InterMet 5: Private Sector Briefings on Innovations in Technology & Forecasting Services

Advanced Automated MET System

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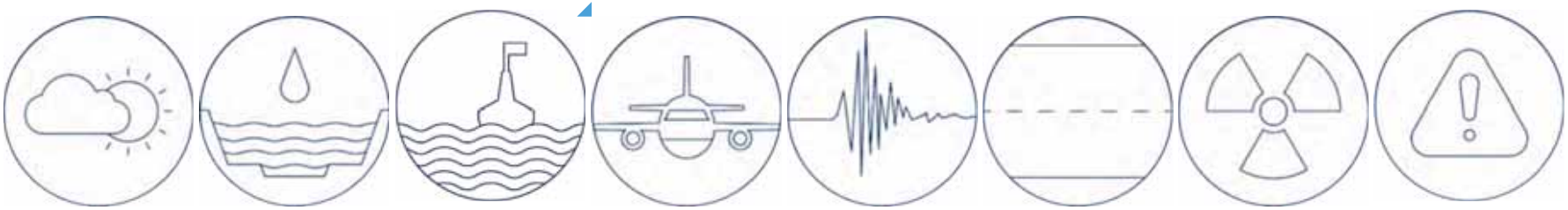
Advanced Automated MET System / Remote Observer

Cloud Coverage and Prevailing Visibility

Pavol Nechaj, Olga Vorobyeva, Martin Gazak

SESAR PJ.05 RemTow Remote Tower for Multiple Airports



MICROSTEP-MIS

Slovakia, Dubai, India, Russia, Australia, Thailand, Vietnam

25 YEARS OF CUSTOMIZING ACCORDING TO YOUR NEEDS

850+
Successful projects

65+
Countries of the world

330+
Aviation systems

COST EFFECTIVITY OF AIRPORT OPERATIONS

Two parallel approaches of operation optimization:

Remote operation:

- Remote Tower
- Remote MET Observer

Technology:

- Telecommunications
- Cameras

Full automation:

- Fully Automated AWOS

Technology:

- Intelligent sensors
- Artificial intelligence
  - Computer vision

… MicroStep-MIS addresses both approaches

CLOUD OBSERVATIONS

Cloud coverage estimation

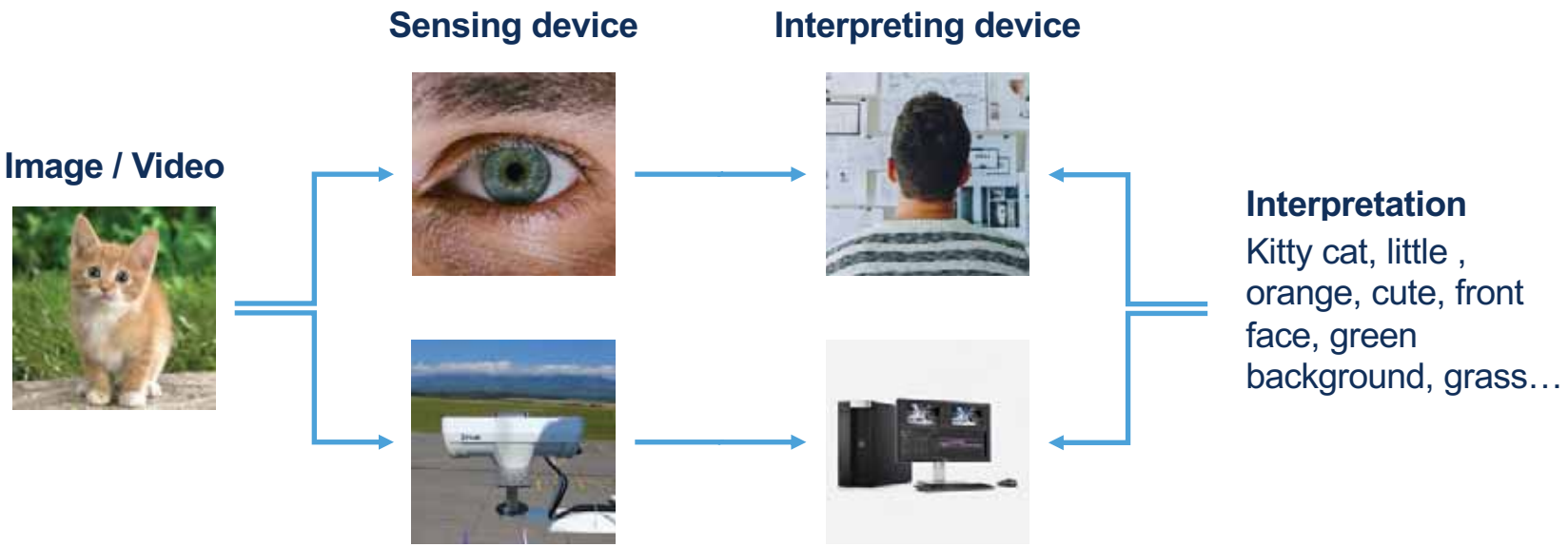
- **Human observer:** observes whole sky and tries to estimate cloud coverage and heights of different cloud layers
  - **Limitations:**
    - Subjective decisions (inconsistency between 2 local observers)
    - Night observation can be difficult
    - Non continuous observations (practically)
- **Ceilometer:** Very good at height measurement
  - **Limitations:**
    - Only one point in the sky (a few points at larger airports)

