UNLV | ECONOMIC DEVELOPMENT

Researcher Exchange Program UNLV & Fraunhofer IVI

Bo Bernhard

Brendan Morris

Six-Month Progress Report

Reporting Period: March 1, 2022 – August 31, 2022

October 1, 2022

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Scope of Work

Infrastructure Support for Connected Autonomous Vehicle Operation

Current autonomous vehicle systems are equipped with numerous sensors which provide high resolution view of the surrounding environment. However, the view is limited to a local surrounding area which can be limited by various environmental factors, such as occlusion from buildings or other nearby vehicles. The limit to environmental perception is particularly challenging when working with large vehicles (such as trucks or buses) in close contact (shipping yards or bus depots). Therefore, connected autonomous vehicles (CAVs), which communicate with infrastructure to remove "blind spots" are desired.

The project task is to develop infrastructure supported perception for fixed locations to provide more consistent field of view and environmental perception for safe operation of autonomous vehicles in constrained environments. The project will consider the following main components

- Selection of appropriate sensing technologies for constrained environments (including camera, radar, lidar, or ultrasonic)
- Development of robust object detection and recognition algorithms for road users (e.g. cars, trucks, buses, and pedestrians) given a sensor package
- Definition of communication scheme for safe CAV control at low speeds (communication protocol and data transmission definition)

The results will include hardware modules for object detection/tracking and communication with a CAV. The hardware will be installed on the UNLV campus for a demonstration. The tasks of the applicant are:

- Research existing solutions which are available at UNLV and Fraunhofer IVI and identify any gaps in existing solutions (e.g. examine Robot Operating System (ROS) technology versus road side units designed by Fraunhofer IVI in other projects).
- Design a CAV showcase to highlight the research environment and educational ecosystem at UNLV and to make the university attractive for potential industry partners in the field of automated vehicles and self-driving cars. The showcase definition will be performed in cooperation with Fraunhofer IVI during the first months.
- Identify gaps in existing capabilities to design and develop an environmental sensor to extend the field of view of a vehicle sensing to see around occlusion-based blind spots (e.g. corners).
- Develop the CAV showcase at UNLV incorporating gap topic insight.

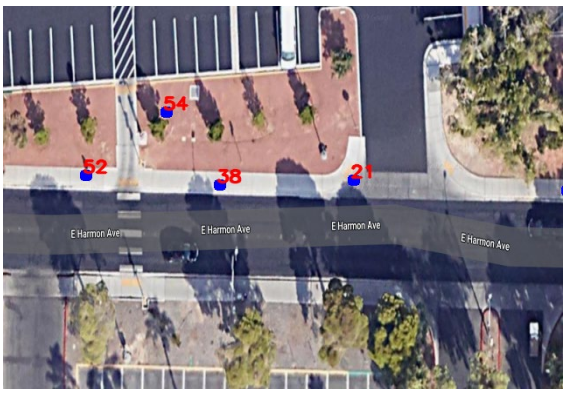
Section 1: Proposal Progress

Overview

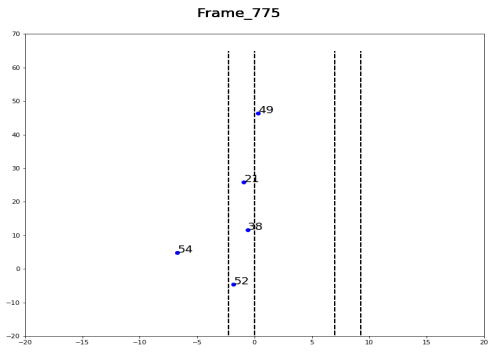
After Covid-19 necessitated changes in the project approach – reduced interaction with Fraunhofer – the project has focused on the demonstration of infrastructure support for automated vehicle operation through a pedestrian emergency braking scenario. The goal will be to safely brake for a pedestrian, either detected by the on-board vehicle sensors or through infrastructure sensing. The demonstration will consider a situation where a pedestrian will cross a street (Harmon St. on UNLV's campus) but cannot be detected by the CAV due to an occlusion (e.g. truck or banner). This is a dangerous situation for the pedestrian since the CAV will have no way to stop since it cannot see the pedestrian but will be able to recognize the crosswalk message from the infrastructure and automatically stop before the pedestrian becomes visible to the car. The bulk of work during the reporting period has been to i) fully develop the sensing (in-vehicle and infrastructure) ii) interface with the MKZ and provide longitudinal control, and iii) communicate infrastructure detections to the vehicle.

Major Accomplishment: Full Infrastructure Sensing System

Under the supervision of our postdoc, Arsal Syed, a fullu functional real-time framework was developed to detect and track pedestrians using the TraffiRadar (combo radar and camera sensor) on Harmon St. on UNLV's campus. The TraffiRadar streams video to a dedicated GPU server which runs a YOLO-based detector (pedestrians, cars, bikes) and DEEPSORT for tracking. Visual detections were mapped into real-world coordinates via a bird's-eye-view (BEV) transformation.

