Geoinformatics Laboratory, IIT Kanpur

AN INDIGENOUS DEVELOPMENT
OF
LAND BASED MOBILE MAPPING SYSTEM

India Geospatial Forum 2013

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Mobile Mapping System

Sporting two lidar sensor heads, the rooftop mobile scanning system collects data while traveling at posted speeds.

Mapping Sensors
- Laser Scanner
- Digital camera

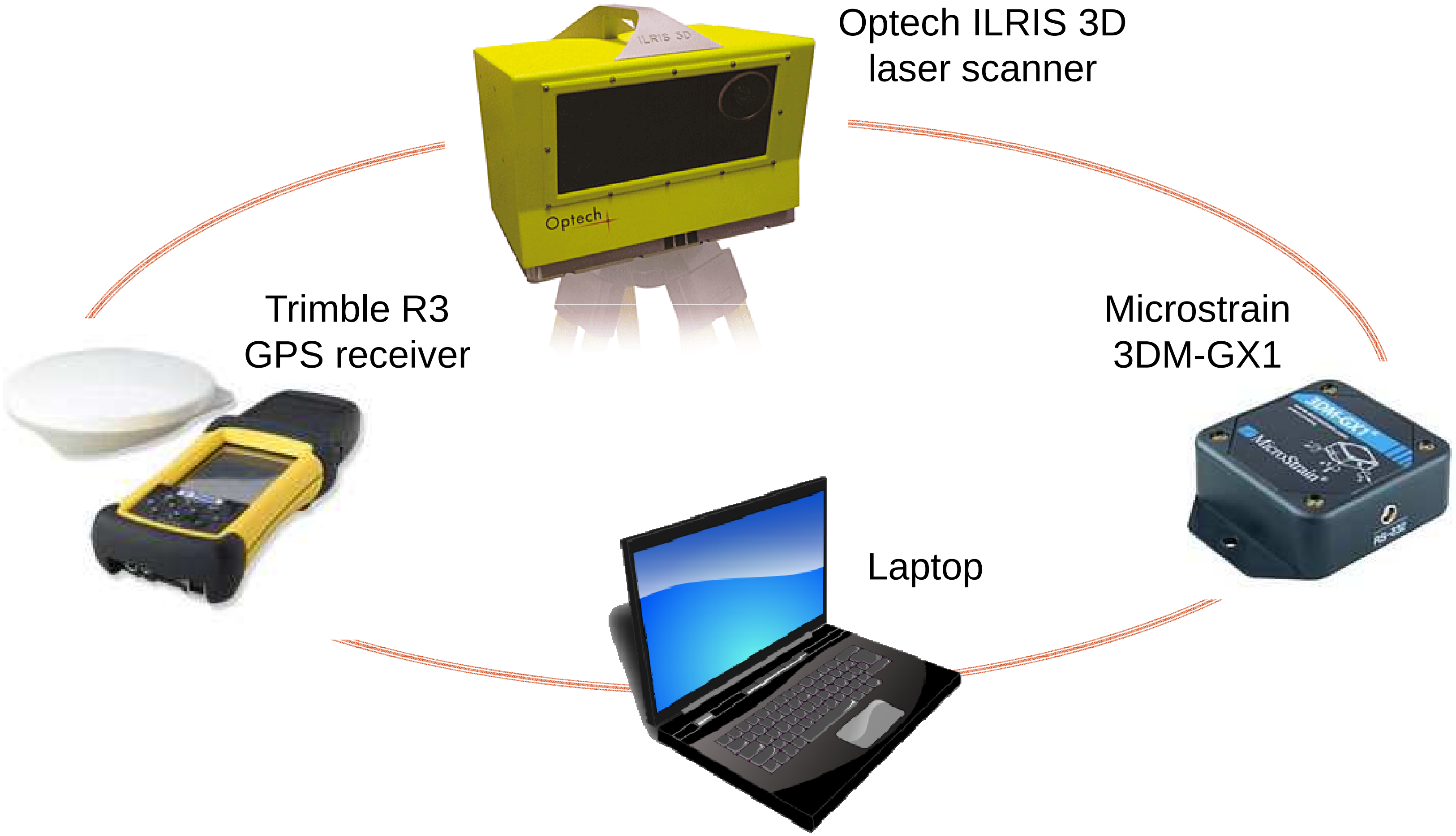
Navigation Sensors
- Distance Measurement Instrument(DMI)
- GPS
- Inertial Measurement Unit (IMU)

Synchronization device

Need for development

- High procurement costs
- Affordability
- Lack of industry standards
- Different needs and requirements
- Customize d solutions
- Commercial developmen t
- Self reliance
- Development of local expertise
- Scalability
- Jobs and opportunitie s
- Building India
- Maintenanc e
- Black box
- Calibration
- Operation s

Components

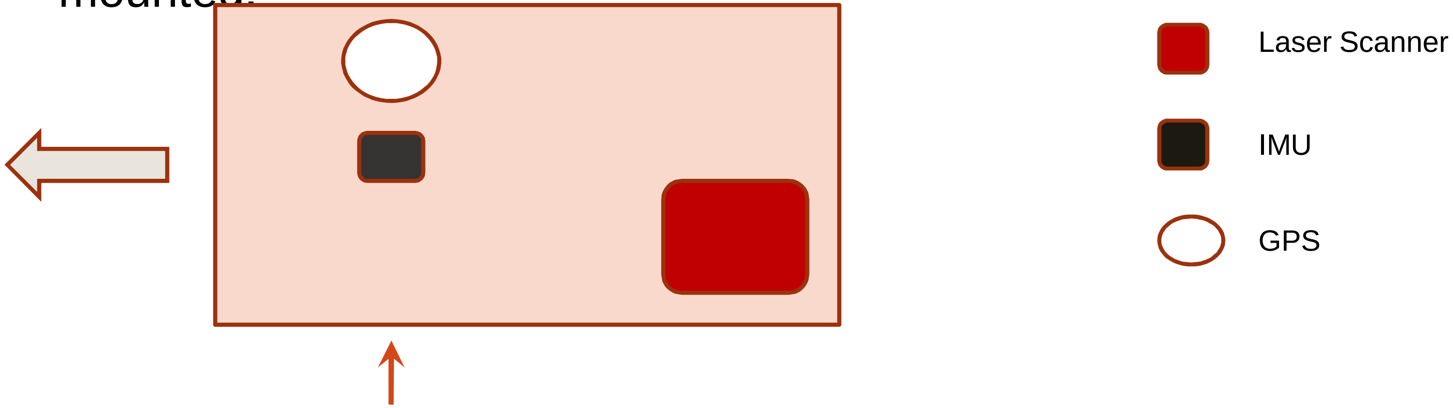

Optech ILRIS 3D
laser scanner
Trimble R3
GPS receiver
Microstrain
3DM-GX1
Laptop

Feasibility analysis

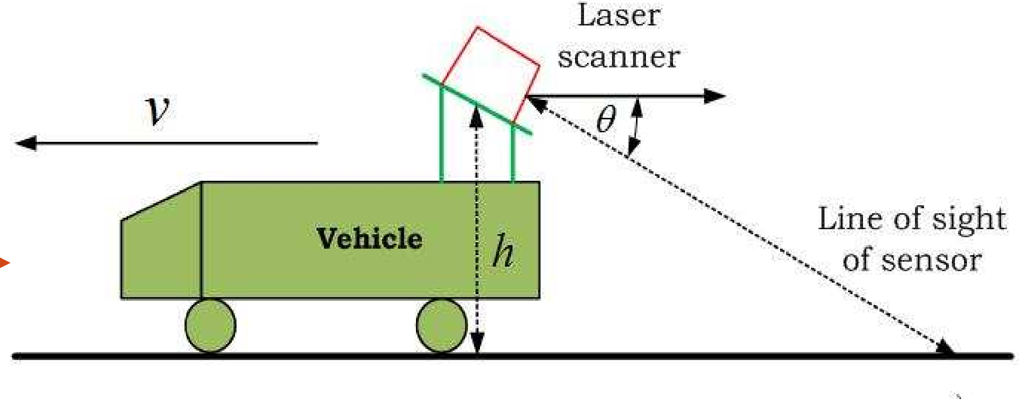
- Component integration
- Equations for calibration and processing
- Simulations and testing

System Design

Determination of angles and heights at which instruments should be mounted.

