators. In such examination setting, students cannot cooperate or share their answers, and therefore, teachers can distribute an identical problem set to all students to evaluate them fairly.

However, this robustness is lost when the same examination paper is administered in an online manner. The situation becomes even more serious for multiple choices or short questions with definite answer (e.g. arithmetic, trace output of programs).

This project aims to design a tool to create an online assessment platform for mathematics or programming modules that can generate variations of online examination paper based on a question bank entered by teachers. It has the following objectives:

- The system supports short questions and multiple choice question type
- The system provides a flexible input method for the examination questions
- The system can randomize the order of options in multiple choice questions
- Teachers can include a random seed value in a question template for generating unique question. For example, the question template “[random from 1 to 10] + 5 = ?” can generate the following questions “1+5=?”, “8+5=?”, etc.
- The system allows the teachers to enter more than one questions that assess similar knowledge or skills. These questions are grouped under a question alternative group.
- When the system generates a variation of the examination paper, it randomizes the order of options in multiple choices, use random seed values to generate question text from a question template, and randomly select one question from each question alternative group.
- The system can automatically grade answers submitted by students.

Related technologies:

- Web or mobile programming

2. File and Task Tracker in CSCW

Computer-supported Cooperative Work (CSCW) is the study of how to use computing technology to facilitate the cooperation of human users to achieve goals. Common cooperative activities include messaging, scheduling, document submission and sharing.

In our program, we are not using dedicated CSCW software. We mainly use E-mail and network folders to implement cooperative activities between teachers and students. For example, in the Final Year Project (FYP), students and teachers have to create, submit and exchange multiple documents. In addition, the FYP panel also needs to monitor the progress of all projects in the cohort.

Another example is quality assurance procedure. Being an IET accredited program, the Computing program follows several detailed quality assurance procedures to monitor different aspects of teaching, assessment, and program management. There are numerous activities throughout a semester, and each activity requires many teachers to prepare and submit documents on or before a deadline.

In this project, students will design and develop an application to support users cooperative work through tracking file sharing and task fulfilment. The project has the following objectives:

- Study common approaches and support tools in CSCW
- Survey the current practice in a cooperative work involving file sharing and task management.
- Design and develop an application for users to
 - Create a task in a workflow. The task may request files of certain formats to be submitted by some users before a deadline
 - Monitor the progress of each task in a workflow, and show which tasks are lagging behind, and which files are not submitted on time
 - Display a dashboard to show the up-coming deadline for a user

Skills required: web development

3. A Learner Model Driven App for Beginners to Learn a Foreign Language

When learning a foreign language, one of the struggles that beginners often experience is memorizing its alphabet and the pronunciation of the letters / characters in the alphabet. While learners may have memorized the letters in their sequential order, they often get confused when the letters appear ‘randomly’ in a word.

This project aims to develop a foreign language beginner learning application that helps the learners to memorize the alphabet and common words. Take Japanese as an example. A highlight of this project is that the application builds a learner model to track the familiarity of letters (Hiragana, Katakana) for a learner, and selects appropriate exercises for the learner to practice unfamiliar letters. Some objectives are:

- Study existing mobile / web app for foreign language learner, and identify common difficulties of learners
- Study common learner model (e.g. Bayesian Knowledge Tracing) and learning theories (e.g. memory decay, distributed practice) in language learning
- Design different kinds of exercises to practice the alphabet. The exercises should put the alphabet practice in context of its usage. Examples: mapping between Hiragana and Romaji, identify Hiragana in common words, fill in the blank for missing Hiragana in a word.
- Design and implement a mobile / web app
- Collect user data in language practice
- (optional) Evaluate the accuracy of the learner model

Skills required:

- web development
- basic knowledge of a foreign language (e.g. Japanese)
- basic knowledge of learning theory

