Truck Parking Detection Sensor and System

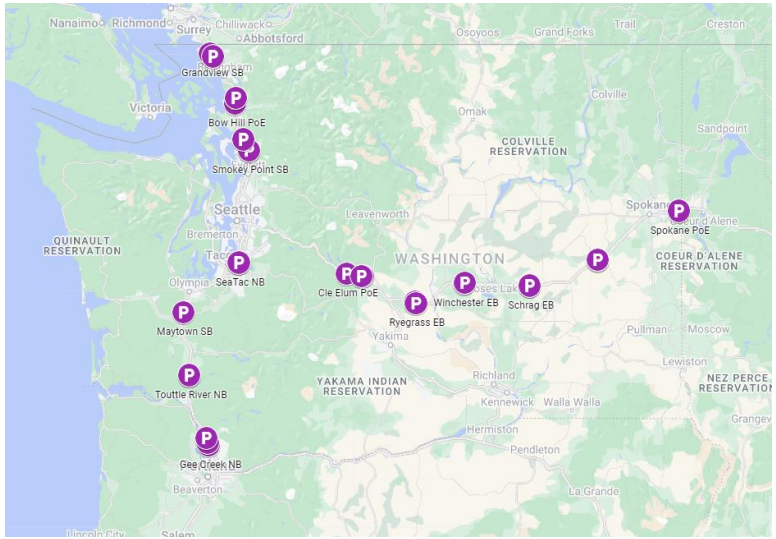
January 18, 2023

University of Washington & WSDOT

Today's Agenda

- *Project's Objectives*
- *Review Pilot Project*
- *System Architecture*
- *Data Exchange Specification Document*
- *Sampling Data from Vendor*
- *Prediction Algorithm*
- *System Requirement*

Project Objective



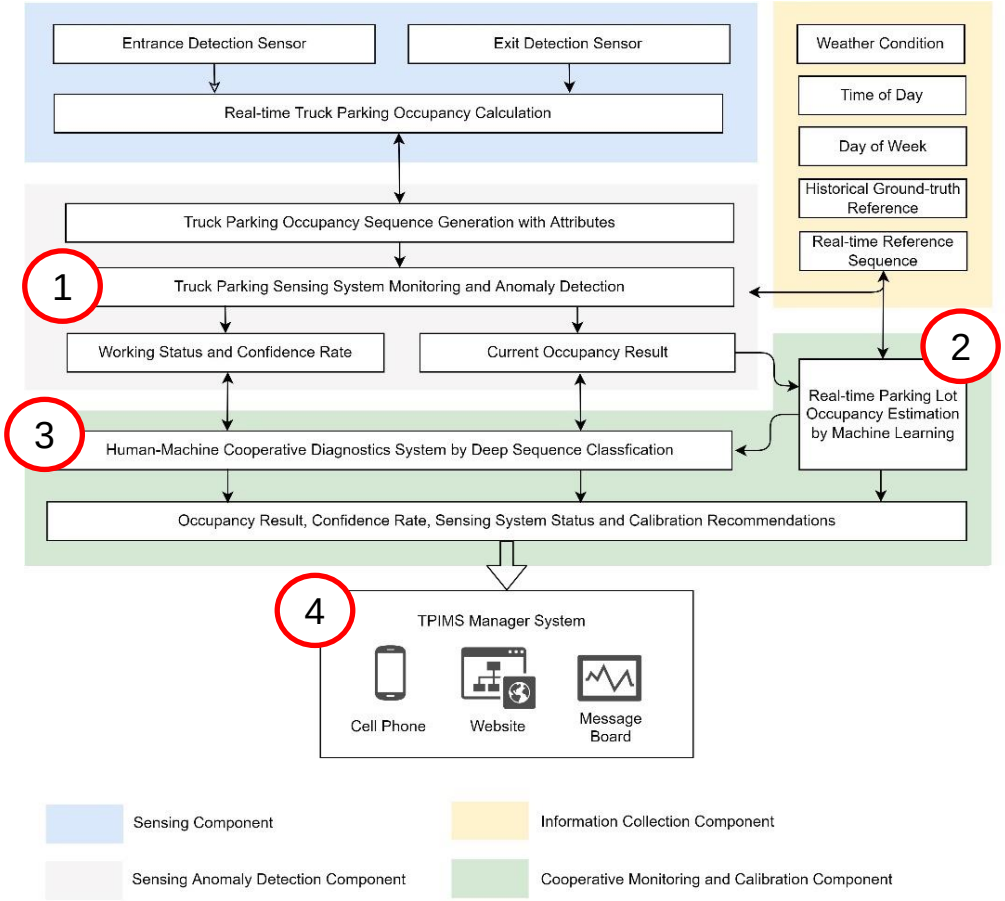
30 Truck parking spots in WA

Create a truck parking monitoring and calibration system empowered by machine learning, for the in/out truck parking counting system

TSPS [Radar-based In/Out counting Sensor]

Project Objective

1. Propose a real-time truck parking sensing system status anomaly detection framework.
2. Propose a real-time parking lot occupancy estimation empowered by deep learning.
3. Propose a human-machine cooperative monitoring and calibration algorithm empowered by sequence classification.
4. Build an API to disseminate the truck parking sensing monitoring and calibration result.