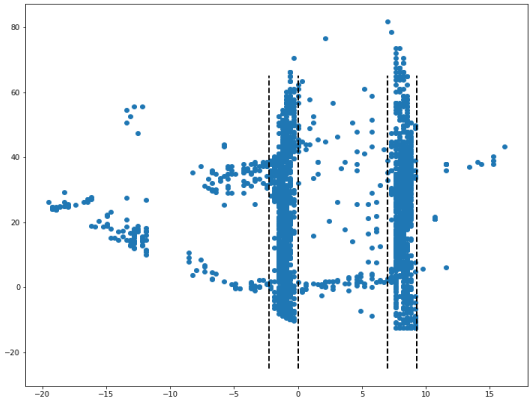


(a) BEV on Google Map [North ↑]

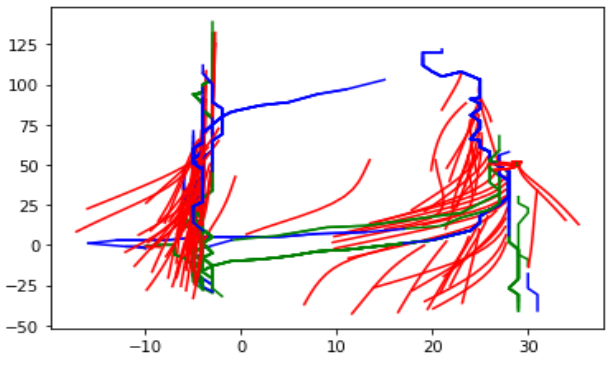


(b) BEV in world coordinates (meters) [North ←]

Detections were collected to build a training dataset for pedestrian trajectory prediction. The prediction can be used to provide advanced warning to a pedestrian intending to cross before setting food into the street.



(a) Raw pedestrian detection/tracks

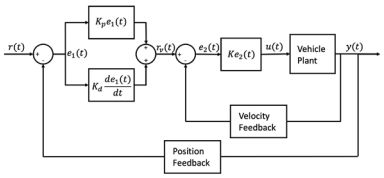


(b) Trajectory predictions (blue observed, red prediction, green ground truth)

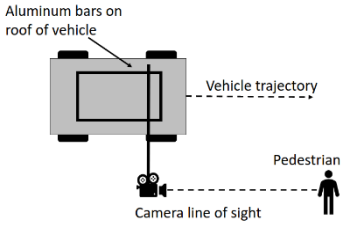
A Flask web service was created to provide real-time visualization in a web browser.

Major Accomplishment: Vehicle Sensing and Control

M.S. student Zillur Rahman has lead development of in-vehicle sensing, vehicle interfacing, and control. He has implemented monocular 3D detection to detect pedestrians and locate their positions for both RGB and thermal IR cameras. He has worked through the MKZ sensing package documentation and was able to verify operation of all the systems including vehicle CAN messages through the Dataspeed controller, GPS and IMU, Lidar, and Radar signals. The vehicle interface utilizes the Robot Operating System (ROS), which is a standard in the research community, due to extensive driver support. During the 2022 Summer, he worked closely with Steven Nguyen, a B.S. student in Mechanical Engineering from the University of California, Santa Barbara, to develop the pedestrian braking control algorithm. This PD longitudinal controller, uses the distance to a pedestrian in front of the vehicle to initiate emergency braking and is designed to stop a set safety distance away (4 m). The controller was tested first in ideal conditions in a simulator before realistic sensor noise was added to the simulation. After tuning the controller, it was written into ROS and implemented into the car. An extendible arm was placed on top of the car to side-mount a camera on the car in order to test the algorithm without having a person in front for safety. Initial test show that the vehicle is able to reliably stop within the safety margin but improvements are required to provide more natural braking response (less jerk).

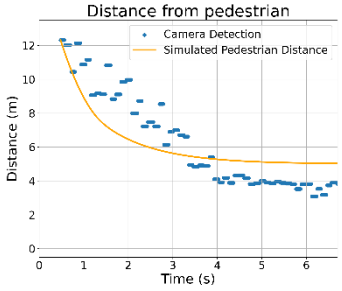


(a) Longitudinal controller

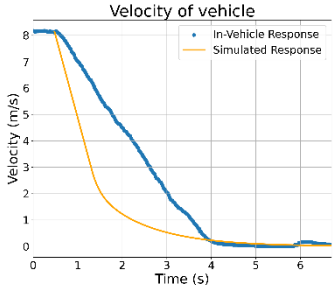


(b) Diagram of pedestrian test

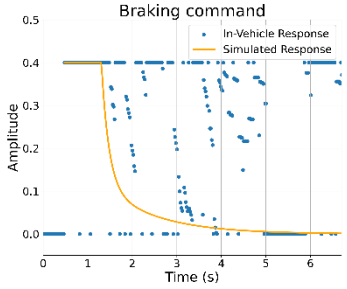
(c) Real vehicle setup



(d) Distance comparison



(e) Velocity comparison



(f) Brake comparison

Major Accomplishment: Infrastructure-Vehicle Communication

While the original plan was to use a V2X RSU/OBU for communication, there were difficulties obtaining the equipment. Instead, the team relied on MQTT, a popular IoT communication protocol, for the demonstration due to prior experience. The MQTT protocol is a lightweight publish-subscribe model that facilities real-time data transmission. Any number of messages can be transmitted, such as position of all vehicles and pedestrians, however, we are currently only providing a single flag to indicate if a pedestrian is in the crosswalk. This is used as an indicator for the vehicle to initiate braking if within the stopping area around the crosswalk. Future improvement will utilize the predicted position and time to stepping off the curb to provide more safety margin for braking. The MQTT communication is implemented through a cellular hotspot in the vehicle and a directly subscribing to the crosswalk messages. While the hotspot does not utilize more traditional V2X protocols, it provides flexibility during development and testing.