PREVAILING VISIBILITY OBSERVATION

Visibility estimation

- **Human observer:** observes horizon and estimates transparency of the atmosphere
  - **Limitations:**
    - Subjective
    - Non continuous observations (practically)
- **Sensors** (Forward scatter, Transmissiometer): very good at measuring transparency of atmosphere
  - **Limitations:**
    - Only local measurement of air between the transmitting and receiving head

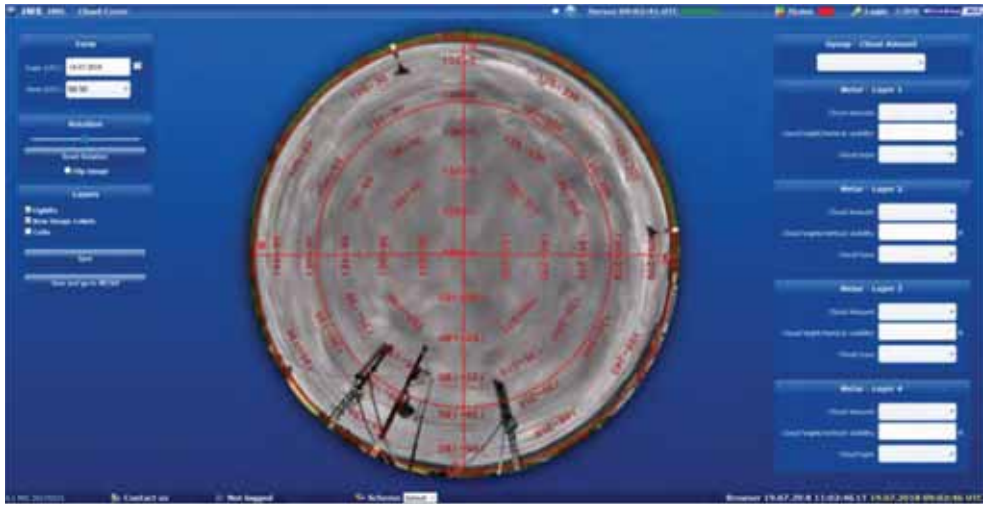
VISION / COMPUTER VISION



CLOUD COVERAGE OBSERVATION

Task:

- Compute cloud coverage from images taken by conventional camera and thermal camera. If it's possible, recognize different layer of clouds and determine their height.

