

# Evaluating Image-Derived Estimates of Road Weather Conditions



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## Background – UDOT Tools to Assess Road Weather

A variety of tools ranging from forecast models localized weather observation stations are used to determine hazardous driving conditions, such as pavement state.



## Background – Localized Road Weather Information

### **RWIS** Capabilities

- RWIS generate 5 to 30-minute observations of traditional meteorological variables, road variables, and traffic camera images.
- Report intervals, observed variables, and sensors for RWIS are dependent on state municipalities.
- The observed metrological variables vary between RWIS stations.
- Spatial Distribution
  - Spatial gaps exist in the network

### Road Weather Information System (RWIS)



## Background – Localized Road Weather Information



## Background – Localized Road Weather Information

### **Station Locations**

- Three RWIS stations, UT224, UTOLY, and UTWLD were used to generate this plot.
- UT224: located along State Road 224 leading to Park City, Utah.
- UTOLY: Located along state road 190 leading to Big Cottonwood Canyon
- UTWLD: located in north SLC along northbound Interstate 15

Study Duration

 Winter months (ND, JFMA) from January 2019 – April 2020



Distribution of RWIS Grip by RWIS Road Condition

**RWIS Road Condition** 

## Background – Helios Real-time Ground Weather Intelligence

### What is Helios

- Helios is software owned and developed by the L3Harris Corporation
- Helios relies on digital image processing to obtain pavement state, precipitation, and visibility information from state owned traffic camera.

### How Helios Works

- Machine learning software is given thousands of images as a training set.
- Once trained, Helios generates automated observations for observation sites.



### Background – Real Time Road Weather Conditions Using Cameras



## Background – Road Weather Conditions Using Cameras

### **RWIS to Helios Comparison**

- L3Harris will conduct random assessments on observation sites to ensure at least 90 % accuracy.
- RWIS and Helios have similar pavement state descriptions pavement state making it easy to determine Helios' accuracy

RWIS Road	WIS Road Helios Road		
Condition Codes	Co	ondition Codes	
Dry	$\Longrightarrow$	Dry	
Trace Moisture	$\Rightarrow$	Dry	
Moist	$\Box$	Moist	
Wet	$\square \hspace{-0.5ex} >$	Wet	
Chemically We	t⊟>	Wet	
Ice		Ice Warning	
Frost		NA	
Snow	$\Longrightarrow$	Full Snow	
Slush	$\Longrightarrow$	Partial Snow	
Damp	$\Rightarrow$	Moist	
No Report	$\Rightarrow$	No Report	

January 17, 1840 UTC



### Background – Real Time Road Weather Conditions Using Cameras

# Complex situations can arise that obscure the roadway making to assess road condition.



 What are the benefits and limitations of the Helios analytics' output for one camera? How can this be used for many cameras?
 How do Helios road weather variables compare to RWIS weather variables and camera images? How can this comparison be made where there is no RWIS present?

## Methods – Case Studies

**Study Location** 

- Major roadways and metropolitan areas in Utah, Colorado, and Wyoming
- Minimum distance between RWIS and traffic cameras < 1km.</li>

**Study Duration** 

• Winter months (ND, JFMA) between January 2019 - April 2020

Case Study Focus

 Compare pavement state, RWIS variables with camera images to understand if observations are accurate relative to camera images



### Data – Utah Observations

# Total Possible Utah Observations from Jan 2019 to Apr 2020 302 Days 4530 Hours 27180 Obs

Average Utah Observations (i.e. after finding all matching RWIS/Helios timestamps)



### Where does Observation loss occur?



### Relationship Between RWIS Grip and Road State





### Road State Misclassification - 17 January 2019 Case

![](_page_13_Figure_1.jpeg)

### Relationship Between Grip and Road State

![](_page_14_Figure_1.jpeg)

### Moving or Zooming Camera - 6 February 2019 Case

![](_page_15_Figure_1.jpeg)

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Time

Results 5/6

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### Direct Comparison of Road State

- A contingency table of Helios/RWIS pavement state reveals some differences in their observations.
- Instances of Helios reporting dry pavement conditions while RWIS observes high impact conditions such as wet, icy, or snow-covered roads.
- Overall, Helios performs well relative to RWIS.

CamID: UT224 Description: Park Ave / SR-224 RWIS @ Meadows Dr, PKC Helios Pavement State

		Dry	Moist	Wet	Partial Snow	Full Snow	Total
itate	Dry	6688	116	8	7	0	6819
<b>RWIS Pavement S</b>	Damp	1564	227	29	3	0	1823
	Wet	387	219	149	10	0	765
	Slush	118	54	10	107	0	289
	Full Snow	33	4	2	115	56	210
	Total	8790	620	198	242	56	9906

#### **Helios Pavement State**

		Dry	Moist	Wet	Partial Snow	Full Snow	Total	Removed
IS Pavement State	Dry	5233	116	8	7	0	5364	21%
	Damp	1427	227	29	3	0	1686	10%
	Wet	347	219	149	10	0	725	4.1%
	Slush	97	54	10	107	0	268	7.2%
	Full Snow	28	4	2	115	56	205	2.3%
RV	Total	7132	620	198	242	56	8268	17.2%
	Removed	18.8%	0%	0%	0%	0%	17.2%	١

## Takeaways

# What are the limitations of the Helios analytics' output for one camera? What impact does this have when observing many cameras?

### **Observations:**

- A limitation that Helios was unable to make nighttime observations for the 2019-2020 winter.
- Images that follow a missing image are misclassified as dry.
- A lag may be present between Helios and RWIS observation outputs.

# How does Helios pavement state compare to RWIS pavement state, road temperature, and camera images?

### **Observations:**

- Helios struggles when camera angle and zoom is changed causing inaccurate outputs.
- The relationship between grip and pavement state could be used to find pavement state outliers.

## Summary

- 1. DOT cameras help fill in the spatial gaps in coverage of RWIS stations.
- 2. The large number of cameras make it difficult of observe them simultaneously.
- 3. Image processing and machine learning could consolidate this information to allow for assessment larger segments of roadway.
- 4. Helios Real Time Weather Intelligence software performs well at identifying road state and they are addressing limitations noted in this study.

![](_page_18_Picture_5.jpeg)

![](_page_18_Picture_6.jpeg)

![](_page_18_Picture_7.jpeg)

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# Questions?

Thank you