Additional Accomplishments

Proposals

The UNLV team has been actively seeking ways to leverage the KF to secure additional funding through various mechanisms and submitted five in the last six months (16 total):

- NSF NRT: Collaborative Research: NRT-HDR: Building Data-Enabled Engineering Pipeline through a Career-Oriented training Model for PAthway to Sustainable Success (DATA-COMPASS) [$2.4M] – graduate training grant focusing on data engineering
- This project was part of four DOT University Transportation Center Grants
    - Tier1 UNR, Active Pedestrian and Vulnerable Road User Safety [$150k/year] – Focus: Safety
    - Tier1 Howard, UTC: Research and Education in Promoting Safety (REPS) [$450k/year] – Focus: Safety
    - Regional USC, Pacific Southwest Regional UTC [$190k/year] – Focus: Equity
    - National UNLV, Center for Proactive, Resilient, Equitable, and Sustainable Transportation (PRESET) [$4M] – Focus: Transformation

Awards

In August we received a $539k award from NSF titled "MRI: Acquisition of Connected Autonomous Vehicles (CAV) Infrastructures to Support Cooperative Human-Robot Driving and Pedestrian Safety". The award will provide funding to support i) the upgrade of the MKZ platform to include state-of-the-art sensing (lidar, camera, radar), ii) add hybrid camera + radar infrastructure sensing to three intersections around campus, and iii) hardware for V2X communication from infrastructure to vehicles.

Publications

One publication focusing on rapid development of the emergency braking system was submitted to a conference this period as a collaboration between the summer NSF REU participant Steven Nguyen and UNLV graduate student Zillur Rahman.

- Steven Nguyen, Zillur Rahman, Brendan Tran Morris, "Pedestrian Emergency Braking in Ten Weeks", in ICVES, 2022, in submission.

Commercialization/Partnering

No new partnerships were developed during this period. However, we received a donation of a Codha Wireless DSRC OBU from Lyt.AI.

Intellectual Property

As of August 31, 2022, no considerable intellectual property was created.

Programmatic & Project Changes

While there are no new programmatic or project changes, we plan to request a no-cost extension through 2023. Due to prior changes to the researcher exchange program which was not possible due to Covid, the budget allows for more postdoc and student time through 2023. With an extension, we plan to extend the pedestrian safety demo – longitudinal control – to include lateral control (lane keeping) as well. The expectation is to be able to navigate safely on a set loop on UNLV's campus perimeter in an autonomous mode.

Prior Period Assessment

A summary of goals in the previous period and status are provided below:

- Complete all additional sensor purchases (V2X communication) and integrate into MKZ using fixed mounting solutions that are environmentally protected – incomplete. There were issues sourcing the Commsignia dual-mode DSRC/C-V2X OBU from the local supplier. We did obtain a donation of a Codha Wireless DSRC OBU from Lyt.AI.
- Recruit Ph.D. student for Fall 2022 – incomplete. No Ph.D. student was identified. Recruitment is on-going for the Spring 2023 semester.

- Host one student as part of the NSF REU program to work on the MKZ control – completed. Steven Nguyen, mechanical engineering undergrad from the University of California, Santa Barbara, was hosted from June to August and developed longitudinal and lateral control algorithms.
- Develop vehicle control through on-board computer – completed. Zillur Rahman and Steven Nguyen worked together over the summer 2022 to integrate the longitudinal controller on the vehicle using the Dataspeed CAN interface and ROS.
- Use V2X equipment to transmit infrastructure messages to vehicle – partially completed. Due to issues sourcing the V2X equipment, we developed a short-term work around by using a wireless hotspot and MQTT messaging for communication between infrastructure and the vehicle.
- Request a no-cost extension to the project and recruit another Postdoc position – partially completed. We spoke with Karsten Heise about the possibility of an extension and it was agreed that the request should wait until closer to the end of the project to have a more accurate picture of progress.

Looking Forward

The six month (September 2022 – February 2023) goals are to:

- Request a no-cost extension of the project through December 2023.
- Recruit one postdoc for 2023.
- Recruit one Ph.D. student to start in Spring 2023.
- Upgrade MKZ with new sensor suite.
- Purchase V2X equipment and mount on vehicle in environmentally protected housing.
- Add lateral control to test vehicle through lane detection.