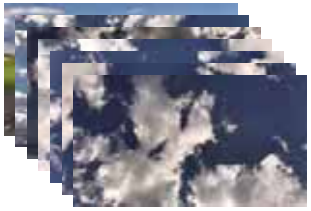


Inputs:

- 61 RGB HD images
- 64 radiometric images (infrared thermal images)
- Additional atmospheric data (temperature profile)

CLOUD COVERAGE – RGB IMAGES

RGB images



Stitching

Sky image

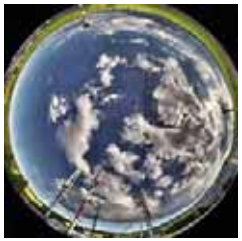
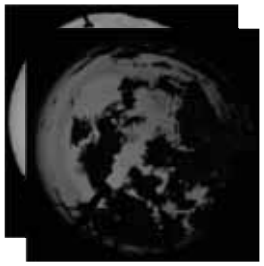
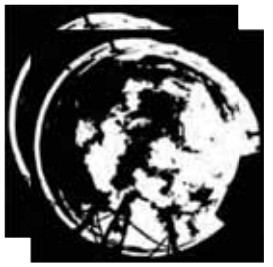


Image Processing

Sky/Grayness index



Segmentation



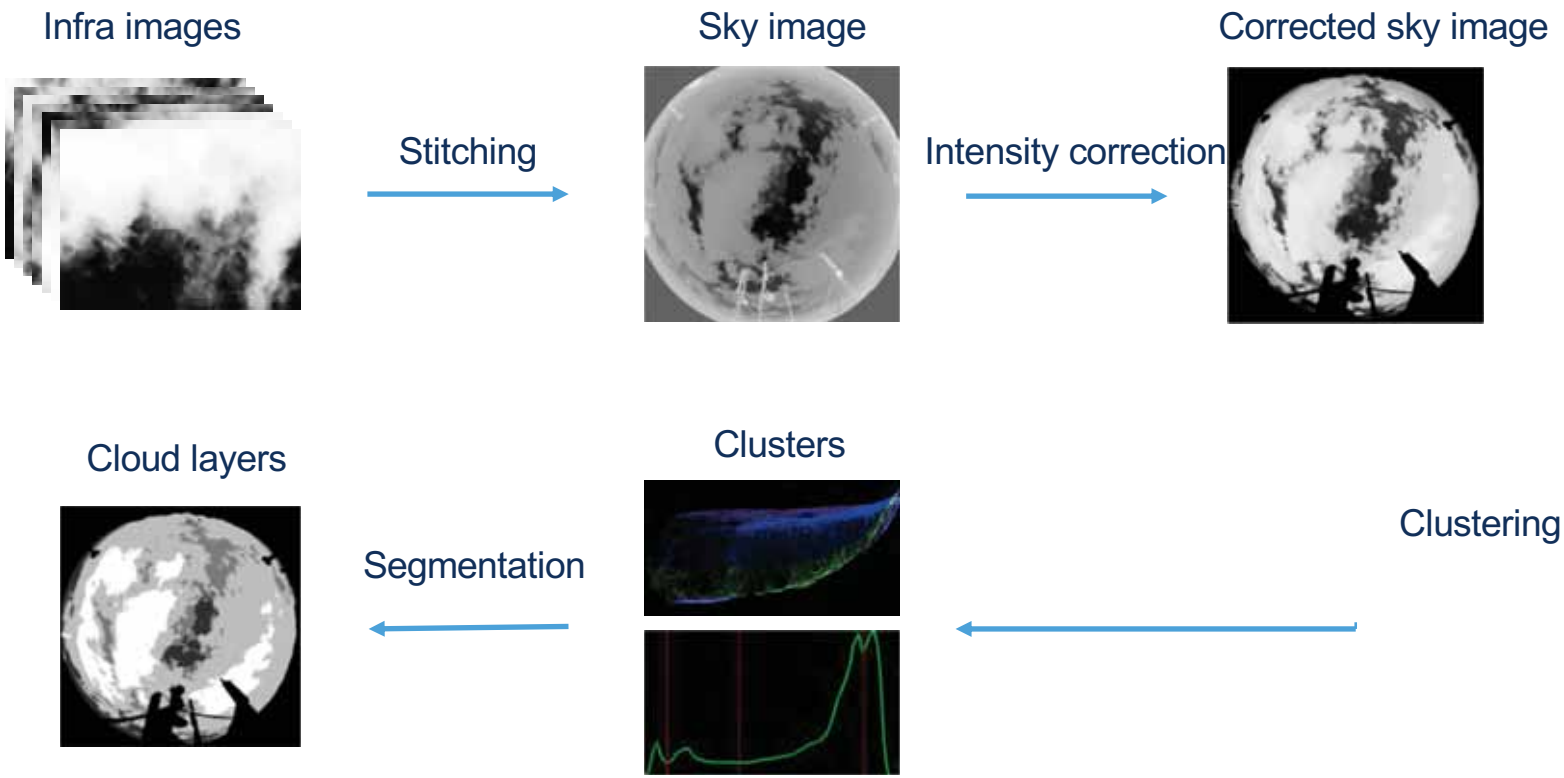
Segmented images

AI decision making

Result estimate

5/8

CLOUD COVERAGE – INFRA IMAGES



VISIBILITY – OBSERVER APPROACH VS. COMPUTER VISION APPROACH

Human observer:

- has a map of visual reference points of known distance (buildings, hills, trees, roads, …)
- Observes, whether the objects are visible (and how sharp) in each direction, select the furthest objects, …
- makes the decision about visibility

Our solution:

- uses similar procedures
- selects large amount of reference points on images (much more then for human observer).
- automatically determines which objects are visible.
- makes decision about visibility

