

# Autonomous Winter Road Maintenance Decision-Making using Artificial Intelligence (AI)

FHWA Project 693JJ320C000022

## Research Team:

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2023 Winter Operations Conference



## App tutorial



[www.smartmdss.org](http://www.smartmdss.org)



Home Demo Contact About Log in/Register

Already have an account?  
Click here to login.

**Register**  
Register an account in order to provide road maintenance information and feedback on the AI algorithm.

Email:

Password:   

- Your password can't be too similar to your other personal information.
- Your password must contain at least 8 characters.
- Your password can't be a commonly used password.
- Your password can't be entirely numeric.

Password confirmation:   
Enter the same password as before, for verification.

User type:

Phone # (optional):

AOI (optional):

Use a drawing tool to select your area-of-interest. After logging into your account, the map will zoom to this area automatically.

[Register](#)

Home Demo Contact About Welcome, mohotavakoli@gmail.com. Change password / Log out

Registration successful

Clicked road info:  
 Road: **US-31 Ottawa @ Business US31**  
 Last upd: Sun Oct 16 2022 09:35

**Road Condition**

Traffic Speed (mph)	Free Flow Speed (mph)	Closure Status	Road Surface Condition (Machine Learning)	Road Surface Condition (Accuracy)
37	37	No!	Wet surface	77

**Surface Temperature**

Nearest RWIS station	RCPT Now	RCPT 24 hours	RCPT 48 hours	RCPT 72 hours	RCPT 96 hours
	46 °F	50 °F	49 °F	46 °F	0 °F

**Weather Status and Forecast**

Temp (°F)	Hum (%)	WS (mph)	Vis (mi)	Desc.	
Now	45	83	6	10	broken clouds
3 hour	48	78	14	10	light rain
6 hour	49	69	16	10	light rain
9 hour	46	78	18	10	light rain
12 hour	45	72	18	10	light rain
18 hour	42	81	21	4	light rain
24 hour	39	81	24	4	light rain

**US-31 AT S. AIRPORT RD.**

US-31 Grand Traverse Co @ S Airport Rd W Traffic closest to camera is traveling north

## How can you help us to improve the app?

Clicked road info:	
Road	<b>US-131 Antrim County @ M-32 (N Jct)</b>
Last Upd.	<b>Mon Dec 16 2022 08:36</b>
Road Maintenance	
Actual last 48-h maintenance operations	<b>Add</b>
Recommended maintenance operations	<i>Plow and Salt 100 at 8:00 AM</i>

Log a maintenance operation for route:  
US-31 Ottawa @ Business US31

Date: 10/16/2022

Time: 12:00 PM

Type: **Select...**

- Select...
- Salting
- Plowing

**Cancel** **Save**

## How we can help more...

### FILL OUT OUR REGISTRATION SHEET

- We can add special points on the map for you!
- We can suggest winter road maintenance operations based on your budget, equipment, and resources!
- If you have online surveillance cameras, we can connect your cameras to our app
- If you have an online weather stations, we can use your data for decision-making
- If you need a weather station in your area, we can provide a cost-effective weather station for you and add it to our decision-making system

Scan it with your smart phone



## PI Team



### ○ **PI, Dr. Zhen (Leo) Liu**

- Multiphysics and numerical simulation
- Cold regions engineering
- Deep learning and data-driven techniques
- Web development



### ○ **Co-PI, Dr. Timothy Colling**

- Organization of training events
- Outreach to county road engineers
- Implementation of web-based apps



### ○ **Co-PI, Dr. Yongchao Yang**

- Deep learning
- Image data processing
- Structural health analysis



### ○ **Co-PI, Mr. Michael Billmire**

- Software development
- Data acquisition and management



### ○ **Core Member, Hossein Tavakoli**

- Deep learning
- Modeling of snow and ice dynamics
- Web development
- Road instrumentation



## Project Scope

### **Project Title:**

Autonomous Winter Road Maintenance Decision Making Enabled by Boosting Existing Transportation Data Infrastructure with Deep and Reinforcement Learning