Section 2: Performance

GOED Metrics

GOED Metrics	8/19/2019 8/31/2019	…	9/1/2020 2/28/2021	3/1/2021 8/31/2021	9/1/2021 2/28/2022	3/1/2022 8/31/2022
number of **Companies Moved to NV** as a result of REP	0	…	0	0	0	0
number of **Start-Ups Created** as a result of REP	0	…	0	0	0	0
number of **Jobs Created** as a result of REP	0	…	0	0	0	0
intellectual property - **IP Licenses**	0	…	0	0	0	0
intellectual property - **IP Revenue**	0	…	0	0	0	0
number of **Research Grants Awarded** to REP team	0	…	2	2	3	4
amount of **Research Funding Received** by REP team	0	…	$1.36M	$1.79M	$1.79M	$2.33M
number of **Sponsored Research Contracts** executed	0	…	1	1	2	3
number of **Patent Applications** filed	0	…	0	0	0	0
number of **Issued Patents**	0	…	0	0	0	0
number of **Student Internships**	0	…	9	12	13	14
number of **Students Placed** with companies	0	…	0	0	0	0
number of **Faculty/Staffs Hired**	1	…	3	3	4	4
amount/value of **Gifts/Donations Received**	0	…	0	0	0	$5k

Detailed Performance Information

Number of Companies Moved to NV as a result of REP
As of August 31, 2022, none.

Number of Start-Ups Created as a result of REP
As of August 31, 2022, none.

Number of Jobs Created as a result of REP
As of August 31, 2022, none.

Intellectual property - IP Licenses
As of August 31, 2022, none.

Intellectual property - IP Revenue
As of August 31, 2022, none.

Number of Research Grants Awarded to REP team
As of August 31, 2022, four.

16 proposals submitted:

- Nov 2018 Nevada NSF EPSCoR RII Track-1 Program Pre-Proposal on "Infrastructure Improvement for Research and Education in Self-Driving Automobiles"
- Mar. 2019 Thomas Jefferson Fund on "IoT and Edge Vision for Connected Autonomous Vehicle (CAV) Environment Perception"
- Mar. 2019 USDOT Automated Driving System Demonstration Grants on "NAVIGaTE Program"
- Aug. 2019 NSF Research Experiences for Undergraduates on "REU SITE: Smart Cities – Intelligent, Safe, and Secure Mobility"
- Aug. 2020 City of Las Vegas "City Of Las Vegas Connected Intersections and Connected / Automated Vehicles"
- Aug. 2020 US DOT ATCMTD "Integrated Safety Technology Corridor"
- Dec. 2020 NSF AI Institute "Artificial Intelligence in Transportation-Autonomous Infrastructure Networks" with Missouri S&T, University of Nevada, Reno, Georgia Tech.
- Jan. 2021 NSF Major Research Instrumentation "MRI: Acquisition of a GPU Cluster for Multi-Disciplinary Research and Education at UNLV"
- Mar. 2021 NSF REU Site Supplement, $118k
- Jan. 2022 NSF "MRI: Acquisition of Connected Autonomous Vehicles (CAV) Infrastructures to Support Cooperative Human-Robot Driving and Pedestrian Safety", $539k
- Feb. 2022 FACE Foundation Thomas Jefferson Fund "IoT and Edge Vision for Connected Autonomous Vehicle (CAV) Environment Perception", $10k, collaboration with EFREI Paris
- Aug. 2020 US DOT, Tier1 UNR, Active Pedestrian and Vulnerable Road User Safety [$150k/year] – Focus: Safety
- Aug. 2020 US DOT, Tier1 Howard, "UTC: Research and Education in Promoting Safety (REPS)" [$450k/year] – Focus: Safety
- Aug. 2020 US DOT, Regional USC, "Pacific Southwest Regional UTC" [$190k/year] – Focus: Equity
- National UNLV, "Center for Proactive, Resilient, Equitable, and Sustainable Transportation (PRESET)" Aug. 2020 US DOT, [$4M] – Focus: Transformation
- Sep. 2022 NSF NRT, "Collaborative Research: NRT-HDR: Building Data-Enabled Engineering Pipeline through a Career-Oriented training Model for PAthway to Sustainable Success (DATA-COMPASS)" [$2.4M] – graduate training grant focusing on data engineering

Amount of Research Funding Received by REP team
As of August 31, 2022, $2.33M.

- $405k; Mar. 5, 2020; NSF Research Experiences for Undergraduates on "REU SITE: Smart Cities – Intelligent, Safe, and Secure Mobility".
- $955k; Dec. 2020 US DOT ATCMTD "Integrated Safety Technology Corridor" (UNLV share of full $15M to RTC-SN), awaiting contracting
- $432k; Aug. 2021 NSF MRI: Acquisition of a GPU Cluster for Multi-Disciplinary Research and Education at University of Nevada, Las Vegas (high performance computing for deep learning)
- $539k, Aug. 2022 NSF MRI: Acquisition of Connected Autonomous Vehicles (CAV) Infrastructures to Support Cooperative Human-Robot Driving and Pedestrian Safety

Number of Sponsored Research Contracts executed by REP team
As of August 31, 2022, three.

