Project Introduction

Zimou Gao

Leader of EV Charging Robot Team
Program Manager of Florabot
Research Assistant of Field Robotics Lab
Product Manager of TP-LINK
Consultant of MiracleTech
Graduate Student of Robotics in NEU

6 Years Working Experience in Engineering R&D and Program Management

2018 - Present

- Created a robot system for Robotic EV charging **(Leader)**
- Developed robotics for floral industry **(Program Manager)**
- Infrared Image SLAM & Drone Application **(Research Assistant)**
- Wearable Device for Parkinson Patients **(Developer)**
- Expanded US market for MiracleTech Co. **(Consultant)**

2015 - 2018

- Built & characterized Security Monitoring product, the pioneering work for TP-LINK Smart Home System to scale from 1 - N **(Product Manager)**
- Teaching-by-Hand Spaying Robot **(Developer)**

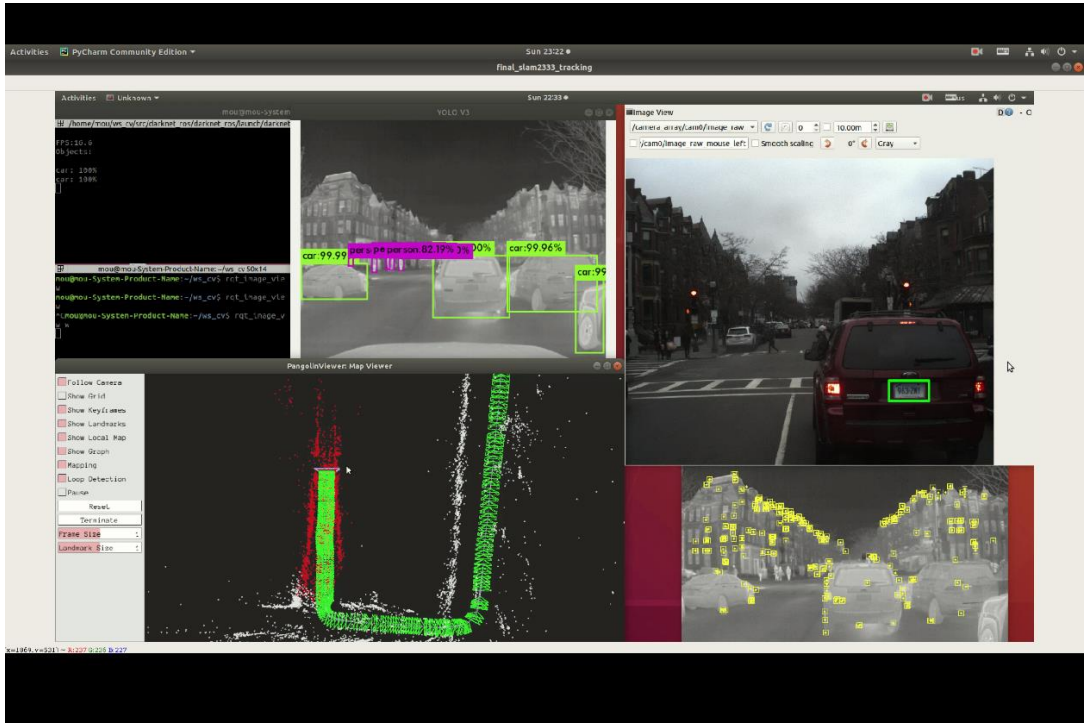
TP-LINK Product Line Development (Product Manager)

Product	Member	Design	HW	SW	Test	Manufacturing	Marketing
Monitor & Network Device	**Cross-functional Teams**	**√**	**√**	**√**	**√**	**√**	**√**
Product Website Link	• SW/HW • Designer • Buyer • Factory • Distributor	• Structure design • Product design	• PCB • Battery • Chip, etc.	• APP • UI • Monitoring system	• Safety certification • CCC/CE/ROHS/EMC • Structure test • Reliability test • SW & HW test • Materials test	• Plastics/sheet metal/labeling/electromechanical manufacturing • First Batch • Injection molding • Welding • Packaging	• Website design • Customer service • Sales forecast