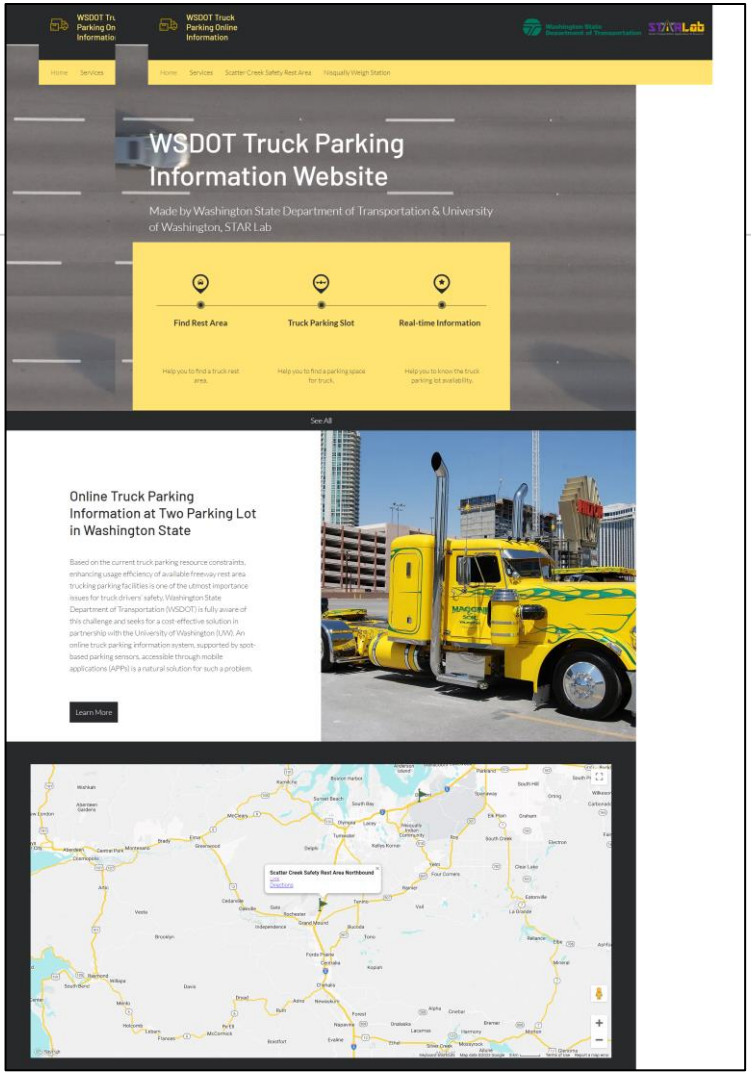


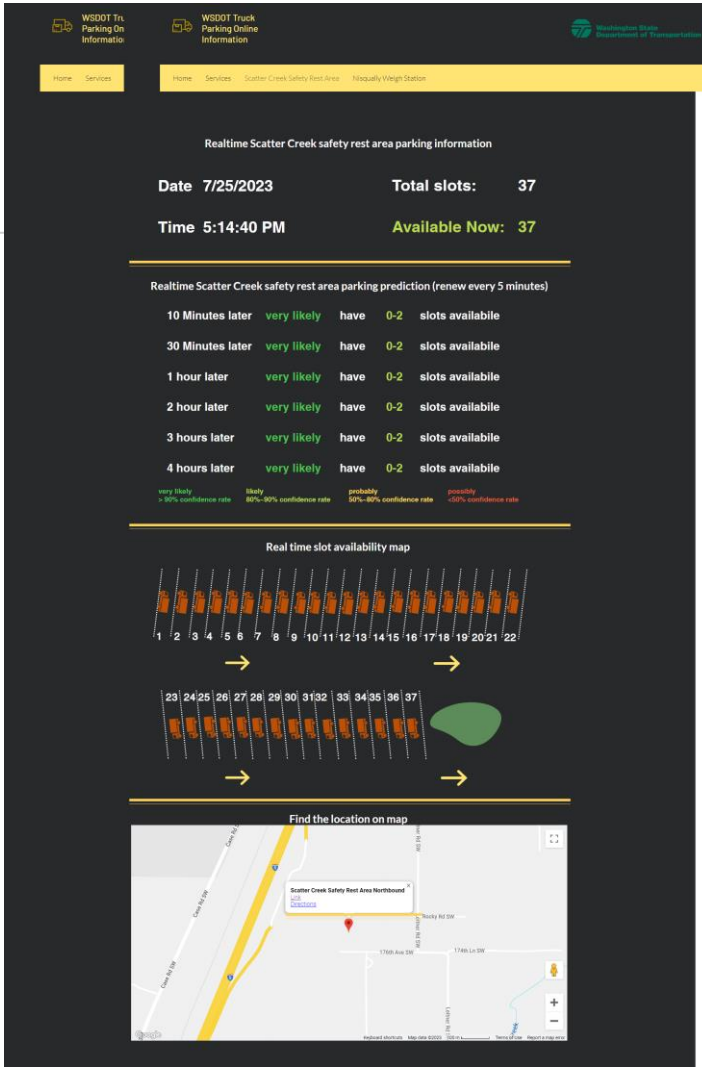
WSDOT Truck Parking Information Website: Main Services

- Main services
  - **Real-time Information** show availability
  - **Slot Availability Prediction**
- Two sites
  - Scatter Creek Safety Rest Area
  - Nisqually Weight Station

Use Slot-by-slot detector

https://uwstarlab.wixsite.com/wsdotparking





Site Information

Slot availability prediction

Real time slot availability map

Location on map

Pilot TPIMS Architecture

Main functions

1. Visualization
2. Archive data
3. Prediction

Sensing Device

Parking data

Service Provider Server

- *Data stored as **XML file***

URL request

Response

STAR Lab Host Server

- *Public IP address for worldwide access*
- *Create file*
  >> History data stored as text file
  >> Current data overwritten in a JSON file
- *Prediction function*