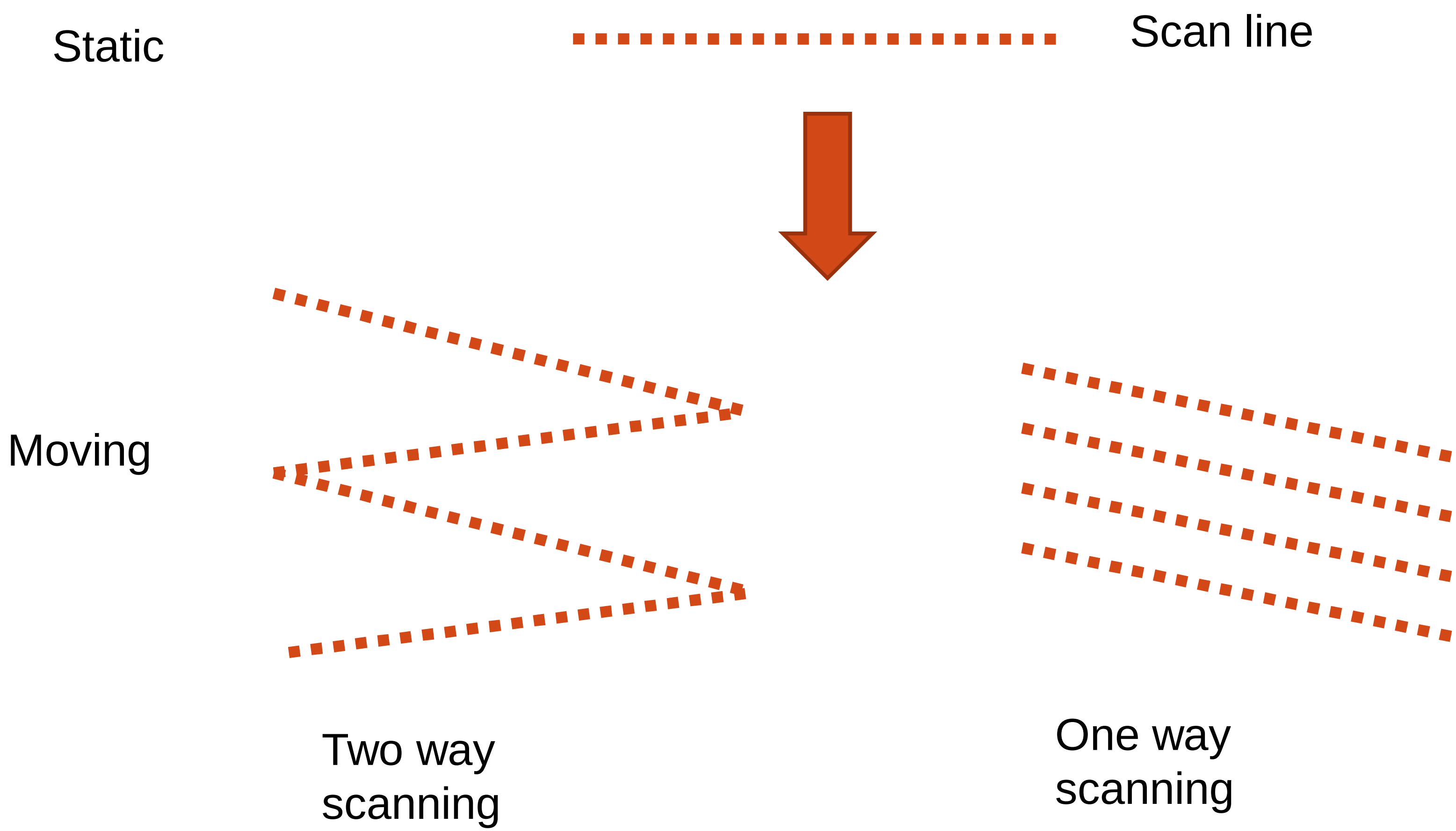


Top view



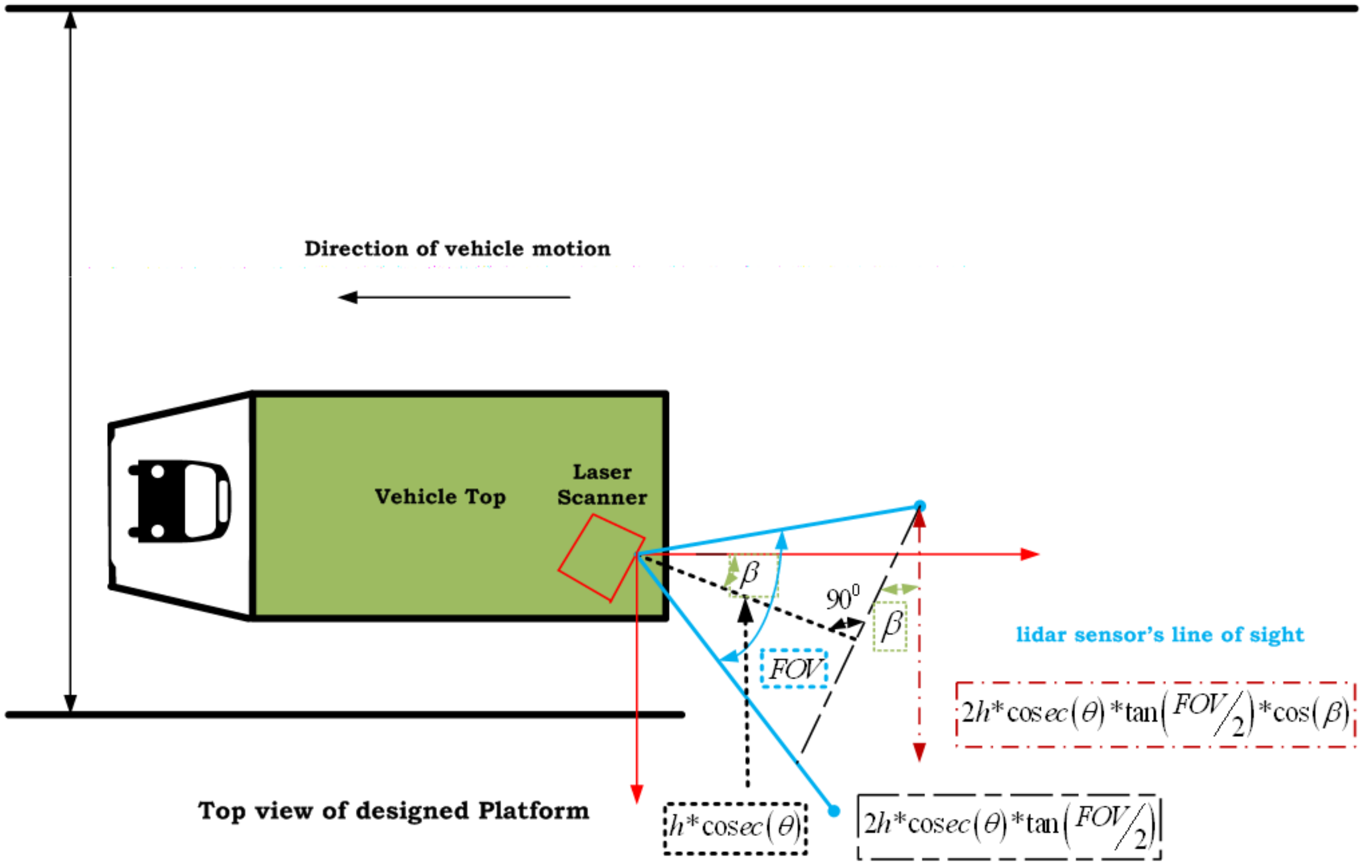
Side view

System Design



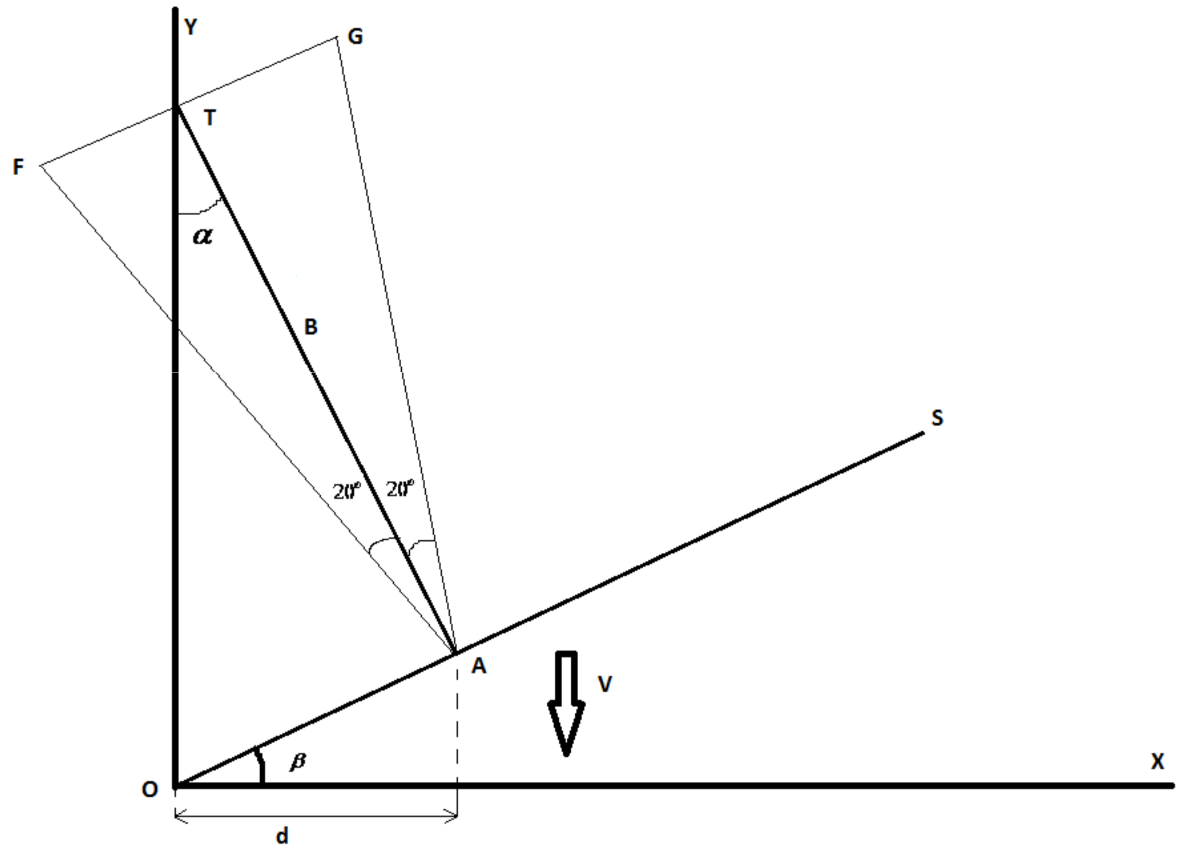
System Design

MMS: System Designing



Top view of designed Platform

System Design



$$OS = (\cos\beta) * i + (\sin\beta) * j$$

$$OT = -\sin(\theta) * k + \cos(\theta) * j$$

$$OS * OT = |OS| * |OT| \cos(90 - \alpha)$$