- Created Security Monitor Product Line
- Launched 20+ new products into market, **achieved $1M monthly sales growth**
- Managed 50+ products, serving millions of consumers
- Optimized product design and productive processes, **lowering 15 % costs & ramping up 300% production in 1 month**

Monitor Camera

Monitor Recorder



Infrared Image SLAM Demo

TIME News of our Lab's research in Antarctic

Research Assistant in Field Robotics Lab

- **IR Application:** Developed IR SLAM System with Object Detection & Tracking for self-driving car at night
- **Drone Application:** Our Lab went to the Antarctic to count the number of Penguin with drones

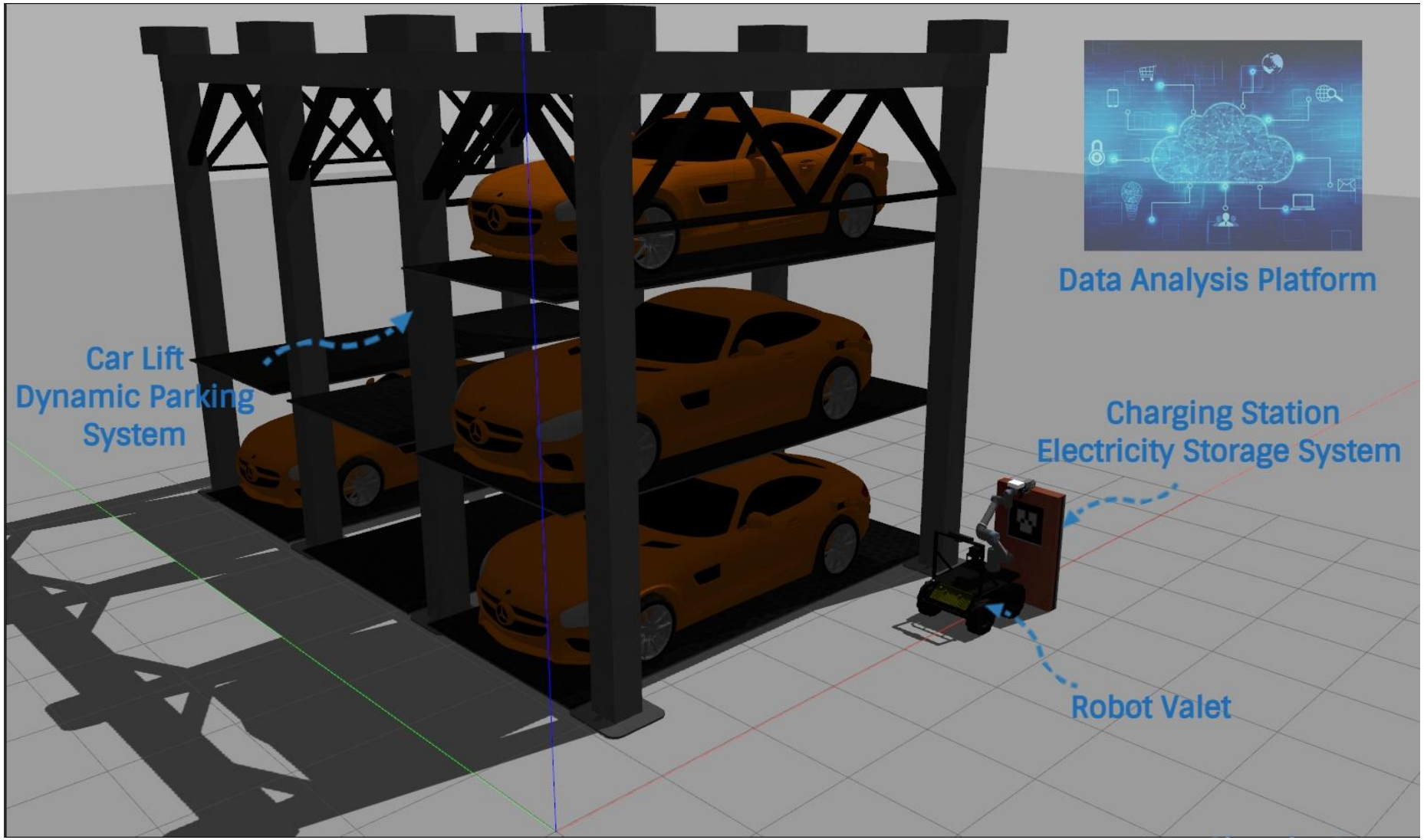
Charging Robot Program (Leader)

