

# **Design Research for Quick Prototyping of Pedestrian Navigation System - A Case Study in Oil Palm Plantation in Malaysia -**

Akira KODAKA,<sup>1)</sup> Naohiko KOHTAKE,<sup>1)</sup>

*1) Graduate School of System Design and Management, Keio University, Yokohama, Japan*





# Outcome of the study



**Manual based land survey**



**RTK-GNSS positioning**

RTK Multi-GNSS solution was designed and **being implemented** in oil palm plantation in Malaysia

# Design research



## Answers:

- Who are system end-users?
- What problems the users have?
- How the users use a service/product

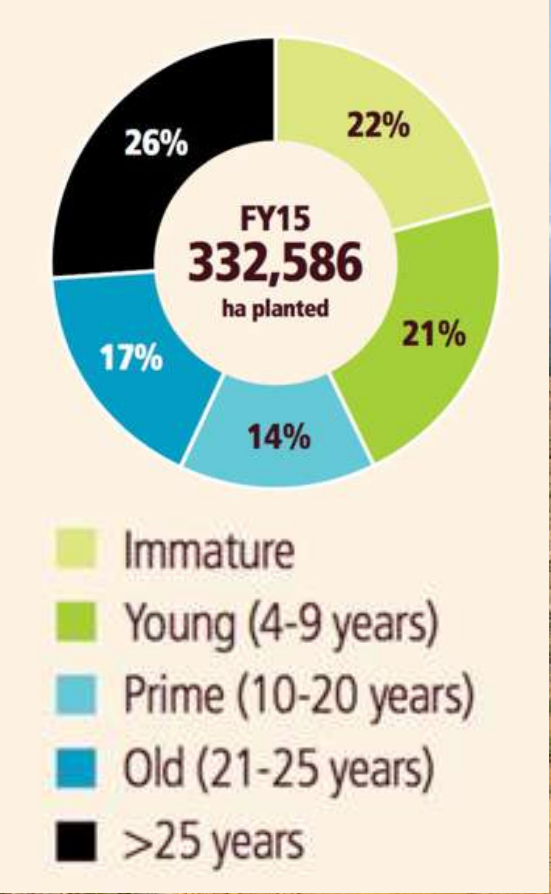
“**WHY**-based” approach on end-users’ behaviors and interactions with surrounding things to derive their **hidden needs** for the system/product



# Background @Malaysia

- Aged oil palm trees have to be replanted as their yields amount decrease.
- About 6 months to complete replanting processes in 100 hectare.

 **Demand on replanting has been increasing**



1) Felda Global Ventures Annual Report 2015 (<http://www.feldaglobal.com/investors/annual-reports/>)