PROPOSED BY YUE LIU

yue.liu@ipm.edu.mo

1. Environment Protection Mobile Application

To maintain sustainable development of human society, environment protection is now catching the eyes of the world. Governments are now trying to reduce people's daily behaviors on consuming plastic products such as plastic straws or plastic bags meanwhile requiring citizens to sort the waste properly for the purpose of better waste recycling. Macao SAR Government currently pays high attention on the issue of 'Reduce waste at source'. the law of "Restrictions on the provision of plastic bags" has passed in the Legislative Assembly on August 8, 2019, and the "Plastic bag charge" measure became effective on November 18, 2019 onwards. Under this circumstance, more and more people bring reusable bags for shopping which greatly reduces the use of plastic bags. On the other hand, sooner or later, Macao will also follow the worldwide trend of waste sorting and recycling. By then sorting thousands variety of waste into several categories will become a big problem for people in Macao.

To teach people knowledge about environment protection and to help people with their behaviours of reusing plastic products, donating old clothes or recycling wastes with the aid of modern technology is something worthwhile considering. The aim of this project is to design a mobile application which helps with people's daily environment-friendly behaviours.

Project objectives

The student requires to:

1. Do background reading on environment protection and consider the way how a mobile application can help with it.
2. Learn about mobile application development.
3. Design the overall architecture and the functions of the application.
4. Implement a function of delivering common knowledge on environment protection.
5. Implement a function which helps one specific environment protection behaviors such as recycling wastes etc.
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, documentation, <https://keras.io/>

2. Second-hand goods exchange, rental, trading system

With the continuous improvement of the quality of life and the continuous change of consumption concept, more and more goods begin to play "surplus value" on the second-hand trading platform. In Mainland China, according to statistics, more than 1 million people publish more than 2 million personal idle items on the second-hand trading platform every day, and the cumulative number of idle items released exceeds 1.4 billion. More and more people are optimistic about the transaction of second-hand idle goods, which has great market potential. In Macao, second-hand good exchanging also has a big market. Macao citizens form Facebook groups, Wechat groups or post on a forum to exchange various idle goods from luxury cars to baby clothes. It benefits the circular consumption and add surplus values. However, Macao does not have a mature second-hand goods exchanging, rental or trading platform which give a more structural and user-friendly way of sharing, searching or retrieve idle goods information.

The aim of the project is to develop a mobile application or a system to provide a platform for Macao citizens to exchange, rent or trade their second-hand goods conveniently. (The platform can be customized just for a certain type of second-hand goods, e.g. second-hand cars or it can be just for a certain location: e.g. campus.)

Project objectives

The student requires to:

1. Investigate second-hand good exchange applications/system and analyze their pros and cons.
2. Design architecture of the application/system.
3. Crawl real trading data from chat groups or forum.
4. Implement accounts with different functions. (e.g. buyer, seller and admin accounts)
5. Add at least one Macao local feature into the functions.
6. Compose a final project report.

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

Reference Reading

1. News on second-hand goods trading:
http://www.chinasei.com.cn/zcjd/201910/t20191008_28872.html
2. Campus Second-hand Trading Market Application System: <https://download.atlantispress.com/article/25844787.pdf>
3. Android studio, <https://developer.android.com/>

3. Traveller Detection at the Border Gate

Machine Learning enables the machines to perform recognitive and cognitive tasks like human beings. Nowadays, as the advanced deep learning algorithms gets its maturity and production of hardware gets cheaper, machines can easily achieve plenty of tasks to assist human beings, like recognizing car plates, human faces and other classes of objects in images and videos. It can greatly improve the work efficiency of people who needs to deal with those tasks in their work routines, e.g. policeman, traffic controller, product quality inspector.

However, low quality of the images is lethal for machine performing detection and recognition. Low quality images or videos can be caused by uncontrollable factors, e.g. bad weather like heavy rain and fog; some are caused by the hardware limitations of the camera, e.g. poor CMOS gives bad contrast and brightness on the captured images at night and low resolution gives blurry images; and moreover some images and videos are made poor deliberately to protect people's privacy.

This project aims to perform traveler detection on the real-time images with rather low quality obtained from CPSP website at the Border Gate by using a machine learning algorithm, and then analyze and optimize the detection results.