Product	Member	Design	HW	SW	Test	Manufacturing	Marketing
Robot	**10 people**	**√**	**√**	**√**	**√**		**√**
Github Link	• Engineers • MBA	• Mechanical structure	• Sensors • Batteries • Communication	• Simulation • Navigation • Manipulation	• Identify bugs • POC	• Prototyping	• Partnership with BP • Business pitch

- **Founded a team of 9 engineers to develop EV Fleet Auto-Charging Robot System from sketching to PoC**
- Provide deep automation to drive down costs, increase quality, availability and consistency of EV fleet charging

Charging Robot

ChargingBot System Components



Robot Valet

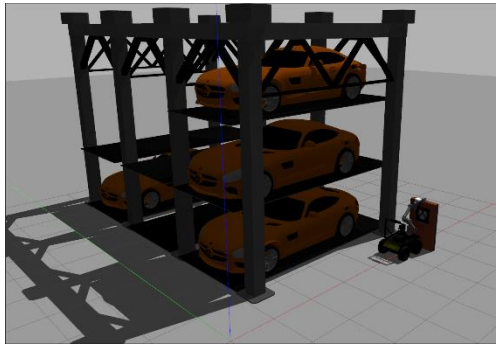
Dynamic Parking System

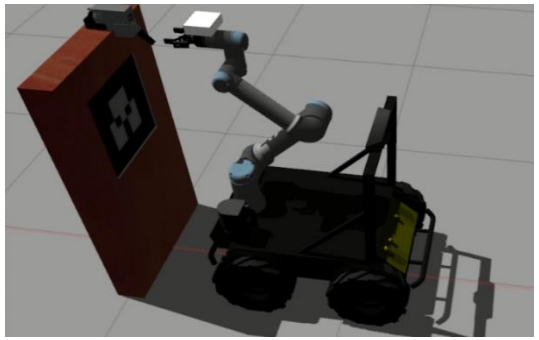
DC Fast Charging Station

PoC & Workflow in Simulation

- Developed robot Control System and Simulation Environment with ROS, SLAM and MoveIt
- Implement latest Reinforcement Learning and Computer Vision algorithms for agile manipulation

1





2

1. Car Lift

Car arrangement, identify charging type and flaps

2. Robot Valet

Navigate to charging station, pick up the connector

3. Robot Valet

Detect EV charging port and plug-in connector

4. Charging Station

Initiate and monitor charging process

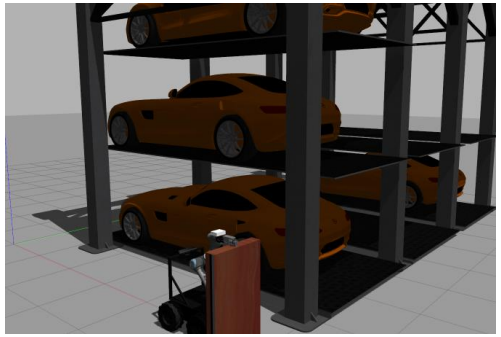
5. Robot Valet

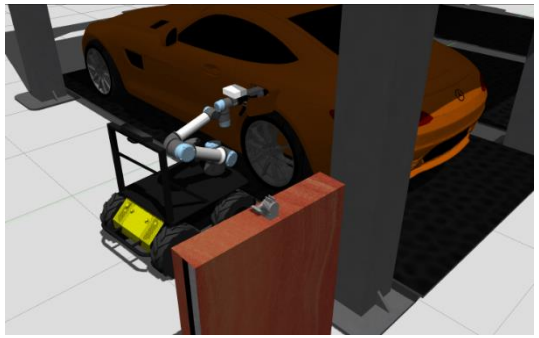
Retrieve connector from EV, close the flap