# Problems in conventional replanting method

1

Low efficiency



2

Low Productivity



Manual-dependent surveying for positioning



Time consumption



Human error

Design

**136** tree/ha



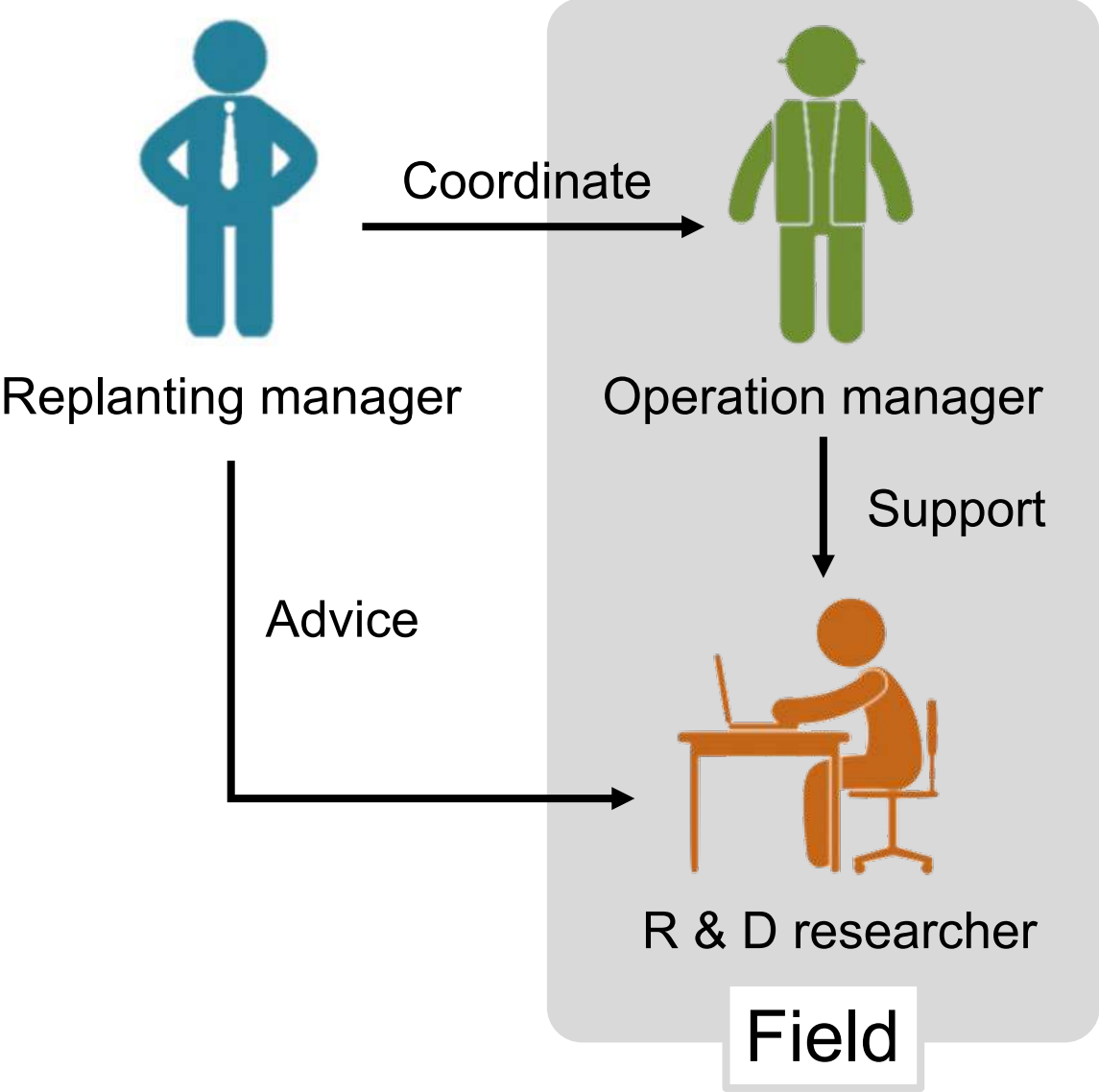