URL request

JSON response

Customer PC/Mobile

- *Shows current data*
- *Prediction result*
- *on wix website*

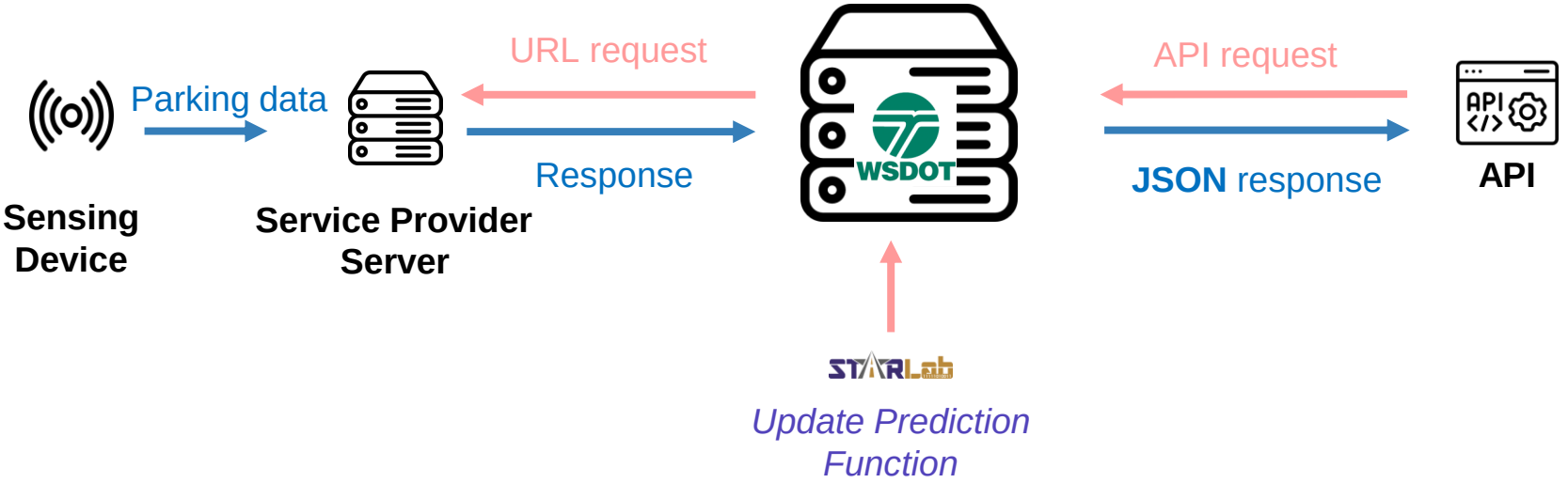
txt response

Archive Data

Purposed new system architecture

Update 12/21/23

- *Host Data*
- *Prediction Function*



TPIMS Data Exchange Specification Document

- MAASTO standard
- HTTP RESTful conventions
  - In JavaScript Object Notation (JSON) format
- Authentication
  - Does not depend on cookies or sessions
  - Require authentication credentials for each request
  - Trusted partner = MAFC, State DOTs, etc.

Dataset/Datafeed Request

1) Request availability and location information for all truck parking sites (Third Party Requests)

- **Dataset#1** – Dynamic public feed
- **Dataset#2** – Static public feed (Updated As-Needed)

  - Share with 3rd party
  - Allow them to disseminate parking available

2) Request most recent archive feed (Only Trusted Partners)

- **Dataset#3** Dynamic archive-only feed →
  - Internal system monitoring
  - Performance measure generation

Dataset#1 – Dynamic Public Feed Database

- Share with 3rd party
- Allow them to disseminate parking available

REQUEST

Call Request Open Feed:

GET /api/TPIMS_Dynamic.json

Call Request Restricted to Authenticated Users Feed:

GET /api/TPIMS_Dynamic?key=<MyKey>

		Location Identifier (Fixed Length)	
Field Position	**Field Size**	**Field Name**	**Description**
0	2	State	Two letter state abbreviation.
2	5	Route number	Five digits with zeros padded to the left.
7	2	Route type	Two letter abbreviation (e.g., IS for interstate, US for US highway, SH for state highway, etc.).
9	6	Reference Post	Also referred to as Mile Marker. Six-digit number with implied 1/10 decimal point and zeros padded to the left.
15	2	Side of Road	Two letter designation indicating the direction(s) of travel that can access the site. Sites accessed from one direction are identified: "0N", "0S", "0E" or "0W". For sites that can be accessed by either direction of travel, a bi-directional identifier such as "NS" or "EW" can be used.
17	8	Unique Site Designation	Eight characters unique location number or name abbreviation to differentiate between multiple truck stops at the same interchange.

Example: MI00094IS0008450WGALESBRA is the Galesburg Rest Area on westbound I- 94 in Michigan near reference post 84.5.

RESPONSE


```
{
    "siteId": "MI00039IS0011300SRSTARE11",
    "timeStamp": "2017-11-17T20:39:59Z",
    "timeStampStatic": "2016-12-02T16:23:22Z",
    "reportedAvailable": "49",
    "trend": "FILLING",
    "open": true,
    "trustData": true,
    "capacity": 68
}
```


Number of available spots
Report "Low" if the low threshold is reached

Whether the site is empty
[CLEARING, STEADY, FILLING, NULL]

Is the site closed (for maintenance or else)
[true, false, null]

Is the site operating normally?
(close for construction, IT maintenance, equipment failure) [true, false, null]

Adding Prediction Data in API

Realtime Scatter Creek safety rest area parking prediction (renew every 5 minutes)

10 Minutes later	very likely	have	0-2	slots availabile
30 Minutes later	very likely	have	0-2	slots availabile
1 hour later	very likely	have	0-2	slots availabile
2 hour later	very likely	have	0-2	slots availabile
3 hours later	very likely	have	0-2	slots availabile
4 hours later	very likely	have	0-2	slots availabile

very likely
> 90% confidence rate

likely
80%~90% confidence rate

probably
50%~80% confidence rate

possibly
<50% confidence rate


```
{
    "siteId": "IL00074IW006200004",
    "timeStamp": "2023-12-21T19:57:21.803Z",
    "timeStampStatic": "2023-12-21T19:57:21.803Z",
    "reportedAvailable": "8",
    "trend": "Steady",
    "open": "true",
    "trustData": "true",
    "capacity": 12,
    "predict10m" : "possibly",
    "predict30m" : "possibly",
    "predict1h" : "probably",
    "predict2h" : "Likely",
    "predict3h" : "veryLikely",
    "predict4h" : "veryLikely"
}
```

Dataset#2 - Static Public Feed Database

- Share with 3rd party
- Allow them to disseminate parking available

REQUEST

Call Request Open Feed:

GET /api/TPIMS_Static.json

Call Request Restricted to Authenticated Users Feed:

GET /api/TPIMS_Static?key=<MyKey>

RESPONSE


```
{
    "siteID": "MI00039IS0011300SRSTARE11",
    "timeStamp": "2017-07-16T18: 26: 16Z",
    "relevantHighway": "94",
    "referencePost": "106",
    "exitID": null,
    "directionOfTravel": "S",
    "name": "Rest Area#11",
    "location": {
        "latitude": 43.428567,
        "longitude": -89.483269,
        "streetAdr": null,
        "city": "JohnsonCounty",
        "state": "MI",
        "zip": "12345",
        "timeZone": "Eastern"
    },
    "ownership": "PU",
    "capacity": 68,
    "amenities": [],
    "images": [],
    "logos": []
}
```


Privately owned or publicly owned [PR/PU]

List of text based amenities descriptions

Link to Image from a surveillance camera

Dataset#3 - Dynamic Archive Only Feed Database

- Internal system monitoring
- Performance measure generation

REQUEST

Call Request Restricted to Authenticated Users Feed:
GET /api/TPIMS_Archive?key=<MyKey>

RESPONSE


```
{
    "siteId": "MII00039IS0011300SRSTARE11",
    "timeStamp": "2017-11-17T21:48:32Z",
    "timeStampStatic":"2016-12-02T16: 23: 22Z",
    "reportedAvailable":"55","trend":"FILLING",
    "open":true,
    "trustData":true,
    "lastVerificationCheck":"2016-12-02T16: 23: 22Z",
    "verificationCheckAmplitude":-3,
    "lowThreshold":5,
    "trueAvailable":55,
    "capacity":68
}
```

Potential Selected System

	Slot-by-slot (Magnetic/Rada-based)	Slot-by-slot (VDO)	In/out counting (With camera calibration)
Level of Precise	• High • Low error accumulate	• Moderate • Error accumulate	• Moderate • Higher accuracy with the camera calibration
Maintenance needs	Require at each detector	Require at each detector	Require at radar unit
Installation	Out of pavement (lot configuration changes)	A location that can capture most of entire parking area	At the entrance/exit of the parking lot

Slot-by-slot
(Magnetic/Rada-based)


Slot-by-slot
(VDO)


In/out counting

TCS [Slot-by-slot video-based]

A few ways to get data from Mistall

- Report Export (CVS format)
- Mistall Push Integration (Annual fee apply)
- Mistall Web Services
  - uses Mistall Web Services (free to use)
  - pulling current occupancy using the **/v2/lots or /v2/lots/{lotID}** functions
  - Occupancy is updated periodically

Web service Example

Wavetronix [In/out counting]

HD data ATP | HD XP20 ATP

File Edit View

```
#
#                       DATE         : 2023-06-16 09:18:56
#                       SERIALNUMBER : 101-0451 00472
#                       DESCRIPTION  :
#                       LOCATION     : 40.229362,-111.658547
#                       ORIENTATION  : 270
#                       NOTES        :
#                       TIMESTAMP    : Beginning
#                       FORMAT       :
#
```