VISIBILITY – COMPUTER VISION APPROACH

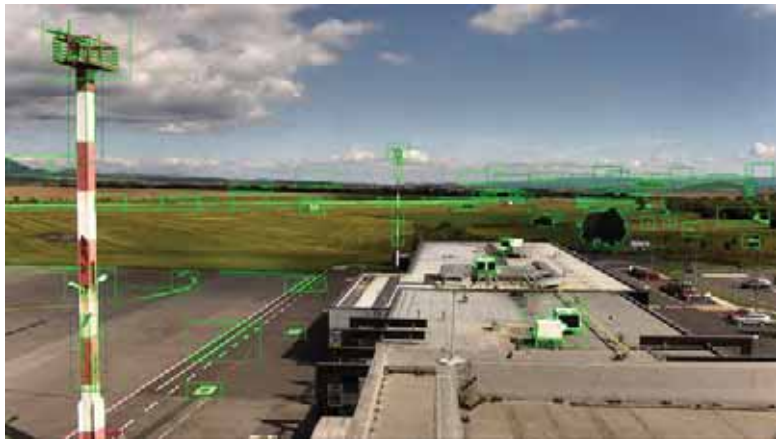
Images of horizon

Set of reference objects at known distances

Recognition

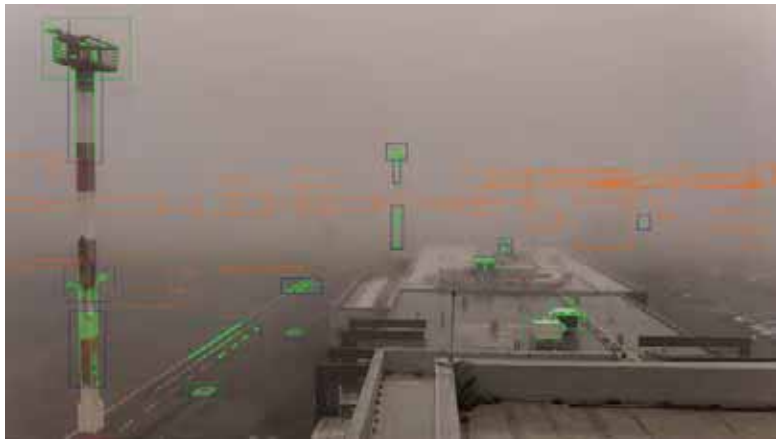
Decision

8 900 m










VALIDATION: AUGUST – DECEMBER 2018

Camera
POPRAD

Server
POPRAD

AWOS Server
POPRAD