$$\sin\alpha = \sin\beta * \cos\theta \quad \text{-------}(1)$$

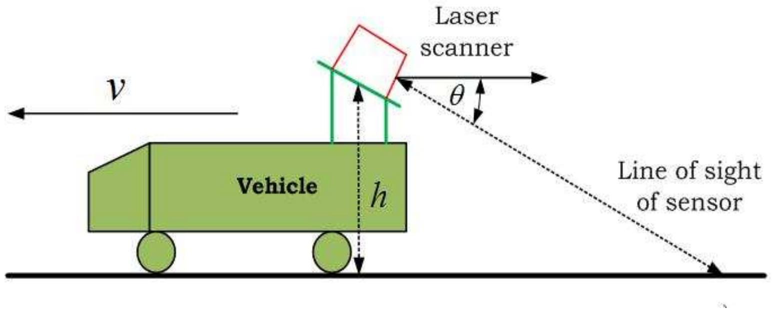
$$\frac{B}{\sin(90-\alpha)} = \frac{d\sec(\beta)}{\sin(\alpha)}$$

$$\tan\alpha = \frac{d\sec\beta}{B}$$

$$\alpha = \tan^{-1}\left(\frac{d\sec\beta}{B}\right) \quad \text{------}(2)$$

System Design

Solve equations (1) and (2) to compute angles.