- Mar 30, 2020; NSF Research Experiences for Undergraduates on "REU SITE: Smart Cities – Intelligent, Safe, and Secure Mobility".
- Feb 24, 2022; NSF MRI: Acquisition of a GPU Cluster for Multi-Disciplinary Research and Education at University of Nevada, Las Vegas (high performance computing for deep learning)
- Sep 26, 2022; MRI: Acquisition of Connected Autonomous Vehicles (CAV) Infrastructures to Support Cooperative Human-Robot Driving and Pedestrian Safety

Number of Patent Applications filed
As of August 31, 2022, none.

Number of Issued Patents
As of August 31, 2022, none.

Number of Student Internships
14 total

- Mr. Arsal Syed, PhD candidate Spring 2021 – Fall 2021 semesters for deep-learning based pedestrian trajectory prediction.
- Ms. Yuria Mann, January - May 2021 to develop deep-learning based environment perception.
- Mr. Zillur Rahman, MS student starting Spring 2022 semester for vehicle sensing and control.

11 summer interns

- 3 (Summer 2019): Mr. Gauthier Contat, Mr. Pierre Gumila, and Mr. Sebastian Michel brought in Summer 2019 to support deep learning-based pedestrian detection, motion-based object detection, and ROS DriveKit control respectively.
- 4 (Summer 2020): Mr. Navaneeth Suresh, Mr. Arindam Biswas, Mr. Taapas Argawal, and Mr. Biswajit Ghosh – joint BS-MS students from India that worked a remote summer internship to work on the trajectory prediction problem
- 3 (Summer 2021): Mr. Colin Saumure and Jaden Hardy for Summer 2021 as part of Faith Lutheran High School STEM Internship to work on trajectory prediction and V2X communication. Dinh Hoang came to UNLV through the NSF Research Experience for Undergraduates (REU): Smart Cities program to work on computer vision for environmental perception.
- 1 (Summer 2022): Steven Nguyen, UCSB, was part of the NSF: Smart Cities site to develop a longitudinal control algorithm for the MKZ vehicle. His controller was implemented, tested, and a publication submitted to a conference (2022 IEEE International Conference on Vehicular Electronics and Safety).

Number of Students Placed with companies
As of August 31, 2022, none.

Number of Faculty/Staffs Hired
4 total

- Hiring of Mr. Christopher Kappes in June 2018 at Fraunhofer IVI and in August 2018 at UNLV.
- Hiring of Mr. Marc Dinh for lightweight deep learning in June 2019.
- Hiring of Dr. Paritosh Parmar for autonomous vehicle simulation and algorithm development in Autoware
- Hiring of Dr. Arsal Syed in Dec. 2021 as postdoc to act as technical lead for demonstration.

Amount/value of Gifts/Donations Received by REP team
As of August 31, 2022, $5000.

- Lyt.AI donated a Codha Wireless DSRC OBU.

Section 3: Budget

Company: University of Nevada, Las Vegas
Period: FY 2023 - 02 August
Worktags: Grant: GR07095 UNLV-Fraunhofer IVI Collaboration

Ledger Account Summary	Original Budget	Budget Amendments	Current Budget	Current Period Actuals	LTD Actuals	Obligations	Commitments	Actuals + Obligations + Commitments	Remaining Budget	Percent Remaining
Direct Expenses										
Personnel Expenses	$24,938.00	$298,334.41	$323,272.41	$9,280.01	$179,135.52	$28,898.36	0.00	$208,033.88	$115,238.53	35.65%
Professional Salary	$18,750.00	$187,113.30	$205,863.30	$4,583.34	$119,762.14	$18,333.36	0.00	$138,095.50	$67,767.80	32.92%
Graduate Salary	0.00	$53,962.00	$53,962.00	$3,000.00	$26,708.34	$4,500.00	0.00	$31,208.34	$22,753.66	42.17%
Hourly Wage	0.00	$6,275.00	$6,275.00	0.00	$5,455.00	$0.00	0.00	$5,455.00	$820.00	13.07%
Fringe Benefit Expense	$6,188.00	$50,984.11	$57,172.11	$1,696.67	$27,210.04	$6,065.00	0.00	$33,275.04	$23,897.07	41.80%
Other Direct Expenses	0.00	$176,727.59	$176,727.59	$1,499.55	$152,981.01	$0.00	$0.00	$152,981.01	$23,746.58	13.44%
Travel Expenses	0.00	$4,887.80	$4,887.80	0.00	$2,887.80	0.00	$0.00	$2,887.80	$2,000.00	40.92%
Materials and Supplies	0.00	$13,487.89	$13,487.89	$1,146.37	$6,109.25	$0.00	$0.00	$6,109.25	$7,378.64	54.71%
Services	0.00	$7,007.00	$7,007.00	$353.18	$4,022.21	$0.00	0.00	$4,022.21	$2,984.79	42.60%
Tuition and Fees Expense	0.00	$12,238.00	$12,238.00	0.00	$5,332.50	0.00	0.00	$5,332.50	$6,905.50	56.43%
Capital Equipment	0.00	$139,106.90	$139,106.90	0.00	$134,629.25	$0.00	$0.00	$134,629.25	$4,477.65	3.22%
Total Direct Expenses	$24,938.00	$475,062.00	$500,000.00	$10,779.56	$332,116.53	$28,898.36	$0.00	$361,014.89	$138,985.11	27.80%
Facilities and Administration Expense	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00%
Total Direct & Indirect	$24,938.00	$475,062.00	$500,000.00	$10,779.56	$332,116.53	$28,898.36	$0.00	$361,014.89	$138,985.11	27.80%