Camera imagery SWIM service

Raw met data SWIM Service

Server

Remote Human Observer
ANYWHERE

A.T.C. Tower
POPRAD

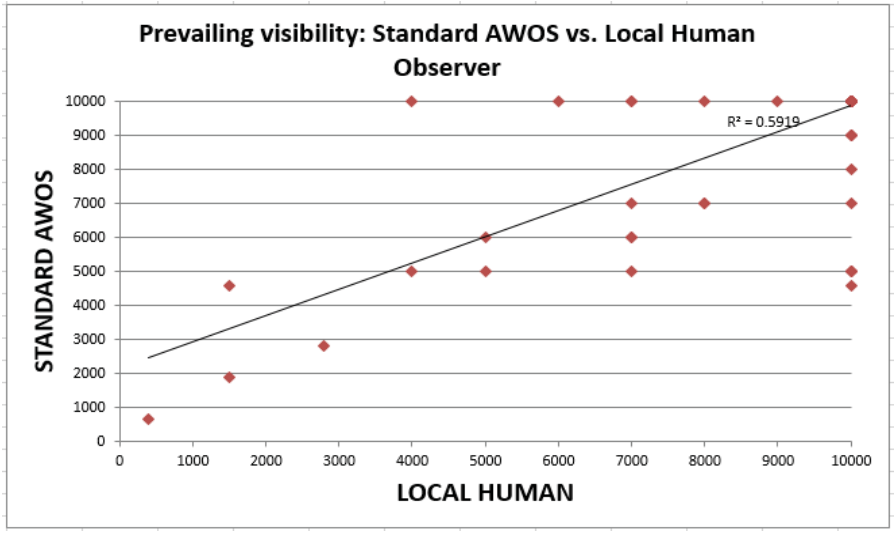
METAR SWIM Service

Worldwide users

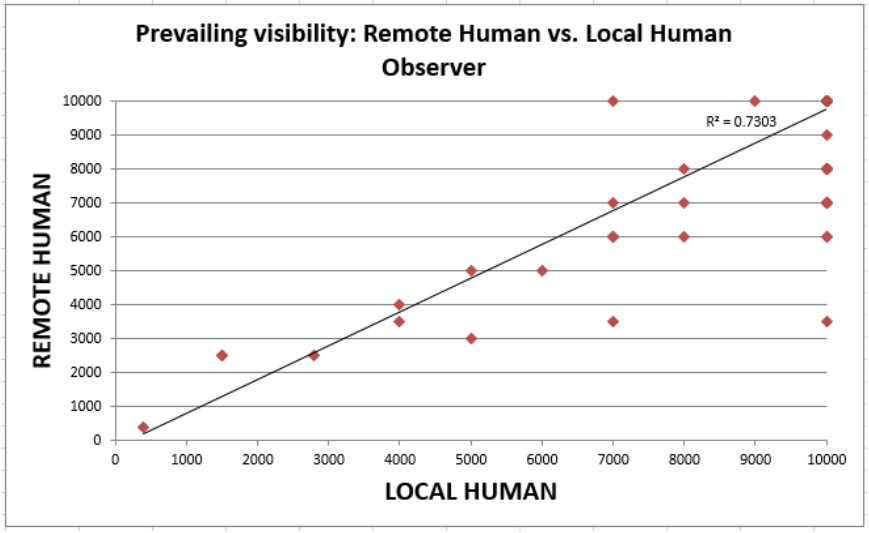
11 qualified remote observers of Slovak Hydrometeorological Institute