$$h = 2.5m$$

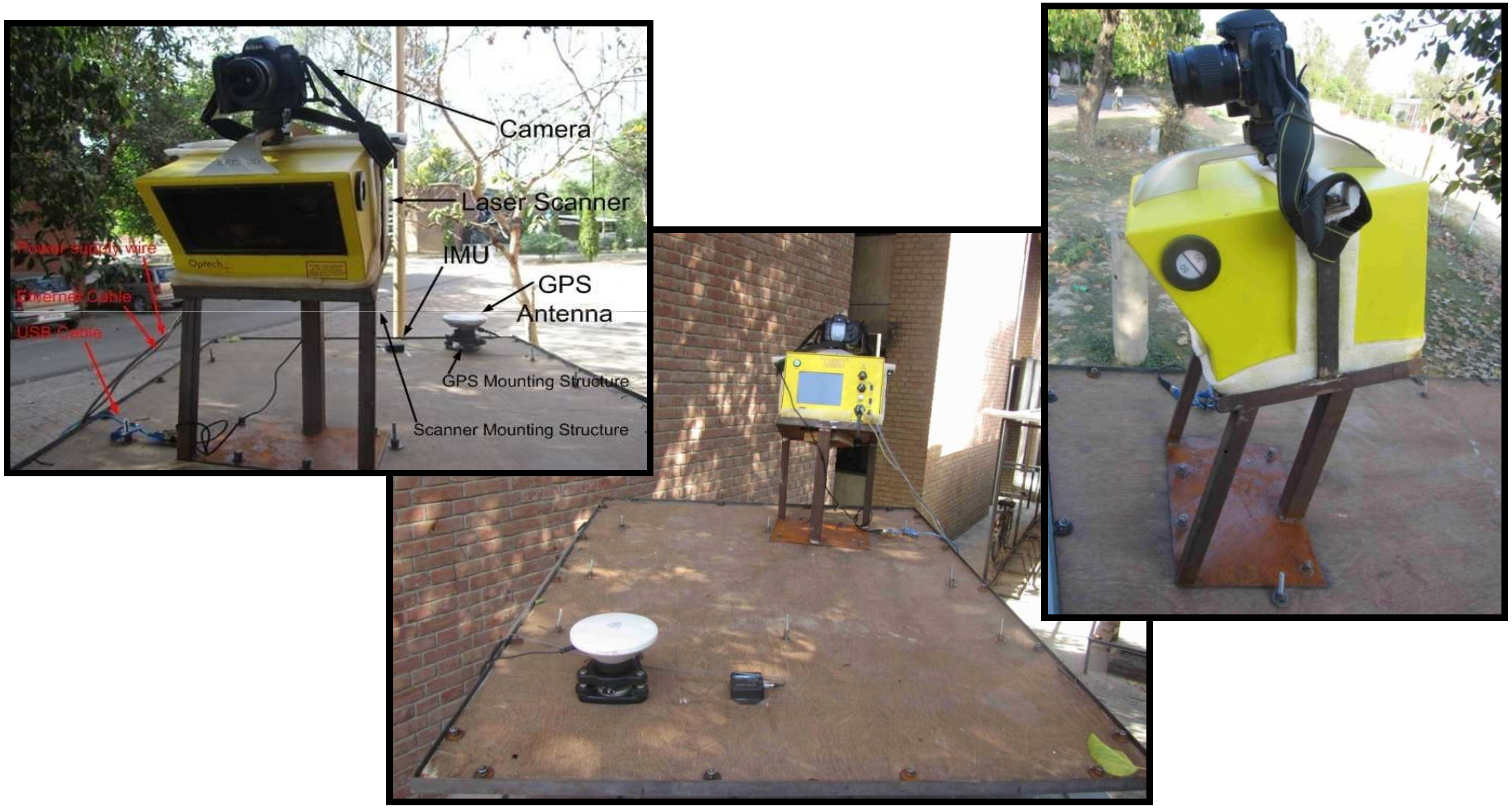
$$d = 1.0m$$

Case 1 Case II

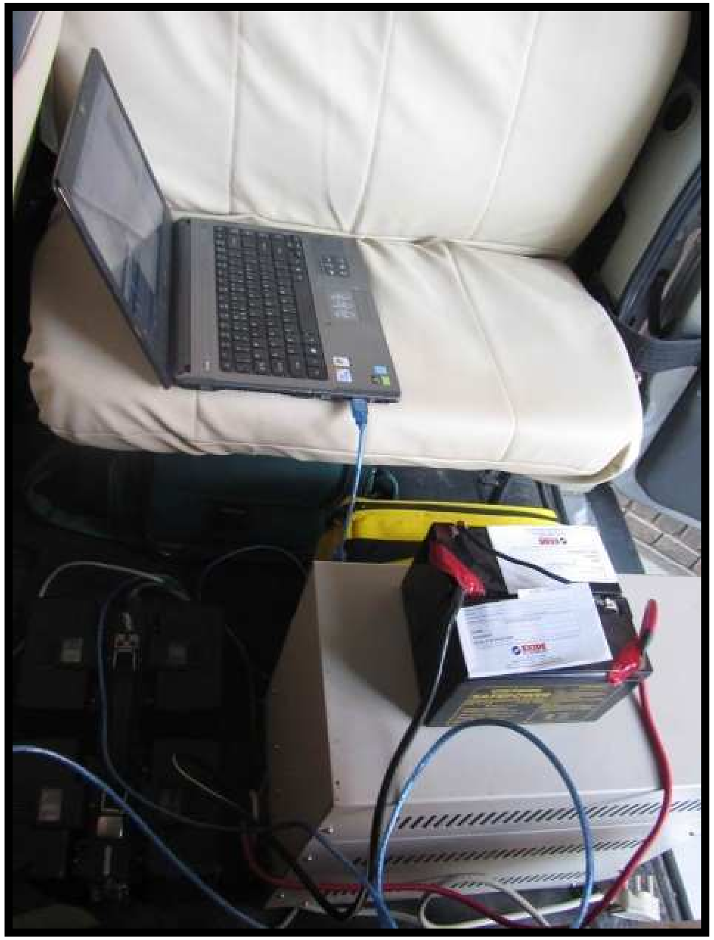
θ = 20°	θ = 30°
β = 8.39°	β = 13.4°
α = 7.87°	α = 11.6°
W = 5.35 m	W = 3.64 m

Increasing the tilt angle decreases the width of the scanned region.