# NAME	VOLUME	Occupancy (%)	Speed (mph)	85% Speed (mph)	Class Count (bin lengths in feet) C1 10	C2 20	C3 30	C4 40	C5 50	C6 60	C7 120	C8	HEADWAY	GAP	SENSOR TIME YYYY-MM-DD HH:MM:SS	Interval (sec)	Speed Bins(mph) SP1 25	SP2 35	SP3 45	SP4 55	SP5 65	SP6 75	SP7 85	SP8 145	SP9	SP10	SP11	SP12	SP13	SP14	SP15	Direction Bins Correct	Wrong
WB Lane 1	18	12.749	51	48	4	6	4	0	0	0	4	-	4259	3745	2023-06-15 08:52:12.00	74	0	7	0	4	0	7	0	0	-	-	-	-	-	-	-	-	-
WB Lane 2	18	12.777	51	48	4	6	4	0	0	0	4	-	4176	3661	2023-06-15 08:52:12.00	74	0	7	0	4	0	7	0	0	-	-	-	-	-	-	-	-	-
WB Lane 3	18	12.82	51	48	2	8	4	0	0	0	4	-	4093	3575	2023-06-15 08:52:12.00	74	0	7	0	4	0	7	0	0	-	-	-	-	-	-	-	-	-
EB Lane 4	19	15.219	46	44	4	7	3	0	0	0	5	-	4155	3663	2023-06-15 08:52:12.00	74	0	8	4	0	7	0	0	0	-	-	-	-	-	-	-	-	-
EB Lane 5	18	14.795	45	44	3	8	2	0	0	0	5	-	4248	3743	2023-06-15 08:52:12.00	74	0	8	4	0	6	0	0	0	-	-	-	-	-	-	-	-	-
EB Lane 6	19	15.172	46	43	3	9	2	0	0	0	5	-	4147	3653	2023-06-15 08:52:12.00	74	0	8	4	0	7	0	0	0	-	-	-	-	-	-	-	-	-
EB Lane 1	22	18.377	50	48	4	6	5	0	0	0	7	-	4321	3790	2023-06-15 08:53:28.00	92	0	10	0	4	0	8	0	0	-	-	-	-	-	-	-	-	-
EB Lane 2	21	14.64	51	48	3	7	5	0	0	0	6	-	4042	3565	2023-06-15 08:53:28.00	92	0	9	0	4	0	8	0	0	-	-	-	-	-	-	-	-	-
EB Lane 3	21	14.567	51	48	2	8	5	0	0	0	6	-	4116	3638	2023-06-15 08:53:28.00	92	0	9	0	4	0	8	0	0	-	-	-	-	-	-	-	-	-
WB Lane 4	21	14.509	46	44	4	8	3	0	0	0	6	-	4194	3726	2023-06-15 08:53:28.00	92	0	9	4	0	8	0	0	0	-	-	-	-	-	-	-	-	-
WB Lane 5	21	14.547	46	44	3	9	3	0	0	0	6	-	4273	3803	2023-06-15 08:53:28.00	92	0	9	4	0	8	0	0	0	-	-	-	-	-	-	-	-	-
WB Lane 6	21	14.564	46	44	3	9	3	0	0	0	6	-	4353	3884	2023-06-15 08:53:28.00	92	0	9	4	0	8	0	0	0	-	-	-	-	-	-	-	-	-
EB Lane 1	75	13.819	51	48	16	24	17	0	0	0	18	-	4012	3533	2023-06-15 08:55:00.00	300	0	30	0	15	0	30	0	0	-	-	-	-	-	-	-	-	-
EB Lane 2	75	14.301	51	48	14	26	16	0	0	0	19	-	4088	3592	2023-06-15 08:55:00.00	300	0	30	0	15	0	30	0	0	-	-	-	-	-	-	-	-	-
EB Lane 3	75	14.292	51	48	8	32	16	0	0	0	19	-	4073	3574	2023-06-15 08:55:00.00	300	0	30	0	15	0	30	0	0	-	-	-	-	-	-	-	-	-
WB Lane 4	75	14.21	47	44	16	30	10	0	0	0	19	-	4058	3570	2023-06-15 08:55:00.00	300	0	30	15	0	30	0	0	0	-	-	-	-	-	-	-	-	-
WB Lane 5	75	14.249	47	44	12	34	10	0	0	0	19	-	4042	3553	2023-06-15 08:55:00.00	300	0	30	15	0	30	0	0	0	-	-	-	-	-	-	-	-	-
WB Lane 6	75	14.26	47	44	13	33	10	0	0	0	19	-	4027	3537	2023-06-15 08:55:00.00	300	0	30	15	0	30	0	0	0	-	-	-	-	-	-	-	-	-
EB Lane 1	69	14.093	52	48	13	18	18	0	0	0	20	-	4308	3778	2023-06-15 09:00:00.00	300	0	27	0	14	0	28	0	0	-	-	-	-	-	-	-	-	-
EB Lane 2	70	14.469	51	48	10	21	19	0	0	0	20	-	4311	3779	2023-06-15 09:00:00.00	300	0	28	0	14	0	28	0	0	-	-	-	-	-	-	-	-	-
EB Lane 3	70	14.416	52	48	6	25	19	0	0	0	20	-	4306	3772	2023-06-15 09:00:00.00	300	0	28	0	14	0	28	0	0	-	-	-	-	-	-	-	-	-
WB Lane 4	70	14.328	47	44	13	26	11	0	0	0	20	-	4301	3778	2023-06-15 09:00:00.00	300	0	28	14	0	28	0	0	0	-	-	-	-	-	-	-	-	-
WB Lane 5	70	14.367	47	44	9	30	11	0	0	0	20	-	4297	3771	2023-06-15 09:00:00.00	300	0	28	14	0	28	0	0	0	-	-	-	-	-	-	-	-	-
WB Lane 6	70	14.373	47	44	11	28	11	0	0	0	20	-	4291	3766	2023-06-15 09:00:00.00	300	0	28	14	0	28	0	0	0	-	-	-	-	-	-	-	-	-
EB Lane 1	76	14.335	51	48	15	24	20	0	0	0	17	-	3887	3429	2023-06-15 09:05:00.00	300	0	31	0	15	0	30	0	0	-	-	-	-	-	-	-	-	-
EB Lane 2	76	14.373	51	48	14	25	20	0	0	0	17	-	3906	3447	2023-06-15 09:05:00.00	300	0	31	0	15	0	30	0	0	-	-	-	-	-	-	-	-	-
EB Lane 3	76	14.426	51	48	8	31	20	0	0	0	17	-	3925	3464	2023-06-15 09:05:00.00	300	0	31	0	15	0	30	0	0	-	-	-	-	-	-	-	-	-
WB Lane 4	75	13.743	47	44	16	31	12	0	0	0	16	-	3842	3407	2023-06-15 09:05:00.00	300	0	30	15	0	30	0	0	0	-	-	-	-	-	-	-	-	-
WB Lane 5	75	13.954	47	44	12	35	12	0	0	0	16	-	3861	3425	2023-06-15 09:05:00.00	300	0	30	15	0	30	0	0	0	-	-	-	-	-	-	-	-	-
WB Lane 6	75	13.797	47	44	12	35	12	0	0	0	16	-	3881	3444	2023-06-15 09:05:00.00	300	0	30	15	0	30	0	0	0	-	-	-	-	-	-	-	-	-
EB Lane 1	76	13.953	51	48	16	24	18	0	0	0	18	-	4023	3543	2023-06-15 09:10:00.00	300	0	30	0	16	0	30	0	0	-	-	-	-	-	-	-	-	-
EB Lane 2	76	13.985	51	48	14	26	18	0	0	0	18	-	4005	3523	2023-06-15 09:10:00.00	300	0	30	0	16	0	30	0	0	-	-	-	-	-	-	-	-	-
EB Lane 3	76	14.046	51	48	8	32	18	0	0	0	18	-	3986	3502	2023-06-15 09:10:00.00	300	0	30	0	16	0	30	0	0	-	-	-	-	-	-	-	-	-

TSPS [In/out counting]

- accessing the TSPS endpoints via the MAASTO specification
- API follows HTTP RESTful conventions (Representational state transfer)

