

SIDEWALK DETECTION: E-SCOOTERS AND PEDESTRIANS CAN COEXIST

TECHIE PIZZA #44267

BACKGROUND & PROBLEM

Rental e-scooters are great because they...

- Get people out of single occupancy vehicles
- Are inexpensive and convenient to use
- Are environmentally friendly because they have no emissions

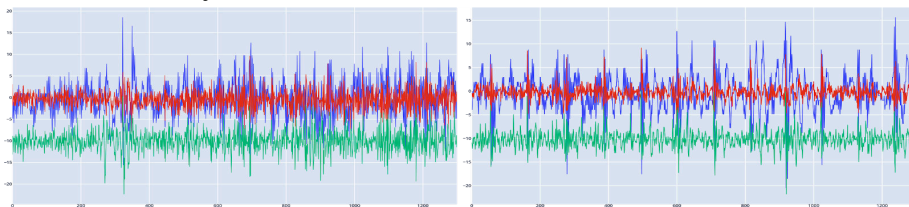
Rental e-scooters are a problem because they...

- Are illegally ridden on sidewalks
- Scare and injure pedestrians

As a result... Cities have banned and lost the benefits of e-scooters

SOLUTION & APPROACH

- Many solutions have been tested (tickets, warning signs, instructions in the rental app, geofencing, etc.)
- We developed software using an accelerometer and machine learning to identify streets (left) and sidewalks (right), using the vibrations caused by contraction joints.



- Slowing the scooter down, sounding beeps, and sending an alert to the user's phone through the e-scooter app encourages the user to avoid the sidewalk.



DEVELOPMENT

At first we planned to...	But we discovered that...
Use a color sensor, an accelerometer, and a GPS to determine whether the scooter is on the sidewalk or street.	Rental scooters already have an accelerometer, and it alone can accurately tell between sidewalks and streets.
Stop sidewalk riding with bear traps, releasing wasps & bees, and blasting annoying songs like Baby Shark.	This is dangerous or annoying to pedestrians; instead we slow the scooter, sound warnings, and send alerts to the user's phone.
Design and 3D print a simple enclosure for our prototype electronics using CAD.	Our first versions needed more height, air vents, and an indented section to avoid a large weld.
Use a simple convolutional neural network.	We needed more layers and lots of experiments for good results.
Label accelerometer data into groups of sidewalk, street, and eventually other surfaces.	People might be just standing with the scooter and we needed to add a label for this.

IMPLEMENTATION

- We collected data from many sidewalks and streets, labelled the data, and then trained an artificial neural network.
- Most rental scooters have an accelerometer already, and our software only needs 18,000 parameters which can fit on the small computers on rental scooters without additional cost
- Our solution is more than 99% accurate in our testing.
- Lime announced their sidewalk detection solution in January, achieving "up to 95%" accuracy. We had shared our data and approach with Lime in October.
- We shared our idea with San Jose City Council member Raul Perez. He said that the City would likely require scooter companies to have similar technology to be allowed to operate.

	Predicted		
	Sidewalk	Street	Standing
Sidewalk	500	0	0
Street	2	387	0
Standing	0	1	230

NEXT STEPS

We want to help solve the scooter sidewalk problem, so...

- We are open-sourcing our implementation!
- We are in contact with scooter companies about using this approach.

ABOUT US

We are a team of eight fourth, fifth, and sixth graders attending Oakwood School in Morgan Hill, California. Last year, some of us were on a FLLJr team, "Company 34," but this is our first year competing in FIRST LEGO League.

KEY SOURCES

- Mallory Moench, "This SF scooter company knows if you're riding illegally on a sidewalk. Here's how," *San Francisco Chronicle*, 1/28/20
- Morgan Romero, "Stop blocking Portland sidewalks with e-scooters: Disability rights group sends message," *KGW*, 10/22/19
- Evan Bell, "San Jose Considers New Safety Regulations for E-Scooters," *San Jose Inside*, 12/10/18
- Daren Weaver and Ari Levy, "The electric scooter deluge is dividing San Francisco," *CNBC*, 5/8/18
- "Singapore targets e-scooters after accidents," *The Asean Post*, 11/12/19
- Colleen Flaherty, "#betterposter: There's a Movement for Better Conference Posters," *Inside Higher Ed*, 6/24/19
- Jason Brownlee Ph.D., "How to Develop RNN Models for Human Activity Recognition Time Series Classification," *Machine Learning Mastery*, 11/24/18
- Jason Brownlee Ph.D., "A Gentle Introduction to a Standard Human Activity Recognition Problem," *Machine Learning Mastery*, 8/5/19
- Tarak Trivedi MD, et al., "Injuries Associated With Standing Electric Scooter Use," *JAMA Network Open*, 1/25/19

TOOLS

- **Python, Pandas, NumPy, SciPy, Jupyter Notebooks, Plotly, VSCode** - Tools for programming and data science
- **TensorFlow & Keras** - Google's tools for machine learning
- **Raspberry Pi** - Small, embedded computer
- **dRonin FlyingPi** - A small accelerometer and power supply "hat" for Raspberry Pi
- **AutoDesk Fusion360** - Mechanical computer aided design software
- **Git, GitHub** - Tools our coaches use to backup and version our work
- **RobotC** - Used to program the robot in the robot game
- **Microsoft Excel, Word; Google Docs, Sheets, & Slides**

CONTACTS

- **Mr. Raul Peralez**, San Jose District 3 City Council Member
- **Mr. Ralph Lyle**, Comp Sci/Math; Morgan Hill Planning Commissioner
- **Mr. Jeff Ota**, Mentor, Mechanical Engineer, Director of Innovation at Rivian
- **Mr. Tae Yoon Oh**, Lime Scooters
- **Mr. Larry Tom**, Biotechnology Management
- **Mrs. Helen Rhee**, Environmental Engineer
- **Mr. Frank Orlando**, Mechanical Engr, Coach of FLL Terminatorz #461
- **Mrs. Michelle Helvey**, Head of School at Oakwood School
- **Gabrielle De May**, Artist
- **Mrs. Dawn Lyle**, Coach, Mechanical Engineer
- **Mr. Michael Lyle**, Coach, Electrical Engineer