Integration Infrastructure

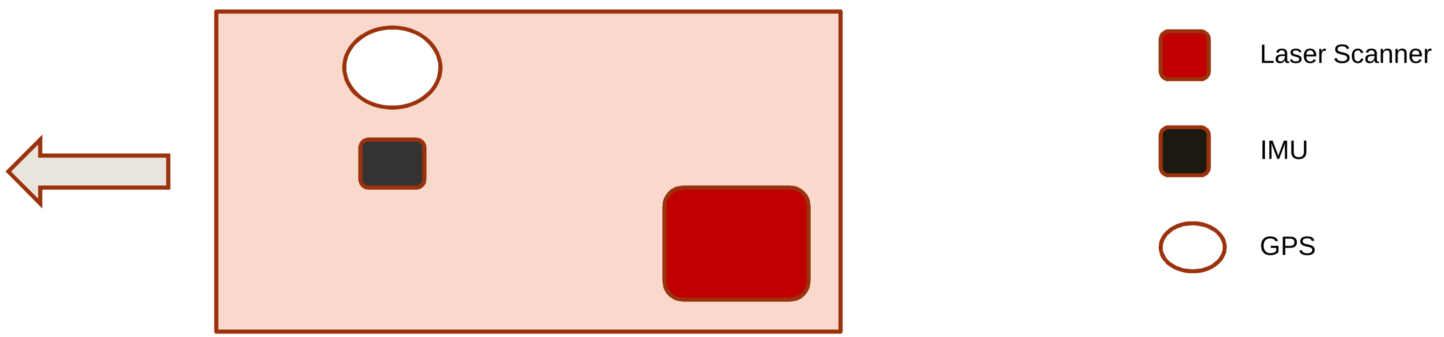


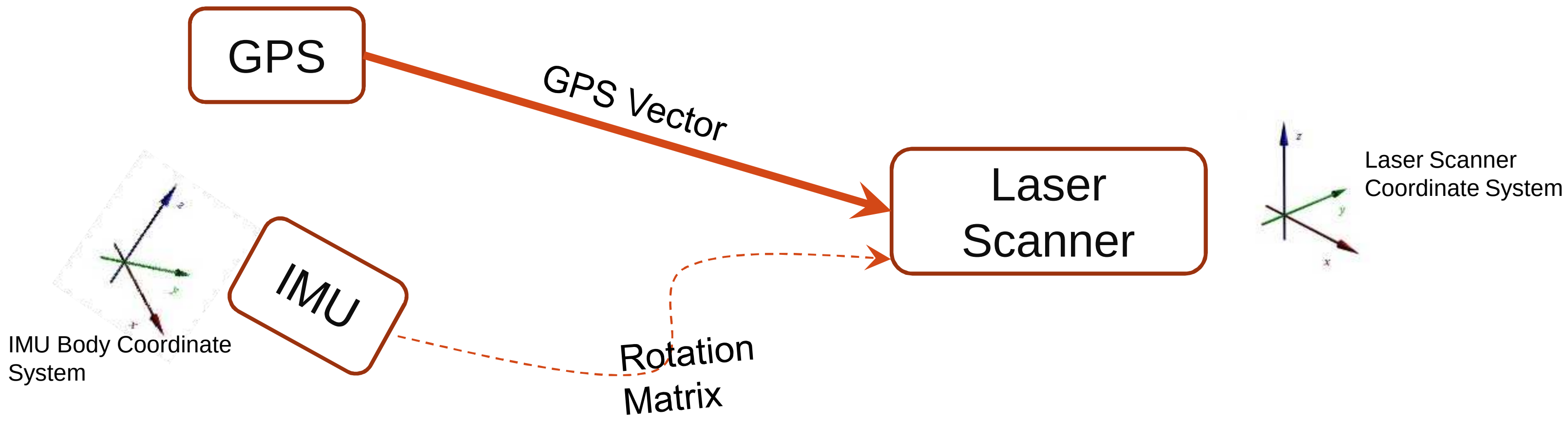
Integration Infrastructure



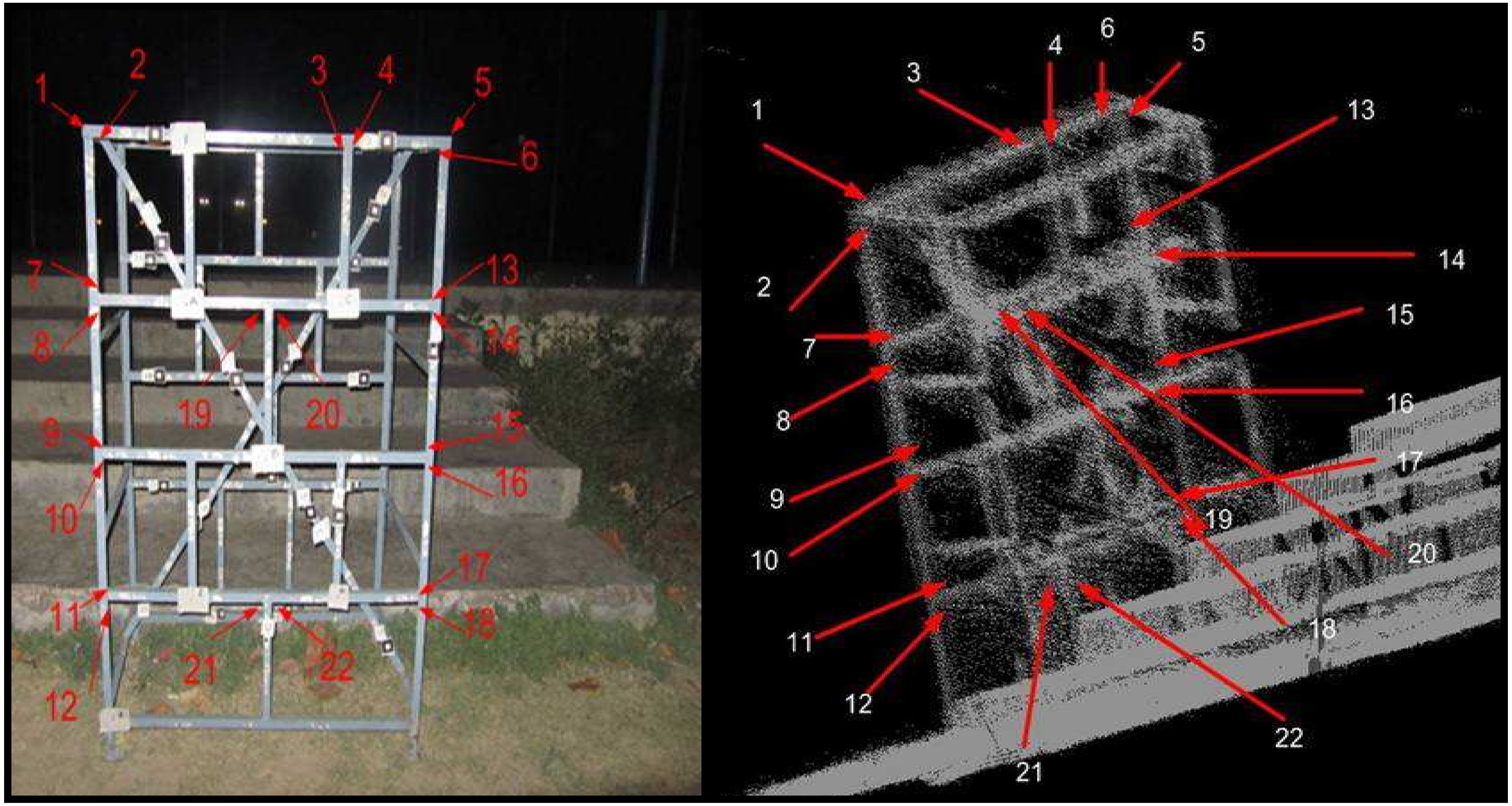
System calibration

Determination of GPS vector and Bore Sight values.