Budget Expended to Date

$ 361,014.89, 62.2% for period ending August 31, 2022

Section 4: Monthly Logs

2022 – September

- Developed MQTT messaging (IoT communication protocol) for V2X communication. Sends message of pedestrian presence in crosswalk which can be received by MKZ.
- Plan for Harmon pedestrian crosswalk testing – trigger braking from MQTT message rather than from detection.
- Computed ROS odometry and fused with IMU for accurate vehicle pose and velocity info
- Need to update hotspot to unlimited data

2021 – August

- Continued testing emergency braking with pedestrian cutout. Improved pedestrian distance estimates with smoothed monocular 3D position and lidar detection.
- Still working on lane detection as it does not work well on campus with Bott's Dots.
- Submit paper to IEEE International Conference on Vehicular Electronics and Safety (ICVES) – Nguyen, Rahman, Morris, "Pedestrian Emergency Braking in Ten Weeks", in ICVES, 2022, in submission.

2022 – July

- LSTM-AE used for pedestrian crossing prediction
- Found RTK-GPS system is not working and was able to fix with support from Hexagon/AutonomuStuff
- FLIR ADK IR camera tested in-vehicle with pedestrian detection trained on FLIR's public dataset
- Testing of longitudinal control – Matlab simulation and in-vehicle
- Develop lateral control algorithm for lane keeping
- Exploring lane detection and free space estimation algorithms for lateral control

2022 – June

- Initiated TMobile Hotspot purchase for V2X communication
- Updated MKZ computer with GPU for real-time in-vehicle detection
- Pedestrian distance measurement implemented in ROS
- Explored Gazebo and Carla as simulators for data collection and control algorithm testing
- Setup database to store pedestrian detections and trained pedestrian trajectory prediction
- Purchased Kvaser CAN2USB adapter to interface with radar and sensors
- Able to visualize radar and lidar data.
- GPS and IMU tested and integrated into ROS code
- Developed longitudinal control algorithm for pedestrian emergency braking

2022 – May

- Two of three UNLV teams travelled to Cluj, Romania to take part in the qualification rounds for the Bosch Future Mobility Challenge. 23 out of 53 teams made it to the in-person qualifications.
- Obtained quotes from Iteris and Commsignia for V2X equipment
- Updated BEV visualization for live YOLO detection and DEEPSORT tracking overlay
- Installed Dataspeed CAN tool driver for electronic control of car messages – ability to turn on turn signals based on pedestrian detection

2022 – April

- Received donation of Codha Wireless DSRC radio from Lyt.AI
- Collected Harmon pedestrian dataset to train trajectory prediction algorithm
- Created bird's-eye-view (BEV) images by converting video detections into world coordinates and map
- Used Robot Operating System (ROS) to retrieve vehicle CAN messages (velocity, yaw rate, etc.)
- Installed ROS packages for Delphi ESR radar and Ibeo Lux sensors.
- Setup Flask service for real-time detection and tracking visualization in web browsing

2022 – March

- Started work on monocular 3D detection and visualization
- Created new settings for TraffiRadar video sensor on Harmon St. on UNLV campus
- Began background investigation into MKZ sensor package

2022 – February

- Zillur completed YOLOv5 based 2D object detection.
- Installed front and rear dashcam in MKZ
- Started exploration into monocular 3D object detection.
- Purchased FLIR ADK
- FY contract extended until Dec 2022 for Arsal Syed.
- Explored Autoware.Auto stack for AV platform.
- Submit collaboration proposal with EFREI Paris to develop edge computing sensors for CAVs.

2022 – January

- Returned back to campus to restart in-person operations.
- Repaired vehicles (MKZ and Pacifica). The Pacifica was broken into and needed to have its window fixed and batter replaced. The MKZ had to be manually opened and batteries recharged.
- Zillur began YOLOv5 implementation for project onboarding
- Researched FLIR ADK thermal cameras – determined appropriate field of view and connection type (USB vs. GSML)
- Submit NSF MRI to augment the MKZ platform with more sensors and add more intersections to the connected infrastructure.

2021 – December

- Official start for Arsal Syed as Postdoc.
- Submission of trajectory prediction paper to Machine Vision and Applications Journal
- Opened application portal for Summer NSF REU program

2021 – November

- Finalized paper work for postdoc position and hire.
- Completed experiments for journal paper on trajectory prediction using semantic segmentation.
- Offer GA position to Zillur Rahman
- Began planning for summer NSF REU program

2021 – October

- Postdoc paperwork regarding budget, search waiver, position listing.
- Video conference with Zillur Rahman, Amir Sharifi potential graduate students
- Mentor three teams for Bosch Future Mobility Challenge 2022

2021 – September

- Began process to hire Dr. Arsal Syed as postdoc.
- Recruitment of students.
- Served as (remote) judge for Bosch Future Mobility Challenge – 1/10 scale AV competition hosted by Bosch Engineering Center Cluj, Romani