Dynamic Public Feed

Response (JSON):


```
[
 {
  "siteId": "IA00080IS001510WBJASPSCAL",
  "timeStamp": "2018-07-20T12:29:50.179Z",
  "timeStampStatic": "2018-07-20T12:29:50.182Z",
  "reportedAvailable": 0,
  "trend": "STEADY",
  "open": true,
  "trustData": true,
  "lastVerificationCheck": "2018-07-19T12:29:50.179Z",
  "verificationCheckAmplitude": 0,
  "lowThreshold": 0,
  "trueAvailable": 0,
  "capacity": 0
 },
 {
  "siteId": "IA00080IS0001900ERA19E000",
  "timeStamp": "2018-07-20T12:29:49.919Z",
  "timeStampStatic": "2018-07-20T12:29:49.921Z",
  "reportedAvailable": 6,
  "trend": "CLEARING",
  "open": false,
  "trustData": true,
  "lastVerificationCheck": "2018-07-19T12:29:50.179Z",
  "verificationCheckAmplitude": 0,
  "lowThreshold": 0,
  "trueAvailable": 6,
  "capacity": 15
 }
]
```


Static Public Feed

Response (JSON):


```
[
 {
  "name": "TA – Battle Creek",
  "siteId": "MI000I94WE0104MM0000TABC00PR",
  "timeStamp": "2015-07-29T19:10:09.417Z",
  "relevantHighway": "I-94",
  "exitId": "104",
  "referencePost": null,
  "direction": "W",
  "location": {
   "latitude": null,
   "longitude": null,
   "street": "",
   "street2": "",
   "city": "",
   "zip": "",
   "state": "MI",
   "timeZone": null
  },
  "ownership": "PRIVATE",
  "capacity": 171,
  "logos": [
   "https://tsps.com/chains/thumb/2-TAonWHT.png?1406572089"
  ],
  "images": [
   "https://tsps.com/photos/medium/1044816-p20150729_14_ku7u0bimage00001.jpg?1438198313",
   "https://tsps.com/photos/medium/1044823-p20150729_6_166ai1cimage00002.jpg?1438199217",
   "https://tsps.com/photos/medium/1044809-p20150729_10_1k71i14image00003.jpg?1438197409"
  ],
  "amenities": [
   {
    "category": "Associations",
    "name": "TSD",
    "value": null
   }
  ]
 }
]
```


All Truck Stop

Response (JSON):


```
[
 {
  "siteId": "IA00235IS0001100WKUM&GO00",
  "timeStamp": "2018-07-20T12:43:53.680Z",
  "timeStampStatic": "2018-07-20T12:43:53.683Z",
  "reportedAvailable": 10,
  "trend": "STEADY",
  "open": true,
  "trustData": true,
  "lastVerificationCheck": "2018-07-19T12:43:53.683Z",
  "verificationCheckAmplitude": 0,
  "lowThreshold": 0,
  "trueAvailable": 10,
  "capacity": 15
 },
 {
  "siteId": "IA00080IS001150EBDALLSCAL",
  "timeStamp": "2018-07-20T12:43:53.690Z",
  "timeStampStatic": "2018-07-20T12:43:53.693Z",
  "reportedAvailable": 3,
  "trend": "STEADY",
  "open": true,
  "trustData": true,
  "lastVerificationCheck": "2018-07-19T12:43:53.683Z",
  "verificationCheckAmplitude": 0,
  "lowThreshold": 0,
  "trueAvailable": 3,
  "capacity": 15
 },
 {
  "siteId": "IA00080IS001510WBJASPSCAL",
  "timeStamp": "2018-07-20T12:43:53.700Z",
  "timeStampStatic": "2018-07-20T12:43:53.703Z",
  "reportedAvailable": 10,
  "trend": "STEADY",
  "open": true,
  "trustData": true,
  "lastVerificationCheck": "2018-07-19T12:43:53.683Z",
  "verificationCheckAmplitude": 0,
  "lowThreshold": 0,
  "trueAvailable": 10,
  "capacity": 15
 }
]
```

Truck Parking Availability Prediction by Non-homogeneous Poisson

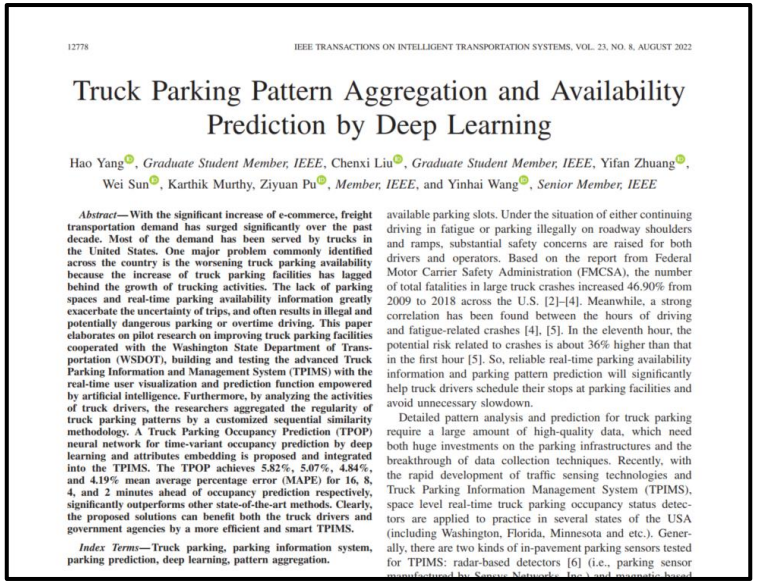
- Ratio of Arrival / Reservation $\frac{a_t - a_{t-1}}{capacity}$

a_t = Parking availability at time t
a_{t-1} = Parking availability at time t-1

- Compute the mean ratio of the historical data
- Use the ratio from historical data to calculate future availability (multiply ration by capacity)

Truck Parking Availability Prediction by Deep Learning (2022)

- Two truck rest areas
- Model: **a multi-layer long short-term memory (LSTM) RNN**
- Use PyTorch
- Work Station
  - two GPUs (NVIDIA TITAN Xp)
  - CPU intel Core i7 8700
  - Linux Ubuntu 16.04



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Truck Parking Pattern Aggregation and Availability Prediction by Deep Learning