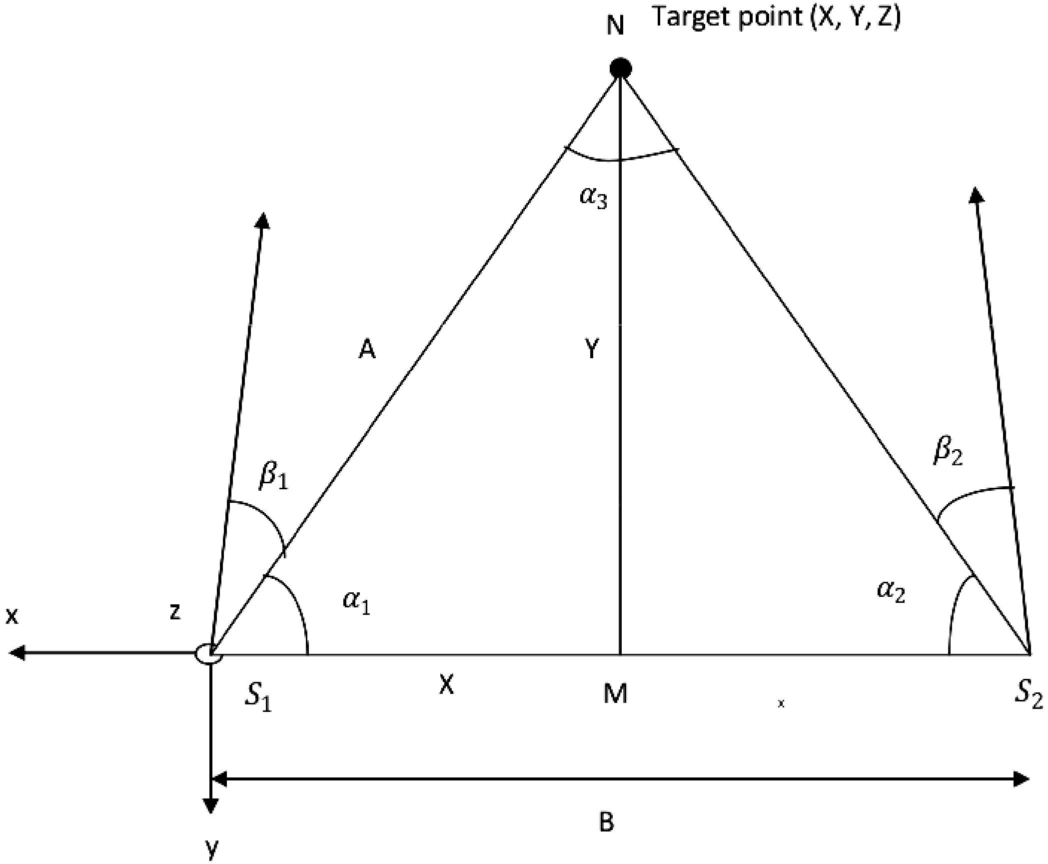




System calibration



System calibration



$$\frac{A}{\sin(\alpha_2)} = \frac{B}{\sin(\alpha_3)}$$

$$A = B\frac{\sin\alpha_2}{\sin\alpha_3}$$

$$\alpha_3 = 180 - \alpha_1 - \alpha_2$$

$$x = A\cos\alpha_1$$
$$y = A\sin\alpha_1$$
$$z = A\tan\beta_1$$

System calibration

Minimize the function to determine the calibration parameters.

$$F_i(l_a, c_a) = r_{global}(i) - r_{las}(i) \times R_{las}^{IMU} \times T_{las}^{GPS} \times M_{IMU}^{global}$$

$$M_{IMU}^{global} = R_{IMU}^{\tan gential} \times R_{\tan gential}^{global} \times T_{GPS}^{global}$$

$$T_{GPS}^{global} = T(X_{GPS}, Y_{GPS}, Z_{GPS})$$

To determine the parameters:

$$R_{las}^{IMU} = R_x(\alpha_0) \times R_y(\beta_0) \times R_z(\gamma_0)$$

$$offsetvector = [dx, dy, dz]$$

Test field


Kalyanpur
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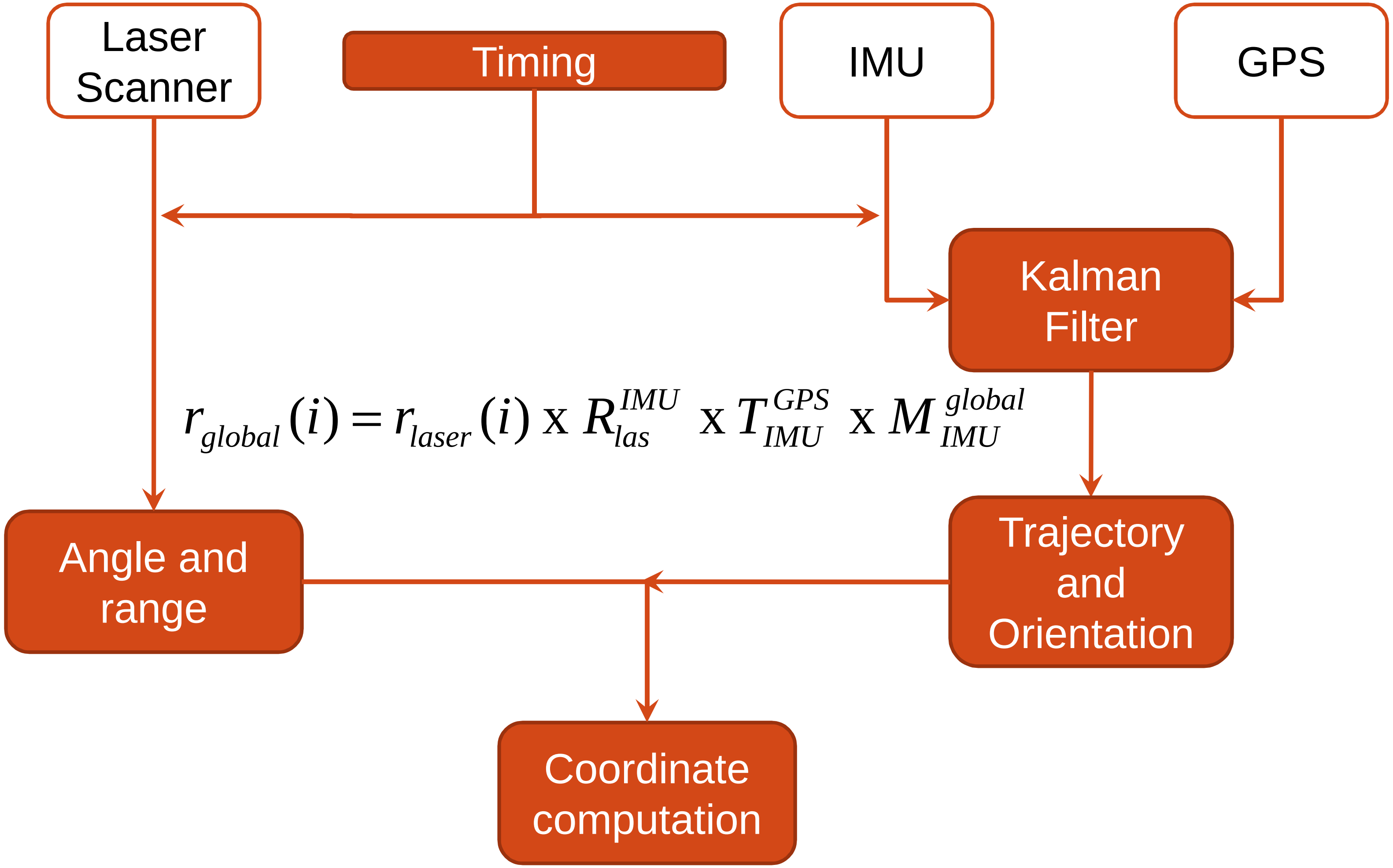
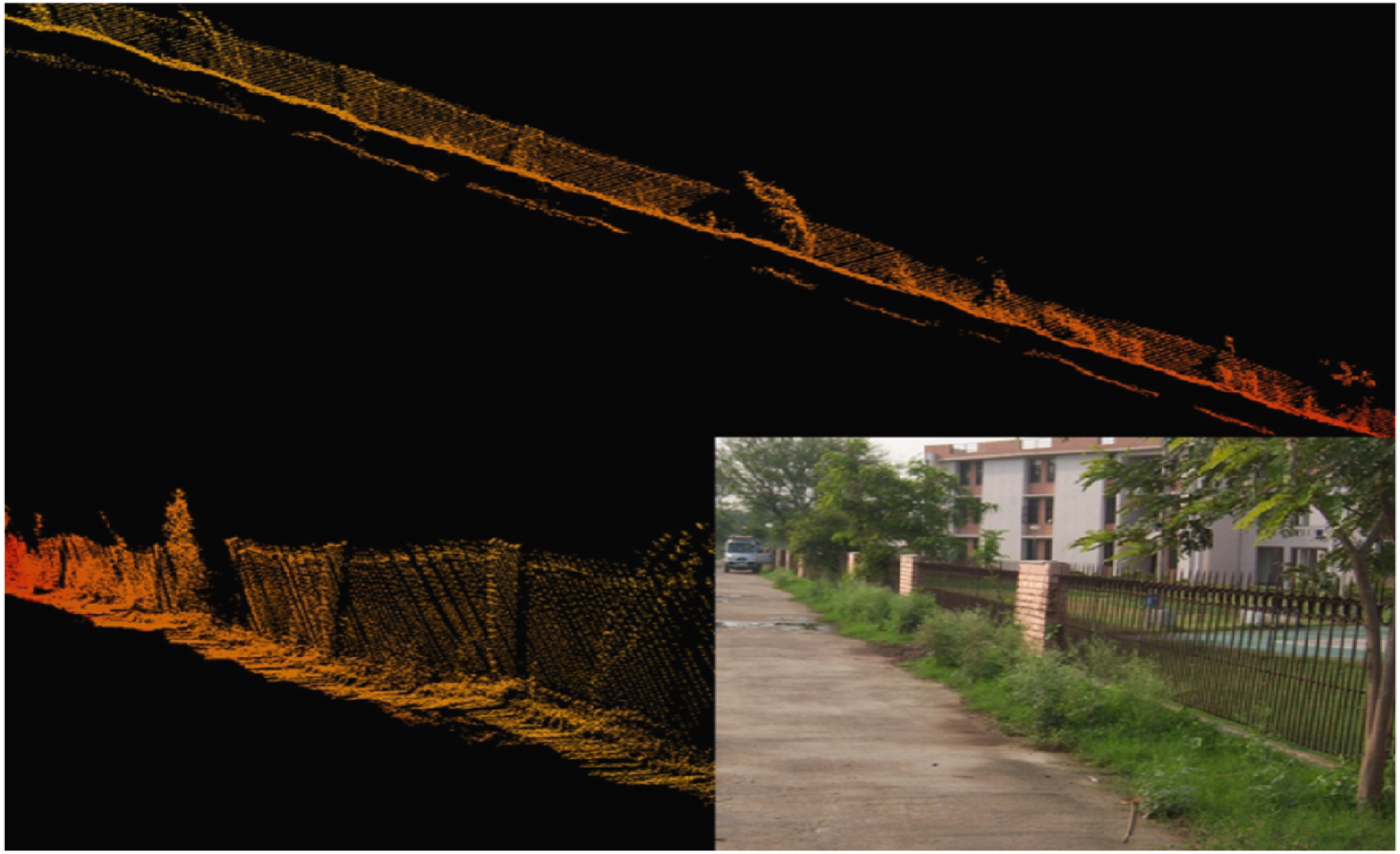
Test field

