Signal Transmission and Networking Improvements of the SLR Telescope Systems in Kunming Station

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Outline

Introduction

Modularity and Scalability Improvements

Signal Transmission Improvements

Networking and IoT Integration

Future outlook and Summary

I. Introduction: SLR Telescopes of Kunming Station

The 53cm Binocular
- routine SLR observation
- Time-to-time extra experiments duty

The 1.2m Telescope
- DLR, LLR
- Multi-task experiment platform

53cm Binocular
ILRS station: 7819

1.2m Telescope
Experiment platform
7820 (inactive)

I. Introduction: Challenges

Limitations:

- Outdated frame
- Fixed mechanical structure
- Redundant cables
- Mono-task oriented design

Needs:

- New devices mounting
- High performance
- Automation oriented
- Multi-task oriented
- Universal interfaces
- Long distance signal transmission

II. Modularity and Scalability Improvements

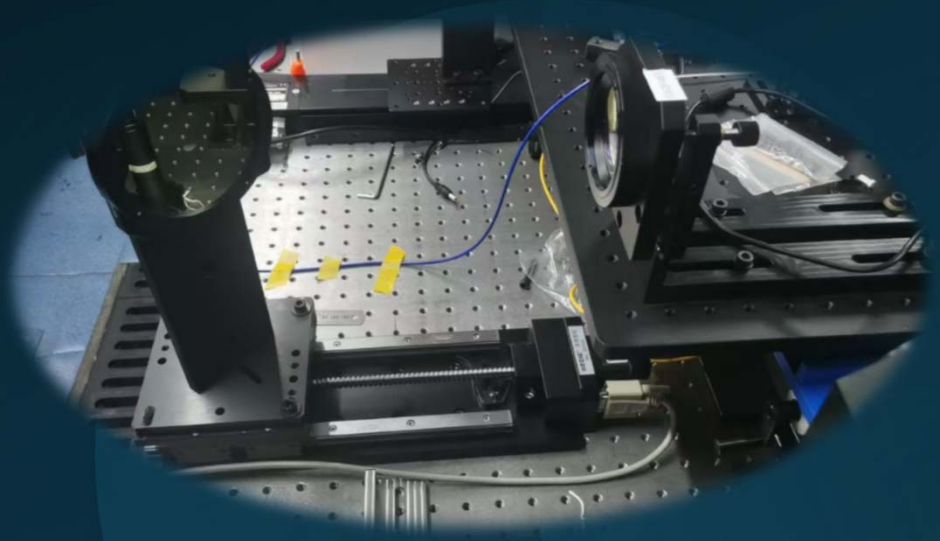
Modular Optical Frame

Camera
Optic structure
SPAD detector
Temp control

+ Flexible
+ Packed design

- Complex routing
- Installation difficulties

II. Modularity and Scalability Improvements



Shifting Platforms and Fast Steering Mirrors:
+ fast switch between functions: night - daytime
+ accurate positioning/pointing

- Size of servo/power/comm. parts
- Routing

Sensors/Heaters/Coolers
+ Static temp. inside
+ overall sys. Info. Feedback
+ close-loop

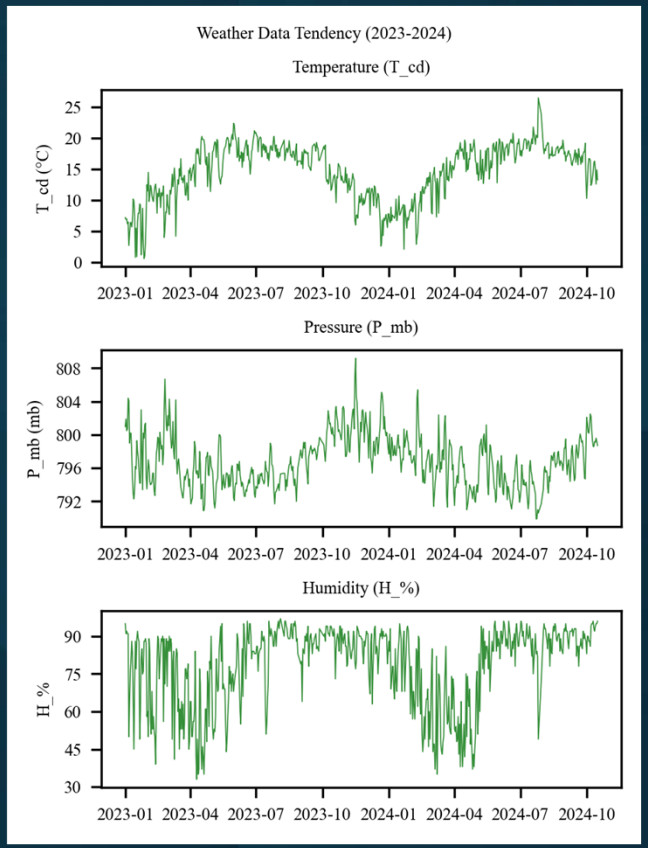
- Extra power/comm. part

III. Signal Transmission Improvements

High performance co-ax cable (25m length, 12G BW)
Key requirements:

- Propagation latency
- Stability

Meteorological Parameters Of Kunming Station



Thermostat (temperature -40°C~50°C)

10MHz signal transmission stability

Freq/Hz	Std. dev/Hz	Stability
10.0M	1.4k	0.14‰

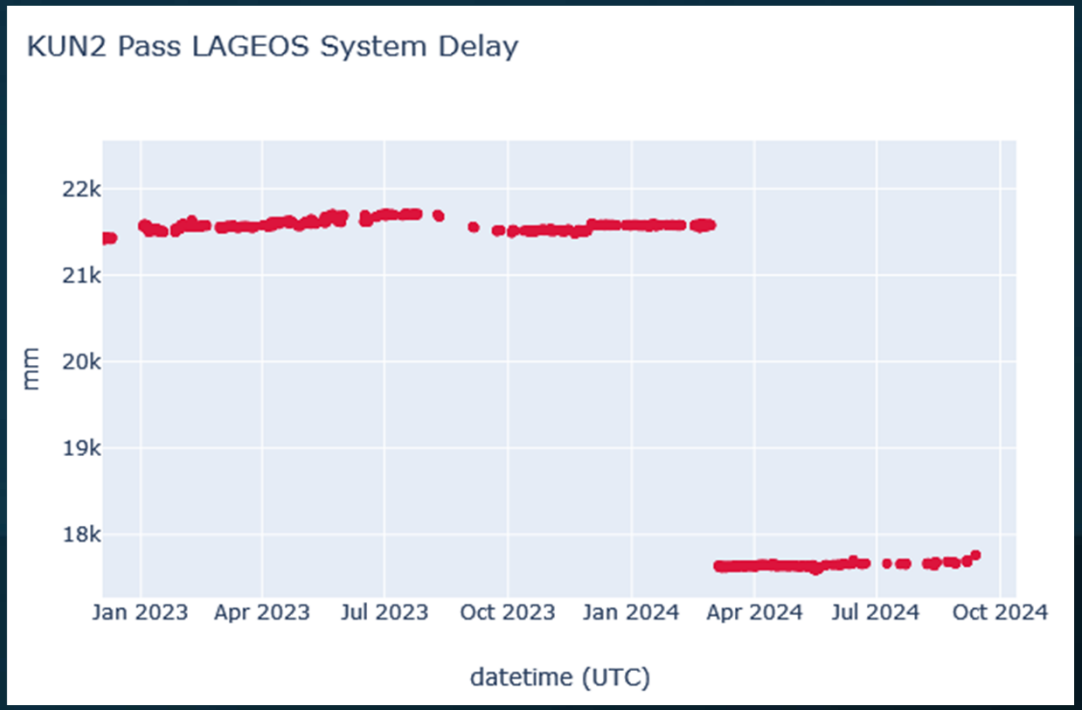
	Sample cable A		Sample cable B	
Temp	Std. dev/Hz	Stability	Std. dev/Hz	Stability
50°C	2.39k	0.24‰	2.60k	0.26‰
24.4°C	2.33k	0.23‰	2.37k	0.24‰
0°C	2.20k	0.22‰	2.23k	0.23‰
-40°C	1.84k	0.18‰	1.87k	0.19‰

Signal transmission Latency

	Sample cable A		Sample cable B	
Temp	Latency/ns	Std.dev/ps	Latency/ns	Std.dev/ps
50°C	20.75	116	21.56	98
24.4°C	20.80	90	21.61	92
0°C	20.79	107	21.59	111
-40°C	20.81	107	21.62	110