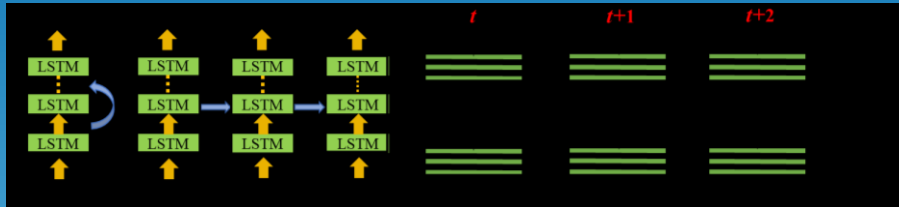
This project aims to boost the current **model-based** winter maintenance with an **Artificial-Intelligence (AI)-enhanced framework**, in which

1. **data** can be analyzed in real-time for **autonomous decision making** and
2. such decision-making ability can be improved continuously as more data is obtained.



# Innovations

## 1. Road Condition Predictions using AI (RNN model)

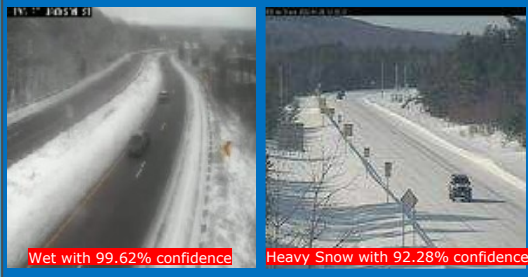


Architecture (a) and working mechanisms (b) of RNN

## Technical Approach & Innovations

### 2. Sense Dynamic Road Conditions

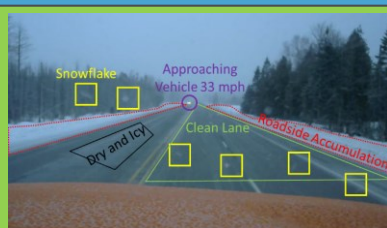
#### Level 1- Image classification



#### Level 2- Snow/Road Detection



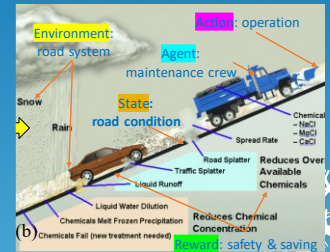
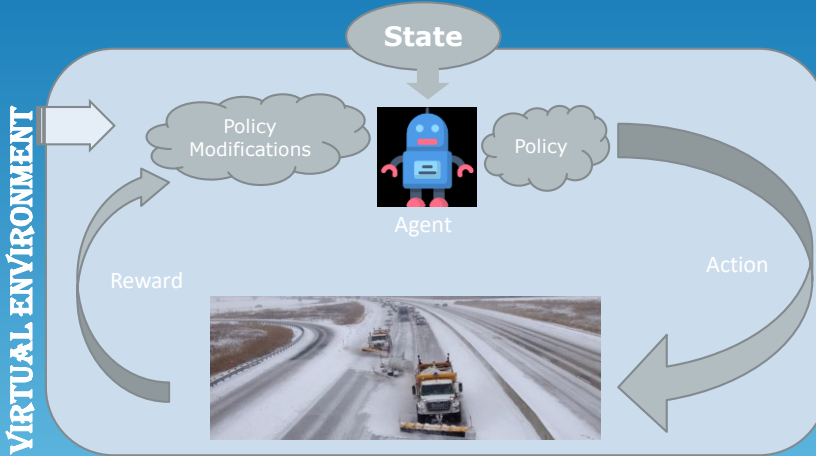
#### Level 3- Use of deep learning for road condition assessment





