



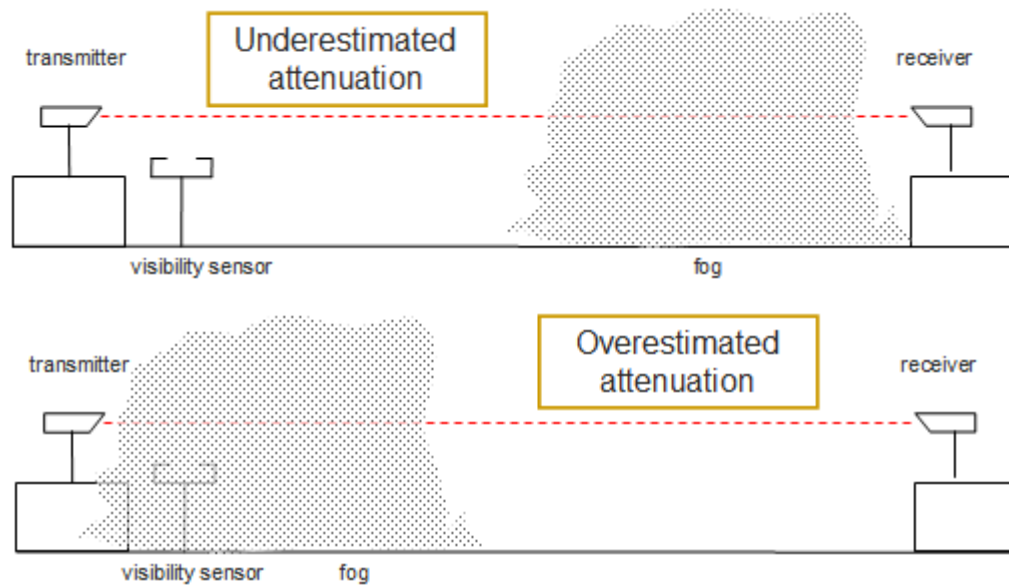
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Visibility measurement using digital camera

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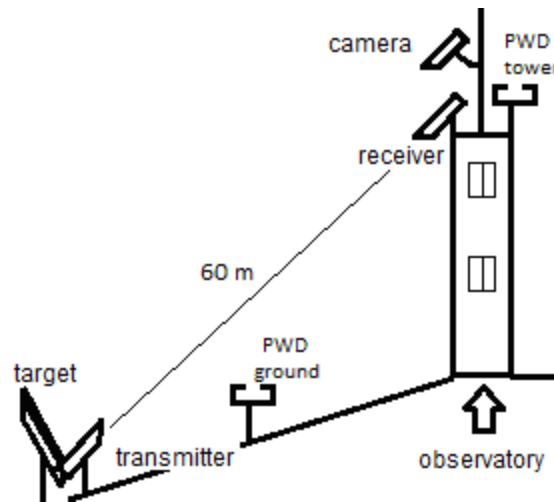
INTRODUCTION

- Visibility is a quantity describing density of fog and clouds which have the highest impact on Free Space Optical (FSO) link transmission
- Based on our experience we know that fog or clouds can be very inhomogeneous even in short distances.
- Professional visibility sensors provide only point measurement
- Modeling of FSO link attenuation from visibility is then distorted



OBJECTIVES

To develop a device for measuring the visibility between two given points (receiver and transmitter of the optical link).



Experimental optical link at
Milesovka observatory



MATERIAL & METHOD

- Camera measures the contrast between black and white parts of the target
- Formula for visibility based on Beer-Lambert law:

$$V = \frac{\ln(0.02)}{\ln\left(\frac{C}{C_0}\right)} \cdot x$$

x distance between the camera and the target

C_0 ... Intrinsic contrast of the target (measured close to it)

C Contrast measured from distance x in possible reduced visibility

Contrast measured by camera:

$$C = \frac{L_w - L_b}{L_w + L_b}$$

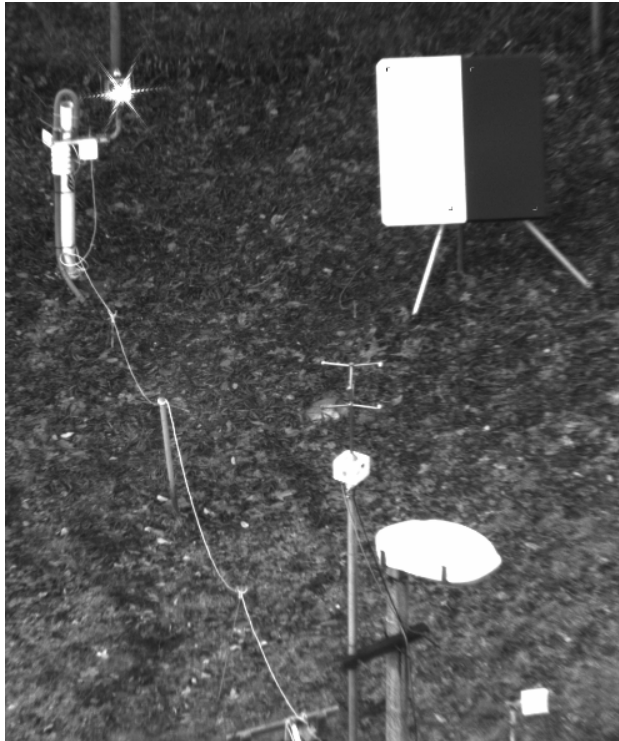
L_w, L_b ... luminance of white and black parts