6. Analysis Platform

Inform EV owner and repeat these process

4





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Developed robotics for floral industry (Program Manager)

Product	Member	Design	HW	SW	Test	Manufacturing	Marketing
Floral Assembly Line	**Cross-functional Teams**	**√**	**√**	**√**	**√**	**√**	**√**
Website link	• Engineers • Buyers • Vendors	• ID • Structure design	• Robots • Sensors • Cooler	• Computer Vision • Manipulation	• Reliability test • POC	• Sourcing components • Manufacture	• Global trade

Youtube Link: FloraBot Investor Presentation Day

- **Led development of robotic assembly line to automate flower arrangement, lowing 80% labor costs**
- Worked with CEO and executive team to prepare business pitch & POC demo for investors

Developed robotics for floral industry (Program Manager)

- Built the Flower Vendor Machine with flower friendly robotics to achieve floral sales automation
- Pioneered 1st China-US fresh flower boat shipping trials, lowing cost of roses by 15%

Outdoor Flower Vendor Machine with Robot Arm

Florabot Intern Spotlight Award

Expended US market for MiracleTech Co. (Consultant)

Product	Member	Design	HW	SW	Test	Manufacturing	Marketing
Healthcare/Lighting	**10 people**	**√**	**√**	**√**	**√**	**√**	**√**
Website Link	• Factory • Designer • Seller	• Product design • Brand registration	• Battery		• CE/Rohs/MSDS • Phalate-free, etc. • Safety & Hygiene certification	• Injection molding • Label printing	• Amazon • Google SEO • Social Medium • KOL collaboration

Founded North American team and formulated operation strategies for Amazon, Shopify & eBay Store, collaborated with foreign distributors to expand global market, **grew it to $1M/year revenue and $300K/year profit in the US**

Lighting Product of MiracleTech Co.

Wearable Device for Parkinson Patients

Eliminate the tremors of Parkinson's patients and stabilize their hands for writing task

Assistive Writing Device for Parkinson's Patient

Jagatpreet Singh Nir, Mingda Ju, Xuyang Sun, Zimou Gao

ABSTRACT

Parkinson patients face a lot of difficulties in their daily lives. Due to some problems in their brains, they can't control their bodies properly.

Therefore, we decided to design a kind of wearable device that assists them to write. The device's function is to eliminate the tremors of Parkinson's patients and stabilize their hands for writing task, hoping to alleviate some problems in their lives.

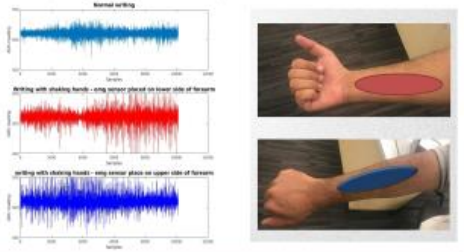
BACKGROUND

Motivations

- Parkinson Disease affects approximately seven million people globally and one million people in the United States [1]. The number of new cases per year of PD is between 8 and 18 per 100,000 person [2]. Therefore, such high incidence rates will inevitably cause a large burden to the patient's families and to the society as a whole.
- Although there are current devices that exist in the market and reported by media to help Parkinson's patients, their high price has discouraged many patients from buying them. So, we aim to build a wearable device using open source platforms and simple components, so that the device can be made available to a more number of patients.

Problem Analysis

- We imitated writing activities of the Parkinson patients and normal people and place the EMG sensor on different area of arms to detect muscular activities data, which is showed below.
- The Parkinson patients do want to control the involuntary torque produced by the forearm muscles, but this kind of behavior sets up a positive feedback loop which will continuously amplify the hand tremors of patients, intensifying the hand movements, making it very difficult for the patient to write.