2021 – August

- Corrected title transfer papers with Hexagon/AutonomouStuff
- NSF REU Poster Session in collaboration with UNLV Office of Undergraduate Research. Dinh Hoang presented on real-time object detection for color and IR cameras and panoptic segmentation for MKZ.
- Award: MRI: Acquisition of a GPU Cluster for Multi-Disciplinary Research and Education at University of Nevada, Las Vegas
- Implemented Real-Time Panoptic Segmentation (Toyota) and YOLO detection on MKZ.
- YOLOR implementation for detection - 25 fps

2021 – July

- Al Mansur was not able to take the UNLV position due to immigration issues. Terminated within UNLV Workday system.
- Trained YOLOv5 for object detection with thermal IR roadway dataset – runs at 25-50 fps.
- Trained models for panoptic segmentation (Panoptic DeepLab – 1 fps, EfficientPS- 0.6 fps)

2021 – June

- MKZ licensed in Nevada, issue with title paperwork needed to be corrected

- Dinh Hoang brought to UNLV as part of the NSF REU: Smart Cities program to work on real-time environmental perception in the MKZ during Summer 2021.
- Trained YOLOv5 object detection for roadway objects on NuImages dataset – runs at 24-54 fps.
- Two high school student interns came to the lab for Summer 2021 as part of Faith Lutheran STEM Internship. They worked on augmenting scene information for trajectory prediction and V2X-MQTT communication for arterials.

2021 – May

- Arsal Syed hired as Ph.D. research assistant for Summer 2021 working on pedestrian trajectory prediction.
- Started long-term pedestrian prediction with inverse reinforcement learning

2021 – April

- AutonomouStuff MKZ Platform training completed remotely.
- Autoware: compiled ROS publisher node with OpenCV
- Completed contract update for Paritosh Parmar
- Finished IV2021
- Re-confirmed Al Mansur's interest in position and timeline for arrival

2021 – March

- Hexagon Purchase Order finalized with 20% prepayment and addition to UNLV vendor list
- Received MKZ autonomous vehicle platform
- Submit NSF REU supplement to add NSF S-STEM scholars to summer program
- Offer to Al Mansur re-initialized in WorkDay

2021 – February

- Web conference with Hexagon (AutonomouStuff) for legal discussion on platform agreement
- Hexagon MKZ Platform agreement signed
- Finalized documentation (platform agreement, insurance, approvals) for MKZ
- Restarted hire and offer letter for Al Mansur

2021 – January

- Submit proposal with AV as project within NSF MRI (PI Mingon Kim, CS)
- Application period and recruitment for NSF REU: Smart Cities project
- Begin work with undergraduate researcher Yuria Mann – training on deep learning for environment perception through semantic segmentation

2020 – December

- AutoWare: Implementation of lane detection pipeline in ROS publisher-subscriber nodes
- Contract of Paritosh Parmar expired – updated time-in/time-out record keeping
- Submit proposal for NSF AI Institutes as a subawardee to Missouri S&T

2020 – November

- Autoware: compiled ROS publisher node with OpenCV
- Completed contract update for Paritosh Parmar
- Finished IV2021
- Re-confirmed Al Mansur's interest in position and timeline for arrival

2020 – October

- Dr. Morris served as General Chair for the IEEE Intelligent Vehicles Symposium (IV2021) (scheduled for Las Vegas but moved to virtual).
- Initiated AutonomouStuff Lincoln MKZ purchase – competitive exception review
- Updated temporary employee contract to meet mandatory minimum rate (Paritosh Parmar)
- Morris and Parmar attended the AutoWare Tutorial at IV2021

2020 – September

- Received quote for DSRC and C-V2X OBU from Codha
- Errors in Autoware installation resolved with assistance from developer
- Real-time scene was successfully simulated in Autoware Auto

- Perception module in the processing pipeline was able to receive raw data for further processing
- Scene object detection successful

2020 – August

- Contributed to US DOT ATCMTD grant (Integrated Safety Technology Corridor) led by RTC with collaborators (Nevada DOT, Nevada Highway Patrol, Waycare) $15M total
- Submit project proposal (City of Las Vegas Connected Intersections and Connected / Automated Vehicles) to City of Las Vegas
- Final quote for MKZ platform + sensor
- Filed UNLV Competitive Exception for MKZ Purchase
- Worked on Budget Adjustment with GOED – adjustments for limited time for Research Engineer and switch to PhD student
- Basic Autoware project for loading and displaying recorded Lidar data was started
- A number of errors were corrected – remote display and Autoware Conda environment variables

2020 – July

- Paritosh Parmar onboarded to project
- Received quote for dual-mode DSRC/C-V2X onboard unit
- Exploration of Autoware platform for automated vehicle platform (real and simulation)
- Autoware Auto platform was selected over Autoware AI
- Autoware computer with Ubuntu 18.04 was setup for remote access
- Autoware Auto and dependencies installed, though they contained errors

2020 – June

- Received quotes for full Lincoln MKZ platform from Hexagon/AutonomouSuff
- Received quote for MKZ sensor package (IMU, Radar, Lidar)
- Identified Paritosh Parmar for contingency support for AV platform development