PREVAILING VISIBILITY: LOCAL OBSERVER VS. AWOS VS. REMOTE OBSERVER STATISTICS NOVEMBER – DECEMBER 2018 DAY SITUATION

Standard AWOS with visibility sensor



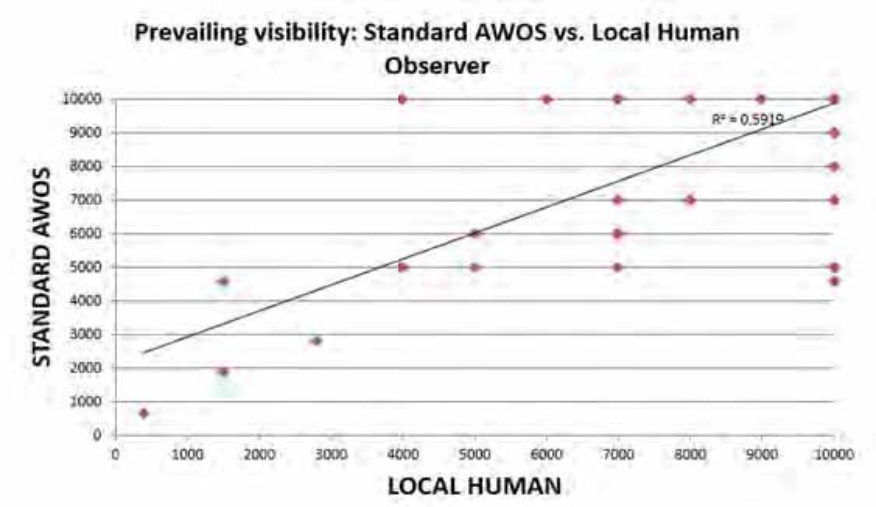
Our validated solution with cameras



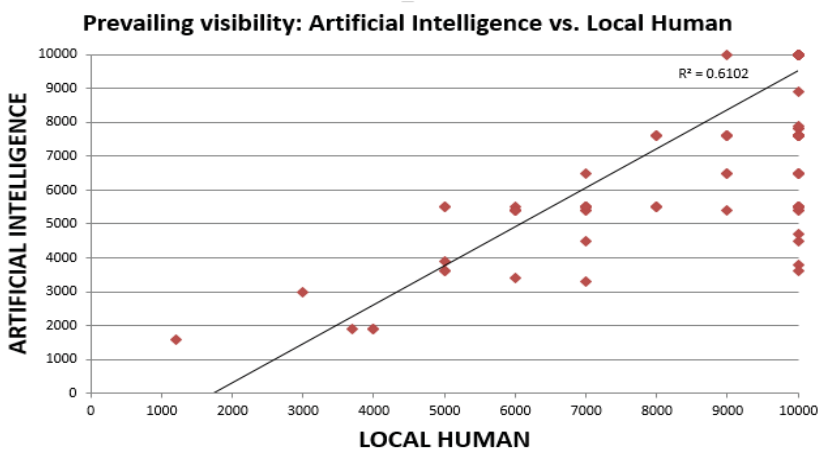
Reference = Local Human Observer (Professional Aviation observers on duty at Poprad Airport)
The comparison of the prevailing Visibility is in favour to validation scenario Remote Observer with correlation coefficient of **0,73**, while standard AWOS reference scenario has **0,59.**