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***Abstract*— With the significant increase of e-commerce, freight transportation demand has surged significantly over the past decade. Most of the demand has been served by trucks in the United States. One major problem commonly identified across the country is the worsening truck parking availability because the increase of truck parking facilities has lagged behind the growth of trucking activities. The lack of parking spaces and real-time parking availability information greatly exacerbate the uncertainty of trips, and often results in illegal and potentially dangerous parking or overtime driving. This paper elaborates on pilot research on improving truck parking facilities cooperated with the Washington State Department of Transportation (WSDOT), building and testing the advanced Truck Parking Information and Management System (TPIMS) with the real-time user visualization and prediction function empowered by artificial intelligence. Furthermore, by analyzing the activities of truck drivers, the researchers aggregated the regularity of truck parking patterns by a customized sequential similarity methodology. A Truck Parking Occupancy Prediction (TPOP) neural network for time-variant occupancy prediction by deep learning and attributes embedding is proposed and integrated into the TPIMS. The TPOP achieves 5.82%, 5.07%, 4.84%, and 4.19% mean average percentage error (MAPE) for 16, 8, 4, and 2 minutes ahead of occupancy prediction respectively, significantly outperforms other state-of-the-art methods. Clearly, the proposed solutions can benefit both the truck drivers and government agencies by a more efficient and smart TPIMS.**

***Index Terms*— Truck parking, parking information system, parking prediction, deep learning, pattern aggregation.**

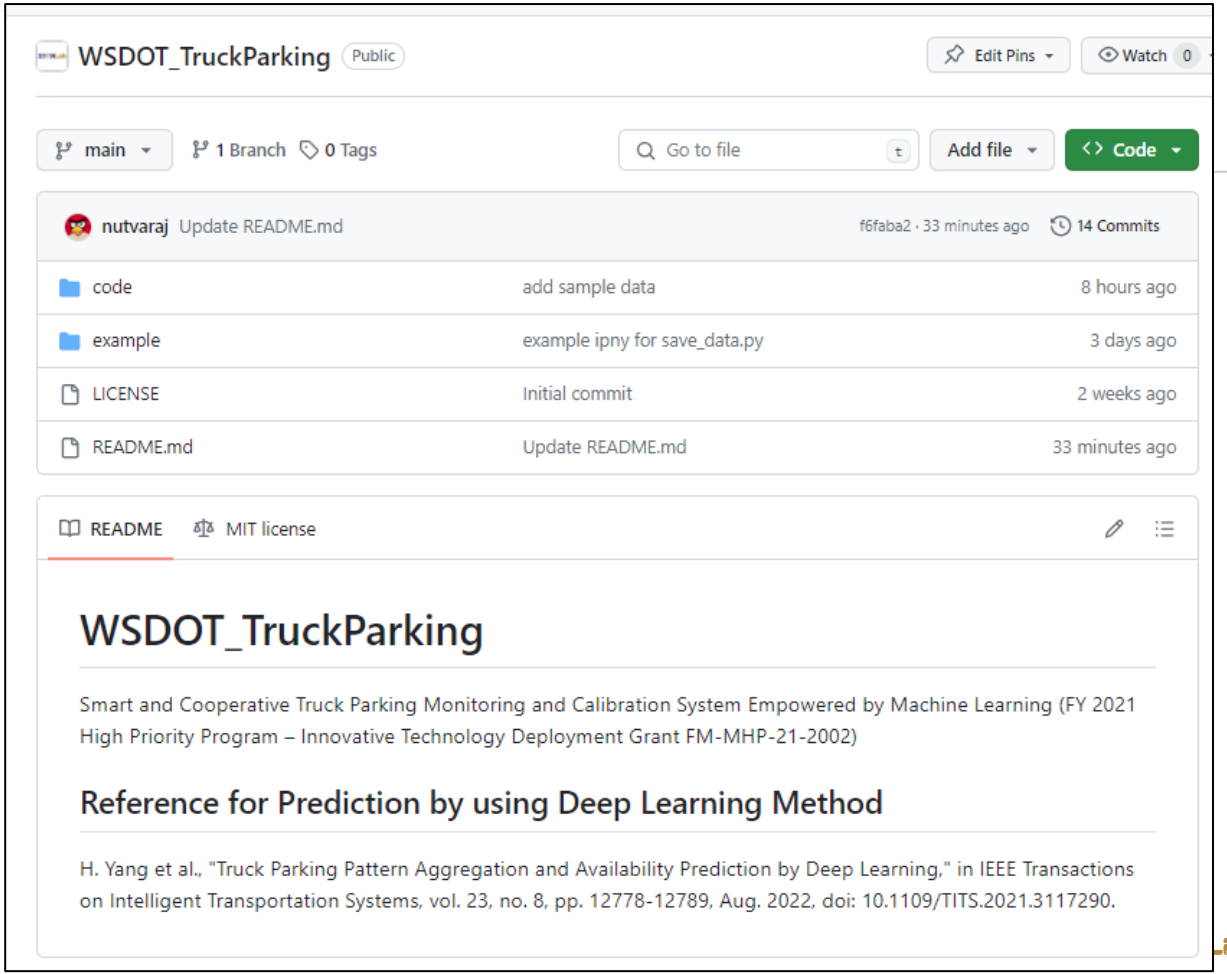
available parking slots. Under the situation of either continuing driving in fatigue or parking illegally on roadway shoulders and ramps, substantial safety concerns are raised for both drivers and operators. Based on the report from Federal Motor Carrier Safety Administration (FMCSA), the number of total fatalities in large truck crashes increased 46.90% from 2009 to 2018 across the U.S. [2]–[4]. Meanwhile, a strong correlation has been found between the hours of driving and fatigue-related crashes [4], [5]. In the eleventh hour, the potential risk related to crashes is about 36% higher than that in the first hour [5]. So, reliable real-time parking availability information and parking pattern prediction will significantly help truck drivers schedule their stops at parking facilities and avoid unnecessary slowdown.