Project objectives

In this project, the student is required to:

1. Do literature review on pedestrian detection and main-stream machine learning algorithms.
2. Generate the training and test dataset of images using CPSP real-time images.
3. Train a machine learning model to record the people flow at the Broder Gate.
4. Analyses the detection results
5. Fine tune the model to optimize the detection performance.
6. Compose a final project report.

Programming language: Matlab, OpenCV, Java, JavaScript or Python etc.

Reference Reading

1. CPSP website: <http://www.fsm.gov.mo/psp/pspmonitor/mobile/>
2. Pattern recognition and Neural Network: http://www.byclb.com/TR/Tutorials/neural_networks/Index.aspx
3. TensorFlow, tutorial and examples: <https://www.tensorflow.org/overview/>
4. Keras, doucumentation, <https://keras.io/>

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

5. Data Visualization for Macao Health Code

At the end of January 2020, the World Health Organization (WHO) declared the arrival of the covid-19 as a global emergency. The world is suffering from the impact of pandemic on all aspects. Although facing the dangerous unknowns, Macao still proves itself capable of battling the spread of the virus. The Novel Coronavirus Response and Coordination Centre was set up quickly to respond and coordinate all issues related to Covid-19, such as mask distribution, casino suspension, hotel quarantine, border control etc. Now the local situation is much more stable due to the strong control mechanism deployed by the government.

During this pandemic, information technology is helping greatly on monitoring and tracking people's status and people's flow to in-timely detect suspected infections. People swipe the QR code (Macao Health Code) to record their daily health status and tracks. Together with the data collection, a series of data operations are done at the backstage to process, monitor, track and analyse the huge amount of data so that suggestions and cautions for public travelling can be issued. This project aims to implement a system to visualize the data assuming the data collected through Macao Health Code is accessible.

The project objectives

In this project, the student is required to:

1. Tracking covid-19 latest status.
2. Do literature review on data analysis and data visualization, app development.
3. Generate synthetic data to simulate the data collected by Macao Health Code.
4. Implement a function of data visualization.
5. Implement a function of issuing travel suggestions.
6. Testing the functions under different scenarios (e.g. fever data input, out of Macao data input)
7. Compose a final project report.

Programming language: PHP, Java, Python, SQL, Android Studio, etc.

Reference Reading

1. Macao Health Code: <https://app.ssm.gov.mo/healthPHD/page/index.html>
2. Data visualizaiton: <https://www.tableau.com/learn/articles/data-visualization>
3. Documentation of Android Studio:
<https://developer.android.com/training/basics/firstapp>

PROPOSED BY AMY LUO

luowuman@ipm.eud.mo

1. Highway Traffic Flow Prediction

Traffic flow forecasting is an important component of Intelligent Transportation System [1]. It is useful for a series of real-world applications such as smart routing, congestion control, event detection, etc. Specifically, traffic flow prediction means obtaining the traffic volume for the next time interval. So far, various approaches have been proposed. Typical examples include neural networks [2][3], Bayesian networks [4], Support Vector Regression (SVR), hybrid fuzzy approaches, etc. However, these methods are suboptimal due to two reasons: 1) their accuracies are not high enough, and 2) the performances of the prediction models vary in different application scenarios (e.g., urban area vs. highway area).

The purpose of the project is to do highway traffic flow prediction. The data used in the project are the tolling data collected from a real-world highway tolling system. In this project, the student is required to convert, store and analyze the tolling data for traffic flow prediction.

The project objectives

In this project, the student is required to:

1. Do literature review on traffic flow prediction.
2. Analyze the application scenarios of the prediction approaches.
3. Apply suitable approach to do prediction.
 - a. Build suitable data model.
 - b. Analyze the dynamics of the data.
 - c. Implement the prediction algorithm.
 - d. Tune main parameters for different prediction time intervals.
4. Compare different prediction models and do detailed analysis.
5. Visualize the comparison results.

Skills required: Student is required to be proficient in Python or other programming languages, e.g., Java, C++, etc.