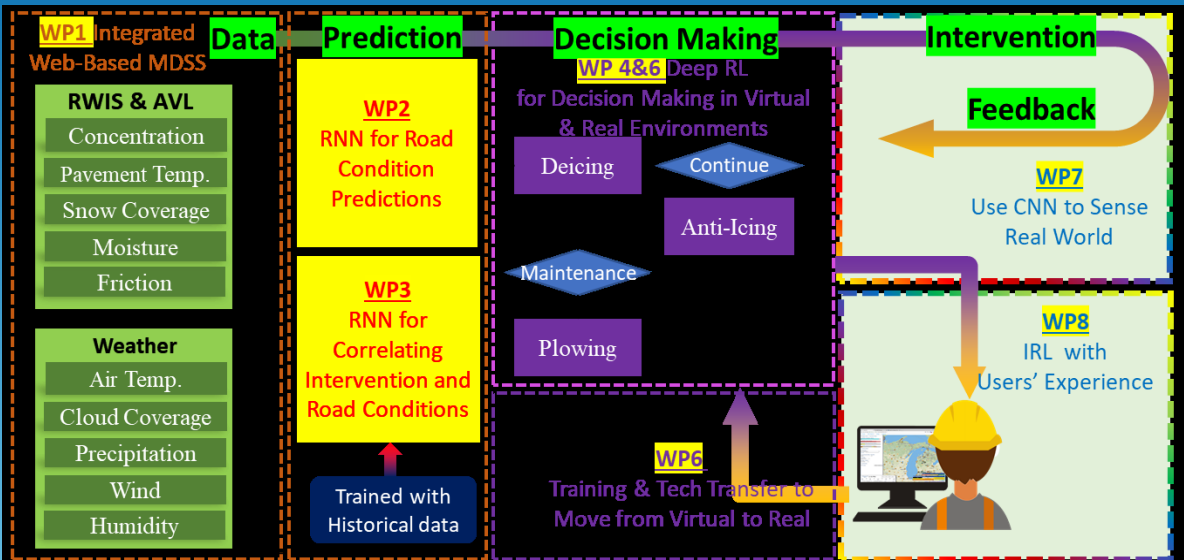
# Innovations

## 3. Autonomous Decision Making Employing DRL

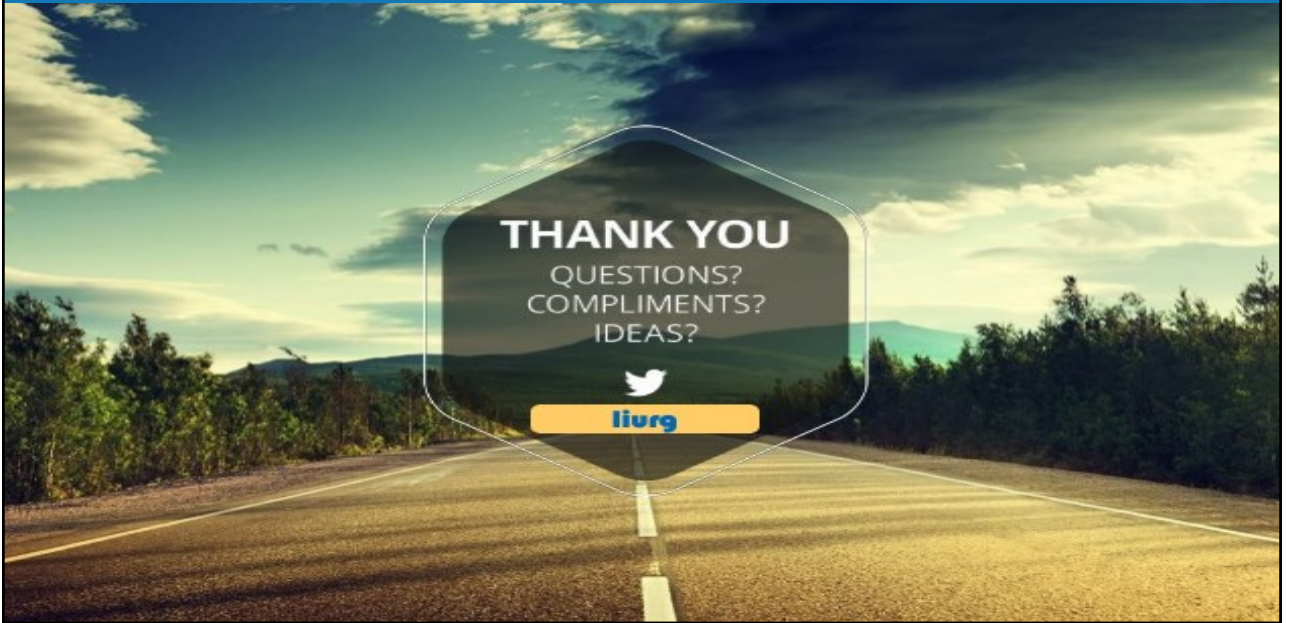


RL conceptual model in winter maintenance

## Overview of the Proposed Work



## The End, is also the Beginning



## How we can help more...

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