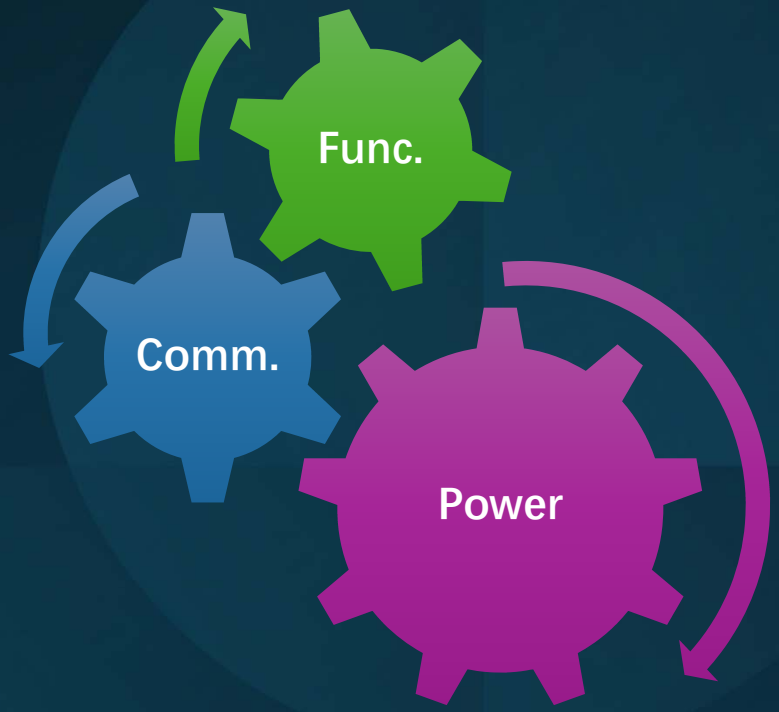
III. Signal Transmission Improvements

Performance Improvement



IV. Networking and IoT Integration: Analysis

1 **Each device is a unity of …**



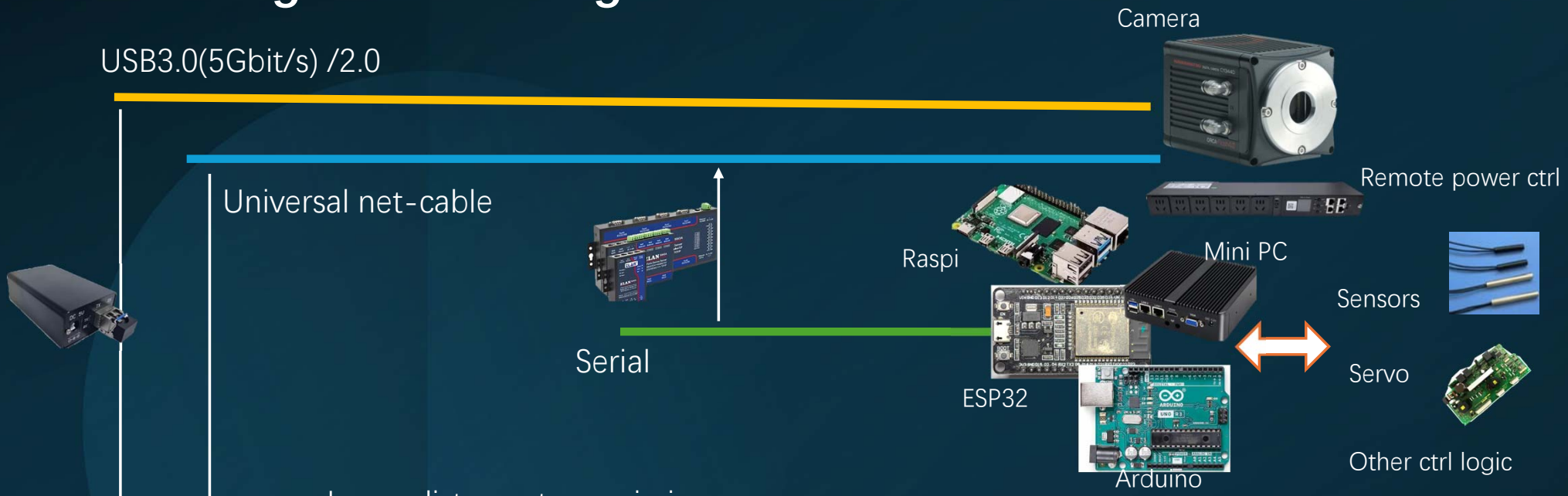
2 **Signal transmission priority**

- Transmit/echo: time-related parameters
- Image (Bandwidth)
- Control/feedback
- Fundamental needs

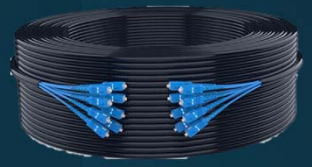
3 **Interface/protocol requirements:**

- Universal
- Small size
- Easy for testing/maintenance

IV. Networking and IoT Integration



Fiber (multi-core)



- Small size/diameter
- High bandwidth
- Universal interfaces
- Armored for durability
- Multi-purpose usage

Universal net-cable

Computer

USB3.0/2.0

- Implemented @ 53cm Binocular

IV. Networking and IoT Integration

- Implemented @ 1.2m telescope

V. Future Outlook

Edge computing

Reduce of redundancy

Automation

- Reduced communication latency between IoT devices and the central IT network.
- Faster response times and improved efficiency.
- Increase network bandwidth.
- Systems can continue to operate offline in case of loss of network connectivity.
- Data processing, aggregation and fast decision-making locally through analytical algorithms and machine learning.

09:45-10:00	**Window Incremental Forest for System Delay Prediction in Satellite Laser Ranging** **Speaker: Yang Chun** **Affiliation: Yunnan Observatories, Chinese Academy of Sciences**

V. Summary

- Limitation results from outdated telescope structures in adaptability to new experimental requirements and technological integrations.
- Recent enhancements in modularity and scalability aimed at improving the system's performance and expanding its functional capabilities.
- High-performance co-ax cables significantly reducing system latency.
- Integration of Internet of Things (IoT) devices, enhancing data bandwidth and enabling more efficient remote management of the telescope system.

谢谢！

Thank you!

23rd International Workshop on Laser Ranging

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