Flow

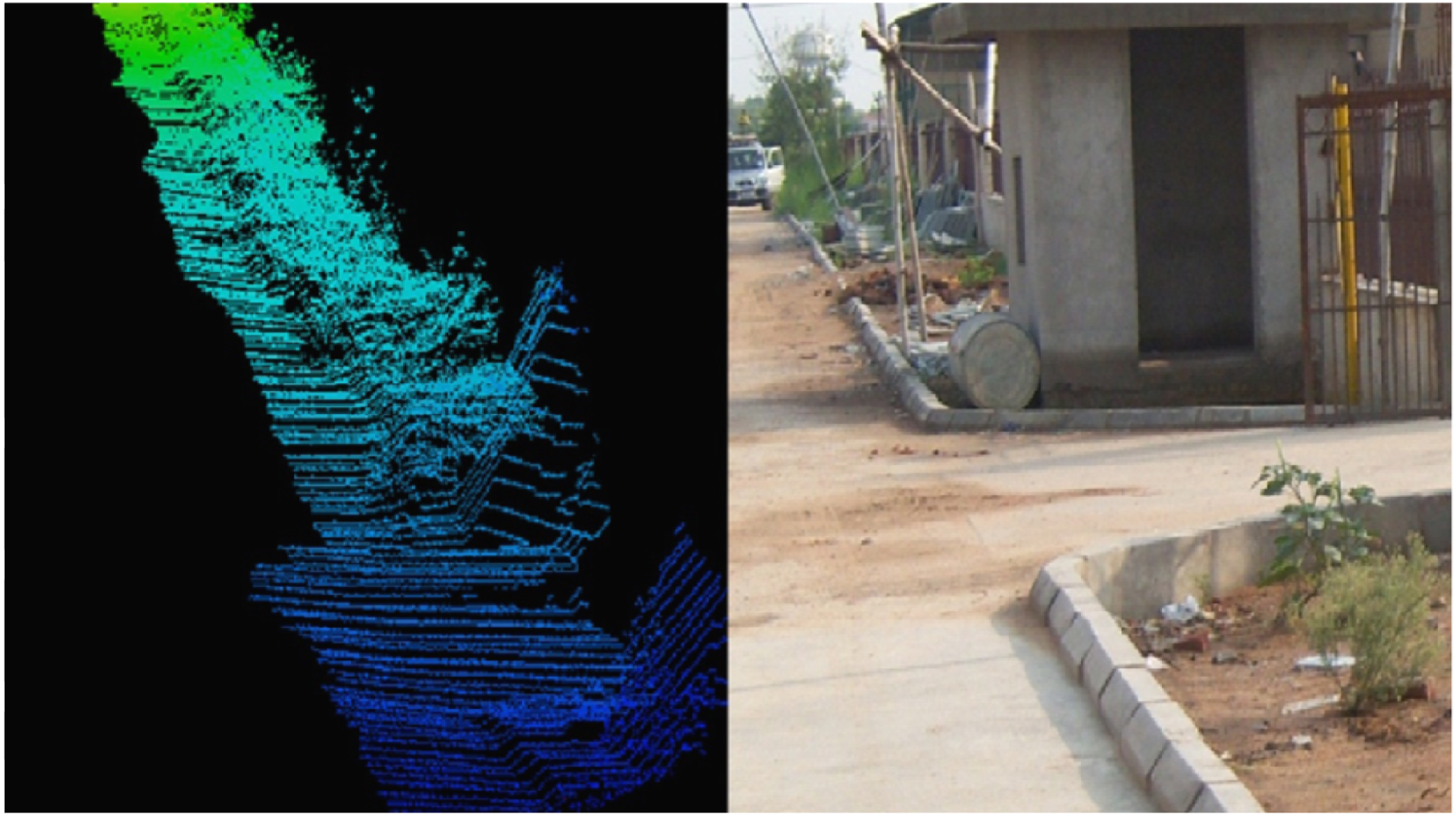


$$r_{global}(i) = r_{laser}(i) \text{ x } R_{las}^{IMU} \text{ x } T_{IMU}^{GPS} \text{ x } M_{IMU}^{global}$$