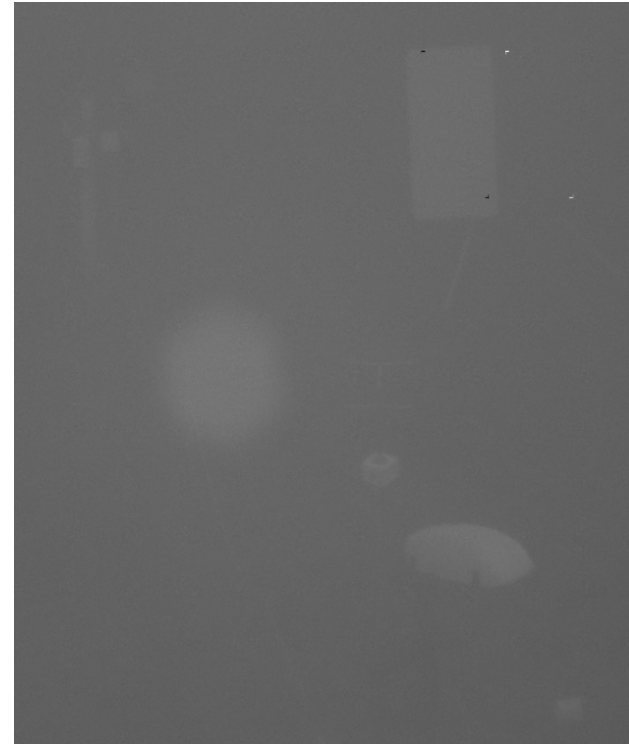
RESULTS

Examples measured by camera

Clear atmosphere – $V = 20$ km



Low cloudiness – $V = 70$ m
7.11.2012

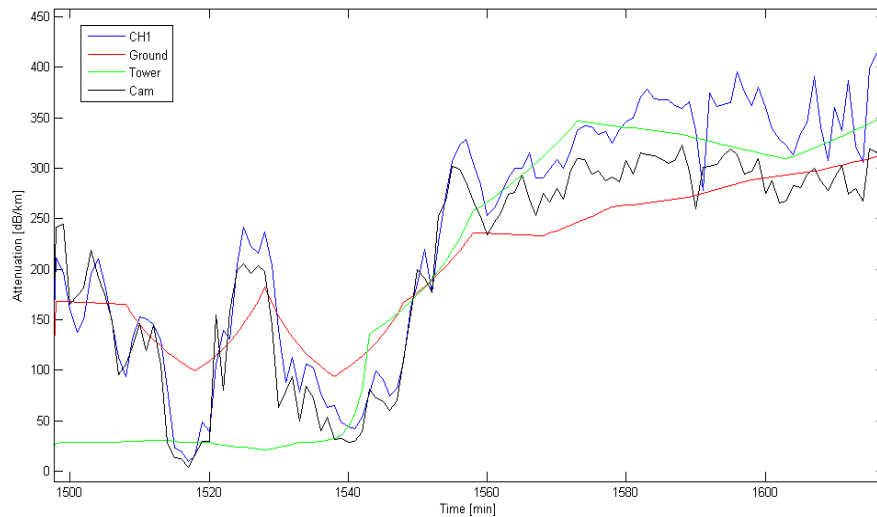


RESULTS

Comparison to professional visibility sensors

From the figure below we can see few advantages:

- PWD11 and PWD21 have a long measurement interval (10 and 15 min), camera can clearly record quick changes in visibility.
- There was the inhomogeneity of visibility in the first part of the time period. While professional sensors show distorted predictions, camera successfully follows the measured attenuation.



Measured optical attenuation at 1550 nm (blue), specific attenuations computed from

- visibility by PWD11 at the receiver (red)
- visibility by PWD21 at the transmitter (green)
- visibility by camera (black)

ACKNOWLEDGEMENT & CONTACT

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The research was supported by the grant SGFEI01/2012
by Internal Grant Agency of University of Pardubice.

Knights Ride a shadowy light into the dangerous world of a man who does not exist. Michael Knight, a young boy on a crusade to change the lives of the innocent, the helpless, the world of criminals who operate above the law.

Thunder, thunder, thunder. All Thunderers are on the move. Thunderers are here. Feel the magic, hear the voice. Thunderers are here. Thunder, thunder, thunder. Thunderers. Thunder, thunder, thunder. Thunderers. Thunder, thunder, thunder. Thunder, thunder, thunder. Thunder, thunder, thunder. Thunder, thunder, thunder.

Uppas, Uppas. Scaring through all the galaxies, in search of Earth. Flying in the night. Uppas, Uppas. Fighting and and flying with all its power and with all its might. Uppas, no-one else can do for things you do. Uppas, the light of thunder from the blue. Uppas, always fighting of the evil forces through power and justice and all.

Just the good of days, when wasn't no born. Born of you're ever was, been in trouble with the law since the day they was born. Stay together the circle. Father the life. Something the moment might get me back the answer will. Hear of their way, the way they know how that just a life of more than the world. Above, the good of days, wouldn't change. They could, fight for the spirit like a true modern day Robin Hood.