Actual

**115** tree/ha

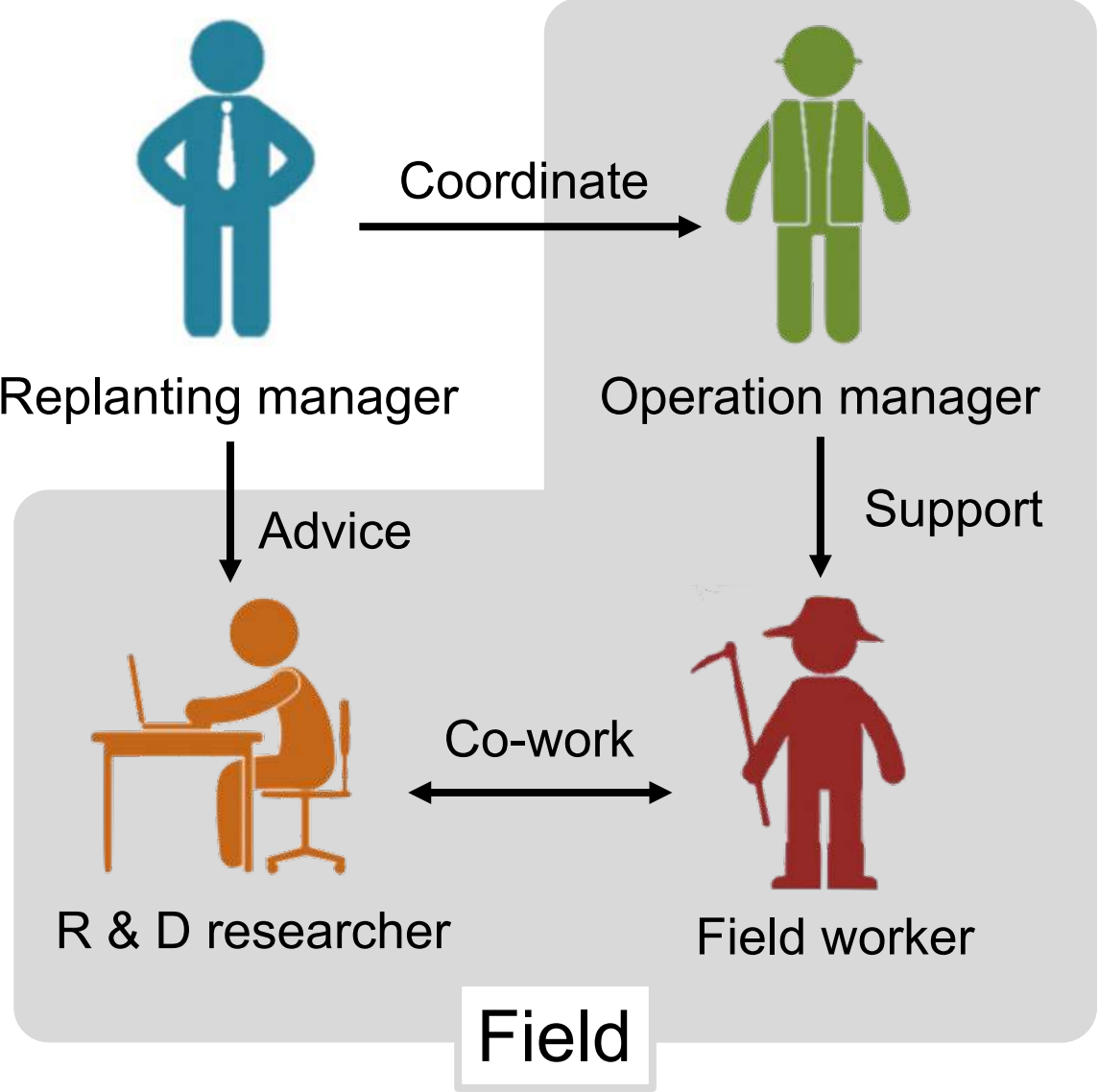
(Example: FELDA's plantation)

➔ Design and evaluate continuous application of RTK multi-GNSS to improve the replanting