PREVAILING VISIBILITY: LOCAL OBSERVER VS. AWOS VS. FULL AUTOMATION STATISTICS NOVEMBER – DECEMBER 2018 – DAY SITUATION

Standard AWOS with visibility sensor



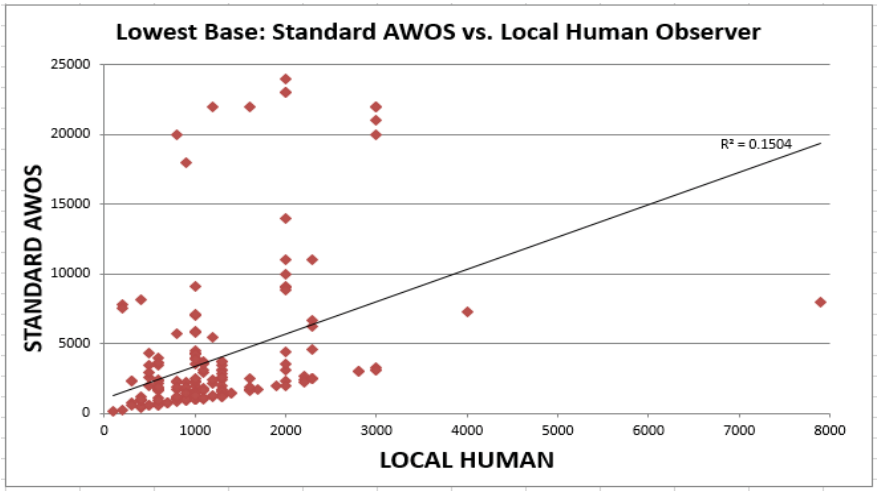
Our validated solution with cameras



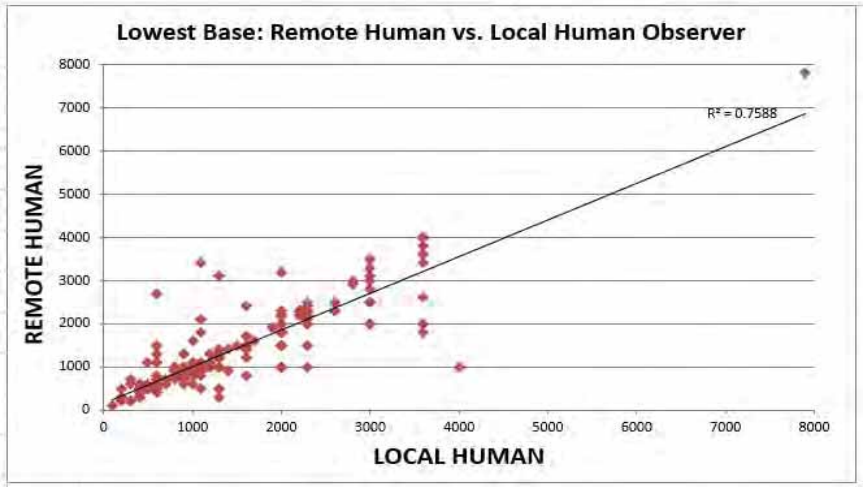
Reference = Local Human Observer (Professional Aviation observers on duty at Poprad Airport)
The comparison of the prevailing Visibility is in favor to Artificial Intelligence algorithm with correlation coefficient of **0,61**; while standard AWOS reference scenario has **0,59**.
The cameras provide the **conservative estimate**, while AWOS error is randomly distributed.

REMOTE OBSERVER - STATISTICS NOV. – DEC. 2018

Standard AWOS with ceilometer



Our validated solution with cameras



Reference = Local Human Observer (Professional Aviation observers on duty at Poprad Airport)
The correlation coefficient of validation scenario **0,7588,** which is significantly higher than correlation coefficient of reference scenario of standard AWOS **0,1504.**

STANDARD AWOS

Validation

Cloud Cover		Standard AWOS			
		FEW	SCT	BKN	OVC
Local Human Observer	FEW	3	5	10	8
	SCT	3	2	15	13
	BKN	0	0	10	67
	OVC	0	0	4	41

Additional Statistics	
Match/All	Match&Error+1/All
31 %	83 %

Cloud Cover: Standard AWOS vs. Local Human Observer

Cloud Cover		Remote Human Observer			
		FEW	SCT	BKN	OVC
Local Human Observer	FEW	56	10	0	0
	SCT	2	21	10	1
	BKN	0	2	68	7
	OVC	0	0	13	35

Additional Statistics	
Match/All	Match&Error+1/All
80 %	99 %

Cloud Cover: Remote Human Observer vs. Local Human Observer

Local Human Observer = Reference (Professional Aviation observers on duty at Poprad Airport)

CONCLUSIONS: CLOUD COVERAGE AND PREVAILING VISIBILITY USING CAMERAS

Human Observations:

- Camera images are evidence – one can verify the (subjective human) observations

Remote MET Observer:

- Accuracy of remote observations approaching the accuracy of the local observer
- Viable solution in the context of the Remote Tower concept

Camera based fully automated AWOS:

- Computer vision brings improvement to standard AWOS in prevailing visibility – especially the inaccuracy is not a **random** one (as in AWOS), but results in a **conservative = safe** estimate of prevailing visibility
- Results promising also in comparison to local observer
- Not a **magic-box** value: the decisions are traceable / justified
- **Great potential for improvement**

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