REFERENCES

[1] de Lau LM, Breteler MM (June 2006). Epidemiology of Parkinson's disease. The Lancet. Neurology. 5 (6): 525{35. doi:10.1016/S1474-4422(06)70471-9.

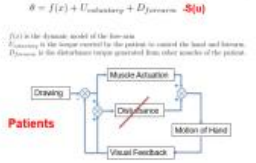
[2] Elbers RG, Verhoef J, van Wegen EE, Berendse HW, Kwakkel G (October 2015). Interventions for fatigue in Parkinson's disease. The Cochrane Database of Systematic Reviews (10): CD010925. doi:10.1002/14651858.CD010925.pub2. PMID 26447539

METHODS

Methodology

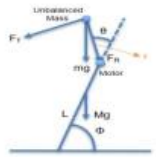
We cancel the involuntary torque produced by the patients' forearm, we can help them to write.

$$\theta = f(x) + U_{voluntary} + D_{forearm} \cdot S(u)$$



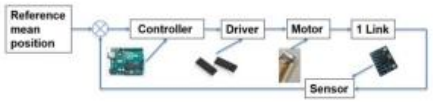
Dynamic Modeling

We used Newton Euler approach to develop the dynamic model of the one link pendulum to simulate the patients' tremors.



Simulation and experimental validation

We built a prototype to test the validity of our controller and understand the limitations of our simulation. Figure below shows the block diagram of major components of our prototype:



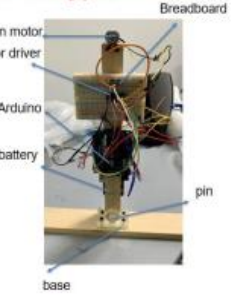
Emma Project's Picture
https://www.microsoft.com/en-us/research/project/project-emma/

RESULTS

Prototype Construction

We built a prototype which is shown above. The pendulum is pinned to the 3D printed base linkage. The base linkage is mounted to the wooden base using 4 screws. In the front, we have Arduino Uno which is our single board computer where control algorithms are run. The motor driver is mounted on the 400 pin breadboard. At the back, we have 9v battery to power the Arduino and 2 × 3V battery to power up the motor.

Introduce the prototype

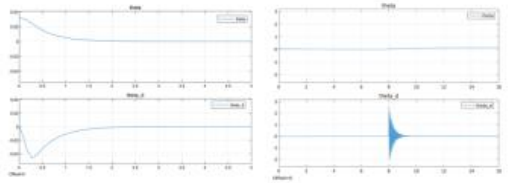


Parts Included In The Prototype

Item	Mass(gram)	Inertia(kg·m² × 10⁻⁶)
Arduino	27.22	4.6
Broadboar	86.18	36.22
MPU-6050	18.14	3.56
Motor	19.54	14.24
Battery(9v) and holder	43	2.1
Button cell and holder	5.27	0.64
Total	241.6	68.50

Simulation Result

A Simulation of one link pendulum that can be balanced by tuning the gains of the PD controller as well as a LQG controller.



CONCLUSIONS

- We have defined a design process for designing a Parkinson's assistive device which is based out of strong mathematical framework supported by simulation and experimental validation
- An extension to the 3D case requires more rigorous simulations, experimental testing and data collection with the actual PD patients
- The device cancels out the tremors of the patient to make motion of hand stable
- The device is light weight. It should not interfere with normal function of the limb
- The device is easy to wear and easy to switch on/off
- The device is operated on battery power, it needs to be energy-efficient

Poster

Teaching-by-Hand Spaying Robot (Developer)

Product	Member	Design	HW	SW	Test	Manufacturing	Marketing
Robot	**30+ people**		**√**	**√**	**√**		
Company Website Link	• Engineers • Factory		• Sensors • Communication	• Manipulation	• Safety certification • Reliability test • SW & HW test		

- Applied IMU calibration and compensation into Gesture Recognition device

Spraying Robot

Teaching-by-Hand

Thank you