Detailed pattern analysis and prediction for truck parking require a large amount of high-quality data, which need both huge investments on the parking infrastructures and the breakthrough of data collection techniques. Recently, with the rapid development of traffic sensing technologies and Truck Parking Information Management System (TPIMS), space level real-time truck parking occupancy status detectors are applied to practice in several states of the USA (including Washington, Florida, Minnesota and etc.). Generally, there are two kinds of in-pavement parking sensors tested for TPIMS: radar-based detectors [6] (i.e., parking sensor

https://ieeexplore.ieee.org/abstract/document/9582619

Code

https://github.com/UWstarlab/WSDOT_TruckParking/tree/main



System Requirement

Mandatory for Hosting Data

- Python 3.6
- Windows OS
- Server
  - RAM 64 GB
  - Storage 2 TB
  - With NVIDIA GPU 2080ti+

Suggestion for Prediction Algorithm

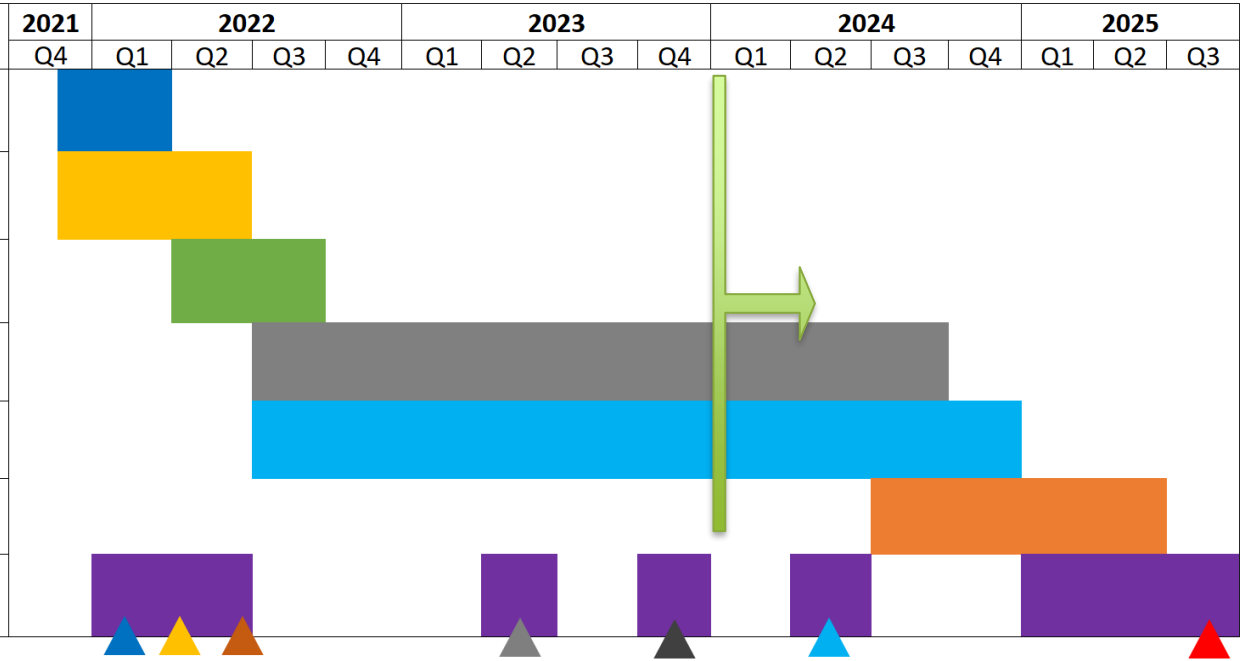
We request 50,000 USD to purchase a data server with the following specifications: CPU with 35.75MB cache, 24 cores, 48 threads, 2.40 – 3.90 GHz Turbo, 165W. Triple GPUs (NVIDIA RTX A6000) with 48 GB GDDR6, 4DP. Storage of 4TB SSD (Table 1).

Table 1 Proposed budget, including equipment, quantity, and cost

No	Item	Price each	Quantity	Price
1	**Dell Precision 7920 Rack Data Science Workstation** Pre-configured by vendor - Dual Intel® Xeon® Gold 6226R (22 MB cache, 16 cores, 32 threads, 2.90 GHz to 3.90 GHz Turbo, 150 W) - Ubuntu® Linux® 20.04 LTS - NVIDIA® RTX™ A5000, 24 GB GDDR6, 4 DP - 192 GB, 12 x 16 GB, DDR4, 2933 MHz, ECC	$11,478.99	1	$11,478.99
2	**Processor Upgrade** Dual Intel® Xeon® Platinum 8260 (35.75MB cache, 24 cores, 48 threads, 2.40 to 3.90 GHz Turbo, 165W)	$7,296.23	1	$7,296.23
3	**Chassis Upgrade** Dell Precision 7920 Rack Chassis A6000	$7.12	1	$7.12
4	**Graphics Card Upgrade** Triple NVIDIA® RTX™ A6000, 48 GB GDDR6, 4 DP	$8,783.43	1	$8,783.43
5	**Memory Upgrade** 1 TB, 16 x 64 GB, DDR4, 2933 MHz, ECC	$15,403.37	1	$15,403.37
6	**Hard Drive** 1.92 TB, 2.5-inch, SATA, SSD, AG-Enterprise Class	$1,048.42	2	$2,096.84
7	**Power Supply Upgrade** Dual Non-redundant Power Supply, 1600W @ 220V	$77.66	1	$77.66
			Total	$45,143.64
			Total + Tax + Discount	**$49,713.94**

Task schedule

ID	Task Name	Start	Finish
1	Stakeholder Engagement	12/1/2021	3/31/2022
2	Detection System Selection and Site Evaluation	11/1/2021	4/1/2022
3	Request for Proposals Development	4/1/2022	8/15/2022
4	Installation	8/15/2022	8/1/2024
5	APP/API Development	7/1/2022	12/1/2024
6	User Testing	7/1/2024	7/1/2025
7	Final Report	1/1/2025	9/30/2025



Next Meeting

Date : **THU** FEB 01, 2023
Time : 2.00 PM – 3.00 PM