References

- [1] Y. Lv, Y. Duan, W. Kang, Z. Li and F. Wang, "Traffic Flow Prediction With Big Data: A Deep Learning Approach," in *IEEE Transactions on Intelligent Transportation Systems*, 2015.
- [2] J. Zhang, Y. Zheng, D. Qi, "Deep Spatio-Temporal Residual Networks for Citywide Crowd Flows Prediction," *AAAI*, 2017.
- [3] R. Fu, Z. Zhang and L. Li, "Using LSTM and GRU neural network methods for traffic flow prediction," 2016 31st Youth Academic Annual Conference of Chinese Association of Automation (YAC), 2016.
- [4] S. Sun, C. Zhang, and Y. Guoqiang, "A Bayesian network approach to traffic flow forecasting," *IEEE Intell. Transp. Syst. Mag.*, 2006.

2. Travel Time Prediction

Travel time prediction of any path in a city is crucial for a series of location-based services such as smart routing, urban planning, ridesharing, taxi dispatching, etc. These days, with the advances of location acquisition techniques, huge amounts of moving trajectories have been generated and collected from GPS-equipped vehicles. Typically, each trajectory is a series of GPS sampling records each of which contains at least three main items: latitude, longitude, and timestamp. Given the digital road network of the city, these trajectories can be mapped to the corresponding road segments and paths.

The objective of this project is to design a real-time system for estimating the travel time of any path in a city, based on the current and historical moving trajectories of vehicles. So far, various travel time prediction approaches have been proposed [1][2][3][4][5], however, most of them are suboptimal. The main reasons are: 1) data sparsity problem, i.e., querying roads may not be traversed by a trajectory at present, 2) each path consists of a sequence of road segments. How to split and combine the trajectories for prediction is very challenging.

The project objectives

In this project, the student is required to:

1. Do literature review on travel time estimation.
2. Obtain online real trajectory datasets and the corresponding digital map.
3. Align the trajectories with the digital map.
4. Apply suitable approach to do prediction.
5. Compare different prediction models and do detailed analysis.
6. User interface design.

Skills required: Student is required to have basic graph knowledge (e.g., what are edge and vertex) and should be proficient in Python or other programming languages, e.g., Java, C++, etc.

References:

- [1] Y. Wang, et al, "Travel Time Estimation of a Path using Sparse Trajectories", ACM KDD, 2014.
- [2] D. Wang, et al, "WhenWill You Arrive? Estimating Travel Time Based on Deep Neural Networks", ACM AAAI, 2018.
- [3] J. Wang, et al, "Traffic Speed Prediction and Congestion Source Exploration: A Deep Learning Method", IEEE ICDM, 2016.
- [4] R. Waury, et al, "Indexing Trajectories for Travel-Time Histogram Retrieval", EDBT, 2019.
- [5] H. Yuan, "Effective Travel Time Estimation: When Historical Trajectories over Road Networks Matter", ACM SIGMOD, 2020.

3. Map Matching using Object Moving Trajectories

Nowadays, huge amounts of moving trajectories of vehicles and peoples are available. Typically, a trajectory is a sequence of records, and each record contains at least two attributes, namely geographical location and sampling timestamp. The attribute of geographical location varies in different application scenarios. It can be GPS records in the form of <latitude, longitude>, or subway/bus station/tourist attraction check in/out records, or other types of location information.

In most practical applications, the trajectories of these forms cannot be directly used without being aligned with the digital map (or road network) in advance [1][2][3]. However, map matching is very challenging due to two main reasons: 1) due to the technical limitations of data acquisition and transmission, data error and data loss often occur in the process of trajectory collections, and 2) the sampling rate of a trajectory can be very low, which makes it nontrivial to identify the moving trace of the object between two sampling records. The objective of this project is to design a map matching system with user friendly interfaces.

The project objectives

In this project, the student is required to:

1. Do literature review on map matching.
2. Obtain online GPS trajectory datasets and the corresponding digital map.
3. Design and obtain the ground truth for map matching.
4. Apply suitable map matching approach to align the trajectories with the digital map.
5. Compare different map matching approaches and do compare their performances.
6. User interface design.