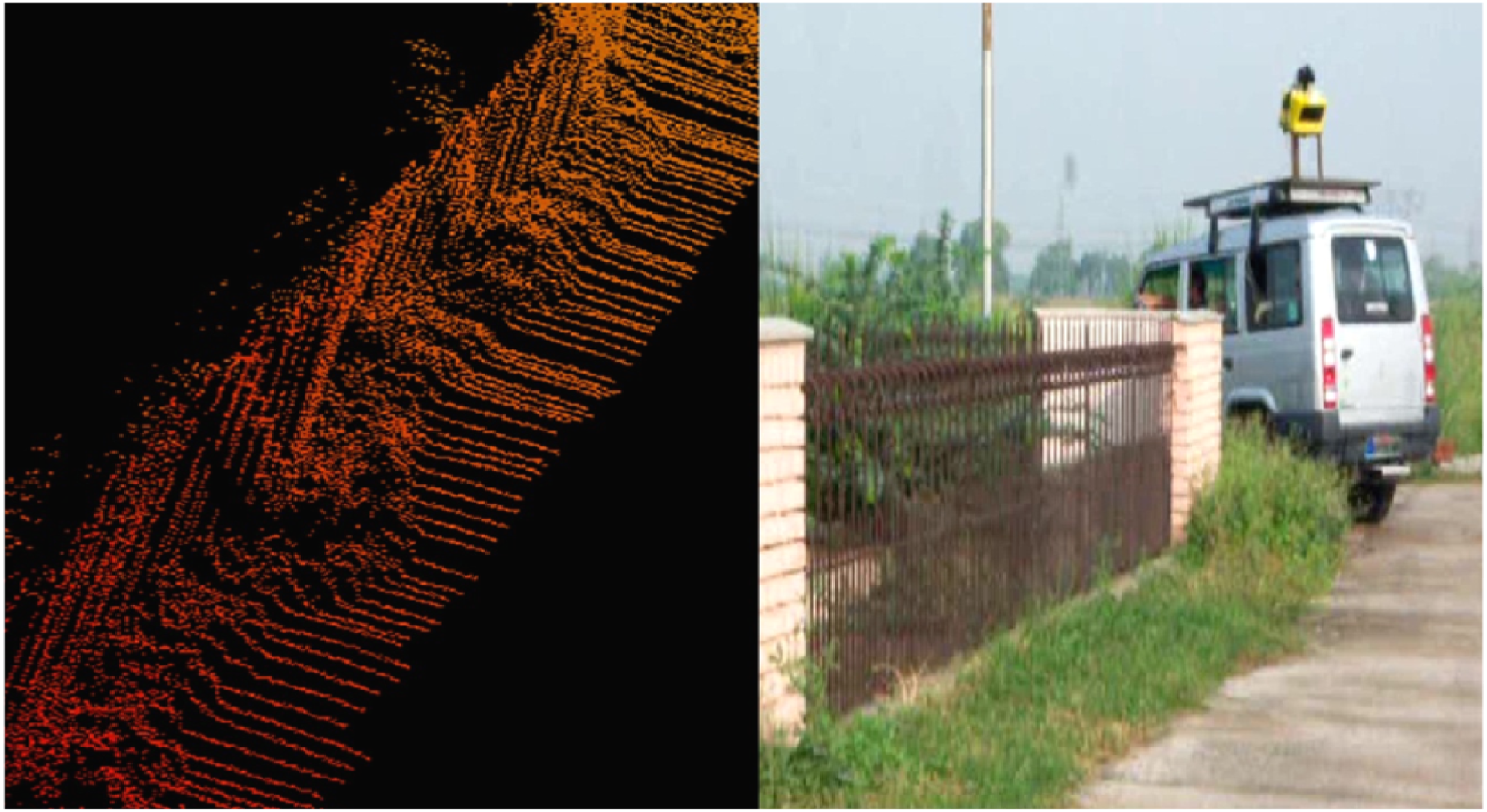
Results



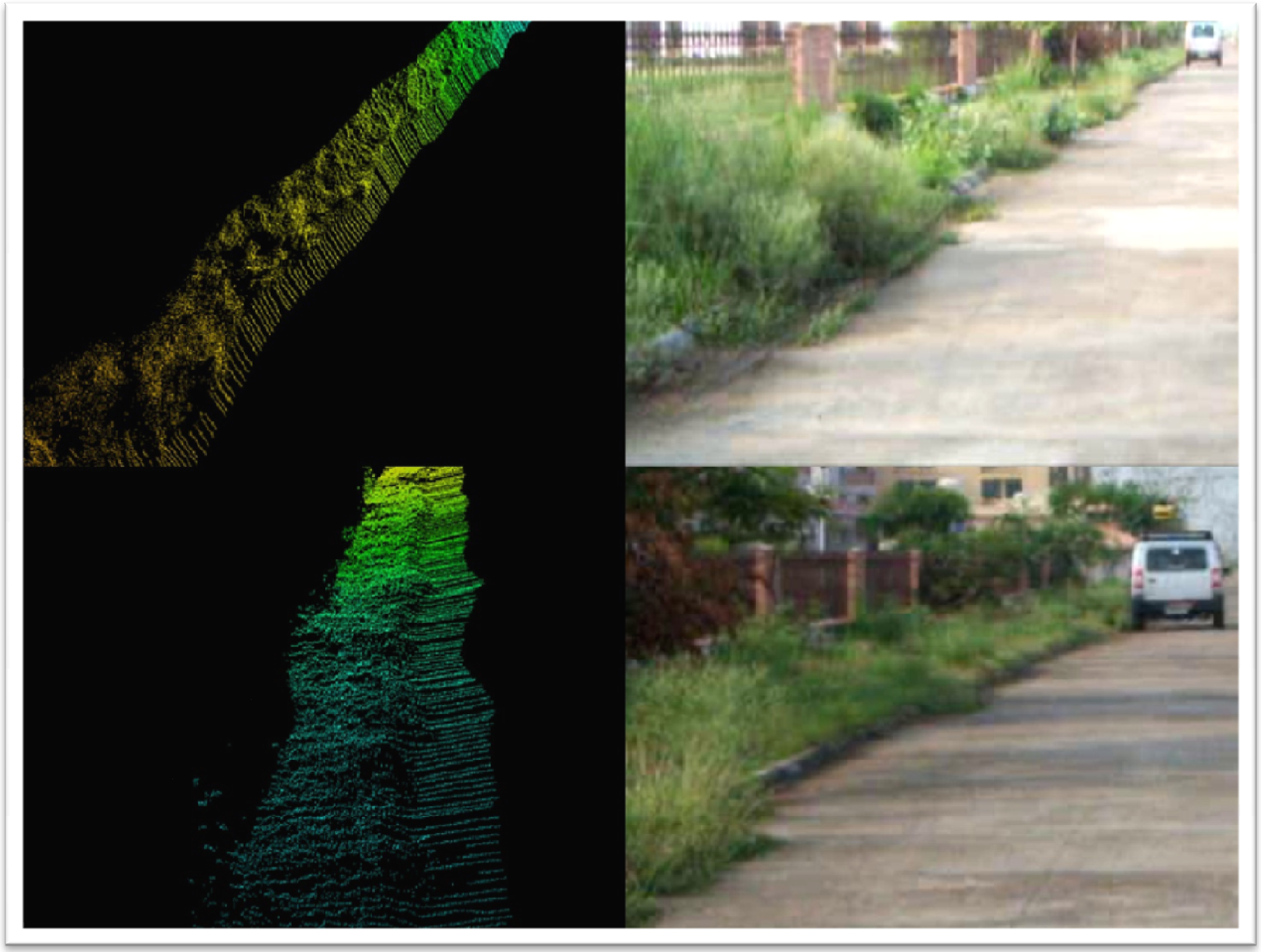
Results



Results



Results



Conclusive remarks

- Developed methodology for calibration and integration of the system.
- Developed complete set of equations for calibration and computations.
- Developed software for processing of data captured by mobile mapping system.
- Realized a complete land based mobile mapping system.

What's for me?

Develop for roads but use for rails and sea

Creating/ Updating 3D Maps
(Roads, Rails, etc)

Flood modeling

Encroachment analysis

Assets

Clearance analysis

Road Surface/Rail inspection

Line of Sight Analysis

Tunnels etc.

Overhead wires

And many more….

Thank you!

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