2020 – May

- Hiring freeze lifted – offer letter to Al Mansur
- Personnel planning – replacement for Marc Dinh and inability to hire Al Mansur due to Covid-19
- Develop plan for restarting research on campus

2020 – April

- UNLV hiring freeze – submitted exception for Al Mansur
- Received hardware quotes from Hexagon/AutonomouStuff for Pacifica drive-by-wire solution and FLIR thermal camera

2020 – March

- Research Engineer position created in UNLV Workday
- Notification of NSF REU Sites award
- On-campus research stopped due to Covid-19
- Exploration of Kia models for completion of Polysync contract – none available

2020 – February

- Al Mansur not eligible for Postdoc, position changed to Research Engineer and process restarted
- Search NV State contracted auto dealers for sourcing of DriveKit compatible vehicle
- Interview summer internship candidates

2020 – January

- Vision-based lane keeping control algorithm development based on LaneNet
- Postdoc salary exemption and approval
- Meeting with New Eagle and AutonomousStuff at CES to discuss options for Pacifica Platform

2019 – December

- Contract extension for Marc Dinh.
- Begin contracting for Postdoctoral Scholar position for Al Mansur, prepare documentation and Search Waiver
- Contact New Eagle for Pacifica Drive by Wire (DBW) Kit

2019 – November

- TensorFlow Lite algorithm development for AV environmental perception (lane segmentation and object recognition)
- Work with Hertz to locate Kia Soul (could not guarantee correct model)

2019 – October

- UNLV Risk Management recommends purchase of Kia vehicle or rental
- Search for Kia Niro and Soul EV rental availability in Las Vegas.
- Complete NV State fuel program

2019 – September

- Identify alternate Kia Soul sourcing since PolySync no longer had access to Niro due to delay with UNLV legal.
- Follow-up with postdoc candidates as replacement for Mr. Kappes at UNLV.
- Lidar sensor quotes from Ouster

2019 – August

- Setup UNLV fuel account for Pacifica.
- Purchase Nvidia Jetson devices for low-cost low-power sensor processing.
- Brendan Morris visit to Fraunhofer IVI for collaboration meeting – identify final candidate for postdoc position.

2019 – July

- Develop highway lane detection/segmentation neural network.
- Present UNLV Legal and Risk Management PolySync DriveKit sourcing issue.
- Update IP address and IT troubleshooting for FLIR systems to improve network performance.
- Skype interviews with four computer vision Postdoc candidates – Fraunhofer to UNLV.

2019 – June

- Complete Pacifica documentation for title and registration.
- Develop motion-based object (pedestrian/vehicle) detection algorithm.
- Develop deep learning-based object detection algorithm.
- Evaluate and comparison of detection algorithms.
- Begin DriveKit ROS simulation.

2019 – May

- Develop remote video data collection application for FLIR TrafiSense and TrafiRadar systems.
- Purchase Chrysler Pacifica.
- Purchase PolySync DriveKit drive-by-wire platform.

2019 – April

- Campus site and demonstration planning.
- Completion of AV sensor evaluation.

2019 – March

- TrafiRadar height adjusted for improved vehicle tracking and speed logging.
- Completed Arduino event wireless communication enclosures and mounting. TODO: finalize testing of TI-xStream communication via Arduino devices.
- Rumble Strip operational testing
- Develop first draft of Rumble Strip paper for Advances in Mechanical Engineering: Special Collection: Vulnerable Road User Safety and Intelligent Transportation Systems (Deadline May 31, 2019).
- Begin quote process for autonomous test platform including vehicle control and sensing capabilities.
- US DOT Automated Driving System Demonstration Grants proposal titled "NAVIGaTE Program" in collaboration with RTC, Aptiv, and others.

2019 – February

- Switch from REP Engineer position to Postdoctoral Scholar
- Initial debugging of TrafiRadar system in collaboration with David Cole from Sierra Transportation Technology and FLIR. Recommendation made to lower TrafiRadar height for better calibration.

- Thomas Jefferson Fund proposal titled "IoT and Edge Vision for Connected Autonomous Vehicle (CAV) Environment Perception" in collaboration with EFREI Paris.

2019 – January

- Autonomous Vehicle Project Space and testing discussions with UNLV facilities
- Offer letters for Dr. Nathanael Lemessa Baisa from Fraunhofer IVI and UNLV
- Installation of FLIR TrafiSense and TrafiRadar camera hardware into Harmon St. site as part of the Rumble Strip project.

2019 – December

- Finalize preliminary testing of TrafiSense and TrafiRadar systems at temporary location to have full familiarity with system capabilities and calibration and settings for pedestrian detection in thermal IR camera.

2019 – November

- Initial interview with REP candidate Dr. Nathanael Lemessa Baisa
- Discussions with Tesla to take part in project and request for test vehicle.

2018 – October

- Christopher Kappes gives AutoTruck overview presentation in RTIS Lab meeting (10/5/2018).
- Mr. Kappes begins testing and familiarization with FLIR TrafiSense for pedestrian detection.
- Identified FLIR TrafiRadar as a combo camera/radar sensor for vehicle detection and speed measurement.