Skills required: Student is required to have basic graph knowledge (e.g., what are edge and vertex) and should be proficient in Python or other programming languages, e.g., Java, C++, etc.

References:

- [1] Chao Chen, et al, "TrajCompressor: An Online Map-matching-based Trajectory Compression Framework Leveraging Vehicle Heading Direction and Change", IEEE Transactions on Intelligent Transportation Systems, VOL. 21, NO. 5, MAY 2020.
- [2] Hong Wei, et al, "Map Matching: Comparison of Approaches using Sparse and Noisy Data", ACM SIGSPATIAL, 2013.
- [3] Hannah Bast, et al, "Sparse Map-Matching in Public Transit Networks with Turn Restrictions", ACM SIGSPATIAL, 2018.

4. Online Car Rental System

As for 2019, Macau has set a record for tourist arrivals for five consecutive years. According to Chinese Special Administrative Region (SAR), Macau welcomed more than 39.4 million travellers in 2019. This number is a 10% increase from the 35.8 million in 2018. This increase in the number of tourists has led to the booming of car rental industry in Macau, especially the online paradigm. In fact, online car leasing provides conveniences for both customers and car rental companies. On one hand, customers can visit the online car rental website whenever they want, because the online website will never be closed unless it is under construction/maintenance. In addition, the online website can provide a complete selection and comparison between cars for customers reference. On the other hand, a fancy and powerful online website can attract many more potential customers for a car rental company, and can ease the entire rental process and save a lot of labor costs.

The objective of this project is to design an online system for a local car rental company. The website presence should be attractive, the user experience should be good, and the car introductions should be complete.

The project objectives

In this project, the student is required to:

1. Survey on existing online car rental systems.
2. Investigate user requirements and design main system architecture.
3. Detailed model function design.
4. Database design and data import.
5. User interface design and refinement.

Skills required: Student is required to have programming skills and basic knowledge of database design.

PROPOSED BY BENJAMIN NG

bng@ipm.edu.mo

1. Social Distance Detector

Background

Due to Covid-19, various measures have been in place to prevent the spreading of the virus. Some main approaches are, for example, maintain the social distancing and impose a limit of how many people may share a table in a restaurant. In this project, student will use machine learning and image processing technique to determine whether there is a violation of social distancing and table sharing limit in a restaurant. This is a desktop application which processes images taken from a camera (such as CCTV), and detect if there is a violation.

Objectives

There are three objectives in this project. First, an application with a user-friendly user-interface allowing the users to upload photos, and input various parameters such as the social distancing limit and etc. Second, using machine-learning-based image processing algorithm (such as YOLO), the application can detect whether there is a violation of social distancing. Finally, using similar techniques, the application can detect whether there is a violation of table sharing limit in a restaurant.

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.

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 (such as wearing masks). 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, wearing masks, 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.

PROPOSED BY JACKY TANG

sktang@ipm.edu.mo

1. Paytable for 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.

2. 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 board 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

3. Portable Navigation Device for Visual Impairment

Background

Visual information is common and important for visually impaired people to understand their surroundings when they move from one place to another place. They usually walk with a stick and/or a guide dog for locating obstacles around them. The walking stick is directional and limited by its coverage range. It is operated by hand and the hands cannot be released. Guide dog is costly and not affordable easily. In addition, most of the indoor environments are not designed for barrier-free access for the visually impairment.

In order to provide obstacle avoidance support for visual impairment people, a navigation device is expected to be developed in this project. It uses technology (suggested by student) to assist in avoiding obstacles while they walk. If any obstacle is found, the device will alert.

Deliverables

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

- a) Correctly design the prototype of the device;
- b) Correctly implement the prototype;
- c) Demonstrate that the prototype is working correctly;
- d) Correctly test the prototype with a feasible test plan;

Technical Skills Required

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

- Programming in Arduino/Raspberry pi

PROPOSED BY RITA TSE

ritatse@ipm.edu.mo

1. Intelligent Battery Management System

Transportation is based on fossil products and produces enormous amounts of CO₂, PM_{2.5} and other pollutants. We live with this necessary hazard to keep the world as we know today running. The sector is being transformed by the advent of electric vehicles that have zero-emission.

Batteries are the single technology limiting today's extensive adoption of electric vehicles. Current technology has not yet reached the safety and single-trip duration needed for extensive commercial and private deployments. Battery recharging is still inconvenient and requires substantial amounts of time. Several battery technologies are commonly adopted with the EVs such as nickel metal hydride (NiMH) and lithium-ion [1]. There are several factors that could affect the performance of lithium-ion batteries such as ambient temperature, over-charge and over-discharge. To overcome those issues, battery management system (BMS) is employed to ensure the reliability and stability of lithium-ion battery.

This project requires the student to collect and create a database to provide battery data. First, the battery energy management system database is established, where the power efficiency of the battery is considered. Next, considering the power constraints of the battery, analyze the state of charge and state of health of the batteries. Then, different algorithms are compared. Finally, simulation and comparison results are given to illustrate the performance of the presented method.

References

- [1] Kwo Young, Caisheng Wang, Le Yi Wang, and Kai Strunz. Electric vehicle battery technologies, pages 15–56. Springer New York, New York, NY, 2013.
- [2] Luo, Zhiliang, Yanjie Li, and Yunjiang Lou. "An adaptive Kalman filter to estimate state-of-charge of lithium-ion batteries." 2015 IEEE International Conference on Information and Automation. IEEE, 2015.
- [3] Rita Tse, and Yubin Xiao. "A portable Wireless Sensor Network system for real-time environmental monitoring." In 2016 IEEE 17th International Symposium on A World of Wireless, Mobile and Multimedia Networks (WoWMoM), pp. 1-6. IEEE, 2016.
- [4] <https://github.com/Samuel-Buteau/universal-battery-database>

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. Android based Bacarrat Dealers Training app

Background

Gambling tourism is Macau's biggest source of revenue, making up more than 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

[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 App 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 in Android
- 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. Intelligent Voice Ordering for Restaurant (or grocery)

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 webrtc SpeechRecognition 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/](https://developer.mozilla.org/en-US/docs/Web/API/Web_Speech_API)

[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/>.

8. Pi Car Autonomous Navigation

Autonomous Vehicles are posed to change the transportation system as we know today. Driverless cars will serve as personal chauffeurs, delivery butlers, and transportation personal assistants. Robo-drivers are powered by machine Learning algorithm and they learn how to drive on a given route, avoid obstacles and interact with other elements of the transportation systems such as, for example, other cars or the transportation infrastructure.

As the research progresses is becoming increasingly clear that moving directly into full autonomous vehicles, it is an impossible challenge both technically and from the societal point of view. Technically is impossible to train the robo-drivers for all the possible situations encountered on the road. On the other end our society we are not ready for robots that make mistakes and driverless cars are expected to be accident-free.

This project aims at an hands-on approach to autonomous driving and more in general to applications of edge computing and distributed machine learning to autonomous vehicles. In particular, we aim at building an autonomous navigation system that using only cameras and proximity sensors is able to follow a given route and avoid fixed obstacles on the route.

The PI car in this project provides a number of sensor including camera and proximity sensors. The student should use existing software and navigation frameworks to control the cars and do navigation.

Final Expected Outcome: Running Car, Software, Measure of Reaction Time and number of accidents.

This project has the following objectives:

- Design a simple track where the car can be driven autonomously.
- Design a navigation algorithm that avoids the obstacles
- Design a simple track with fixed obstacles, the car can drive on a given path with obstacle detection.

References:

- (<https://ieeexplore.ieee.org/abstract/document/5940562>)
- <https://www.youtube.com/watch?v=jbimBoI42AM>
- <https://github.com/topics/autonomous-navigation>
- <http://www.theconstructsim.com/start-self-driving-cars-using-ros/>

PROPOSED BY YAPENG WANG

yapeng.wang@isremo.org

1. Portuguese Voice Commands Recognition for Macau Tourism

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 Portuguese voice command recognition system for Macau Tourism. Macau has become a world tourist attraction that attracts many tourists from Portuguese speaking countries. However, Voice Recognition for Portuguese is less studied due to the fact that it is a small language. The project will focus on a small set of Portuguese voice commands for Macau tourism. These commands will be recorded and provided to the student for training. The outcome of this project is a working voice recognition system which has acceptable recognition accuracy.

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 voice-text corpus.
- Improve the recognition accuracy with limited corpus.
- Test and refine the whole system.
- Compose a final project report.

2. Improving Positioning Accuracy Using BLE Direction Finding

Background

As traditional GPS based positioning is not working in indoor environment, various indoor wireless positioning technologies have been developed using Radio Signal Strength (RSS) measurement, however due to fast fading, the signal is too dynamic so that RSS based positioning normally are not very accurate. Bluetooth Low Energy (BLE) technology has been developed and widely used. BLE has the advantage of low cost, low energy requirement and fast scanning speed. 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 antenna array, 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]. Last year, a student has already done a project examine this new technology and showed it is feasible. In this project, the student will continue research on BLE positioning using direction finding and improve the positioning accuracy.

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 and work from last year student's project (will be provided).
- Propose one or more algorithms to improve the accuracy of BLE positioning using direction finding.
- 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/>

3. Interactive Chatting Robot for MPI Open Day

Background

Along with the development of Artificial Intelligence, Automatic Speech Recognition (ASR) and Natural Language Processing (NLP) has gain significant development and achievement. Such development has led to the emerge of Chatbot and Chatting Robot. Chatbots are extremely helpful for business organizations and also the customers. The majority of people prefer to talk directly from a chatbot instead of calling service centres. Apple Siri is another good example of Chatbot. Chatting Robot is an interactive talking robot that can attract people to get information with natural talking. It an be find in places like museum, tourists attractions etc. It normally has an animated human or robot face to make it more humanised.

In this project, the student will develop an interactive chatting robot for MPI open day using PC. It can great visitors with interactive conversation. If the visitor asked information about a special open day event, the chatting robot should be able to show the detail information about the event, such as time, location and even a guiding map. The student can use various APIs to implement this project such as Speech to Text/ Text to Speech engine provide by Google etc.

Objectives

In this project, the student is expected to achieve:

- Learn the relevant background knowledge of ASR, Text to Speech, NLP etc.
- Implement the core chatbot function that can interact people with text.
- Adding special content about MPI open day into the chatbot.
- Implement a user interface, preferably an animated human or robot face to make the chatting robot more humanized and interesting.
- Finish the whole system with testing and compose a final project report.

PROPOSED BY XU YANG

xuyang@ipm.edu.mo

1. Deep Learning Models on Stock Market Prediction

Background

Financial market forecasting has traditionally been a focus of industry and academia. For the stock market, its volatility is complicated and nonlinear. It is obviously unreliable and inefficient to rely solely on a trader's personal experience and intuition for analysis and judgment. People need an intelligent, scientific, and effective research method to direct stock trading. With the rapid development of artificial intelligence, the application of deep learning in predicting stock prices has become a research hotspot. The neural network in deep learning has become a popular predictor due to its good nonlinear approximation ability and adaptive self-learning.

In this project, the student will use deep learning neural networks (e.g LSTM) to predict stock Price (such as S&P 500).

Objectives

The student is expected to achieve:

- Learn the relevant knowledge of forecasting and different deep learning models (such as LSTM).
- Do the literature review on Stock Market Prediction
- Learn how to use Deep Learning platform such as Keras.
- Collect and analyse data of stock market.
- Design and implement the training system.
- Through experiments to find the appropriate parameters.
- Compare and analyse the experiments' results.
- Compose a final project report.

2. VANET Routing for Vehicle to Vehicle Implementation

Background

Efficient routing algorithms are essential to guarantee reliable communication in Vehicular Adhoc Networks (VANETs). To realize a fully connected vehicular network, vehicle-to-Infrastructure (V2I) communications where messages are transmitted between vehicles and Road-Side Units (RSUs) deployed alongside the roads become a very hot topic. Efficient routing algorithm can improve V2I communications.

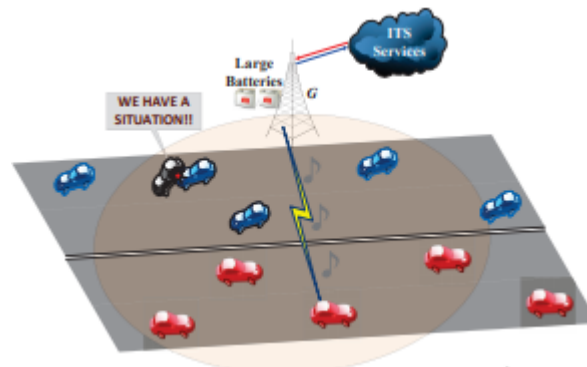


Figure 1 V2I in VANET [1]

Genetic Algorithms (GA) can be a good candidate to achieve the routing in V2I communications. A genetic algorithm is a search heuristic that is inspired by Charles Darwin's theory of natural evolution. This algorithm reflects the process of natural selection where the fittest individuals are selected for reproduction in order to produce offspring of the next generation. They are commonly used to generate high-quality solutions for optimization problems and search problems.

Objectives

In this project, the student is expected to:

- Learn the relevant knowledge of GA.
- Do the literature review on VANET and V2I.
- Build up a V2I roadside communication network.
- Implement GA to achieve Routing.
- Results evaluation, comparison and discussion.
- Compose a final project report.

Reference

[1] Ribal Atallah, Chadi Assi, and Maurice Khabbaz, "Deep Reinforcement Learning-based Scheduling for Roadside Communication Networks", 2017 15th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt)

3. Adversarial Attacks and Defenses for 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.

One of the countermeasures for adversarial examples is to make deep neural networks more robust before adversaries generate adversarial examples.

Objectives

In this project, the student is expected to study the methods to make deep neural network more robust 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 defense methods to make deep neural networks more robust and reduce the impact of adversarial noise.
- Results evaluation, comparison and discussion.
- Compose a final project report.

4. Deep Reinforcement Learning for Trading.

Background

Reinforcement learning (RL) is the task of learning how agents ought to take sequences of actions in an environment in order to maximize cumulative rewards. Deep reinforcement learning is the combination of reinforcement learning (RL) and deep learning. This field of research has been able to solve a wide range of complex decision-making tasks that were previously out of reach for a machine. For example, deep reinforcement learning can beat human experts playing numerous Atari video games, Starcraft II and Dota-2, as well as the world champions of Go. Deep RL opens up many new applications in domains such as healthcare, robotics, smart grids, finance, and many more.

Nowadays, an emerging industry which is growing extremely fast is the financial technology industry, generally referred to by the abbreviation FinTech [1]. The objective of FinTech is to extensively take advantage of technology in order to innovate and improve activities in finance. In the coming years, the FinTech industry is expected to revolutionise the way many decision-making problems related to the financial sector are addressed, including the problems related to trading, investment, risk management, etc. Such complex decision making problems are extremely complex to solve as they generally have a sequential nature and are highly stochastic, with an environment partially observable and potentially adversarial. In particular, algorithmic trading, which is a key sector of the FinTech industry, presents particularly interesting challenges. Also called quantitative trading, algorithmic trading is the methodology to trade using computers and a specific set of mathematical rules. Deep Reinforcement Learning (DRL) can be very good solutions to solve the algorithmic trading problem of determining the optimal trading position (long or short) at any point in time during a trading activity.

Objectives

In this project, the student is expected to achieve:

- Learn the relevant knowledge of deep reinforcement learning.
- Do the literature review on algorithmic trading with RDL.
- Collect the data for trading.
- Implement deep reinforcement learning to perform trading.
- Results evaluation, comparison and discussion.
- Compose a final project report.

Reference:

[1] Thibaut Théate, Damien Ernst , “An Application of Deep Reinforcement Learning to Algorithmic Trading” , Trading and Market Microstructure (q-fin.TR); Artificial Intelligence (cs.AI); Machine Learning (cs.LG)