# Problems in conventional replanting method



Previous approach



Proposed approach



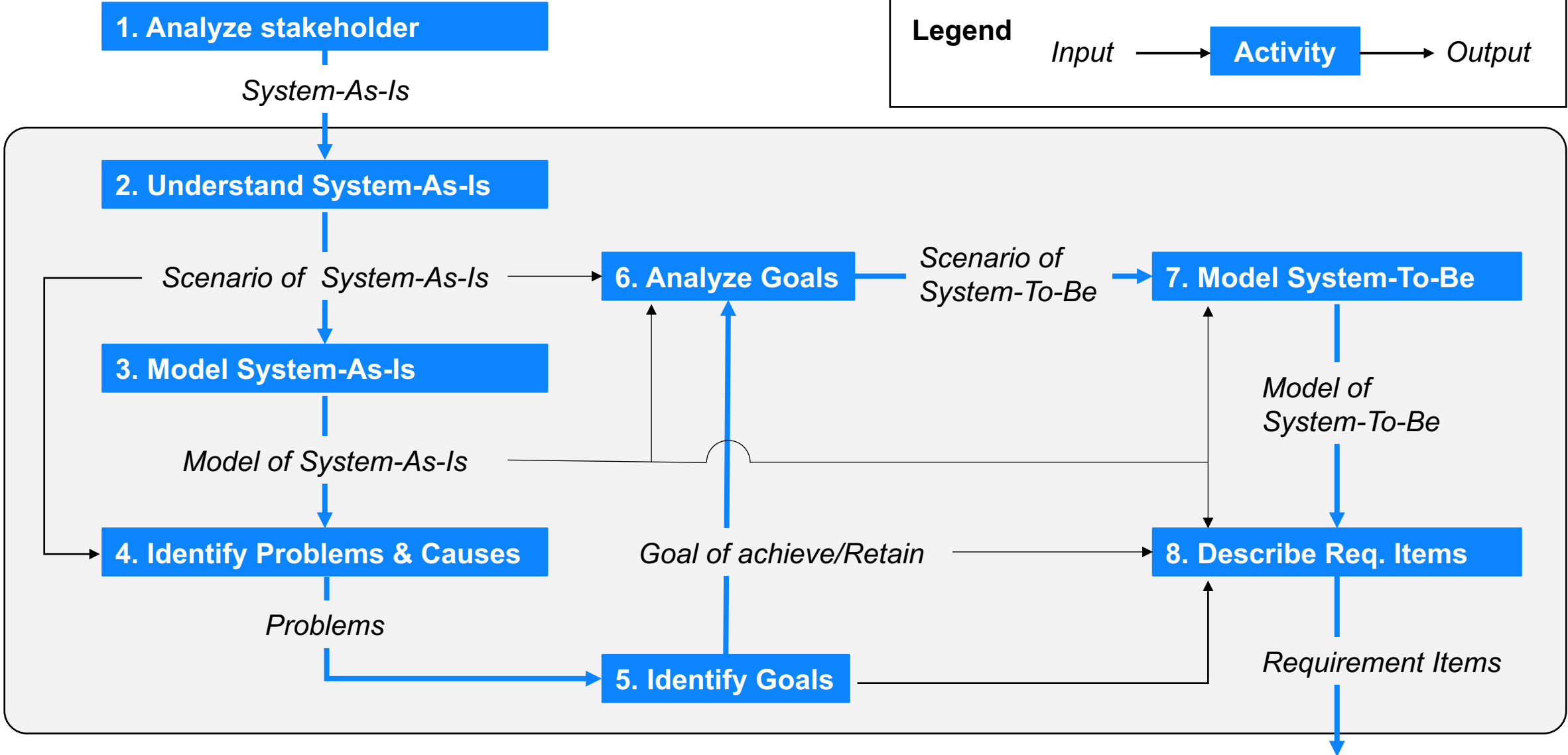
# Who really are the system's end users?



**More than 10 field workers worked with**



# Requirement elicitation activities



Summarized from “REBOK Planning WG, 2011, REBOK, Requirements Engineering Body Of Knowledge, Japan Information Technology Service Industry Association (JISA)”



# Study process

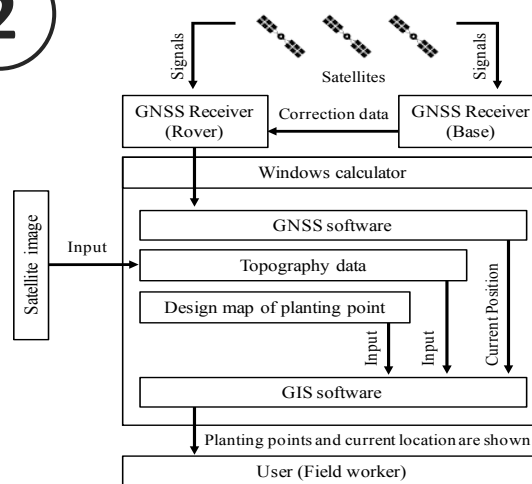
1



## Observation

Understand problems of a conventional method

2



## Prototype development

Develop a new method to improve a conventional one

3



## Investigation

Examine efficiency of the new replanting method

Iterating among each process to improve the requirement elicitation

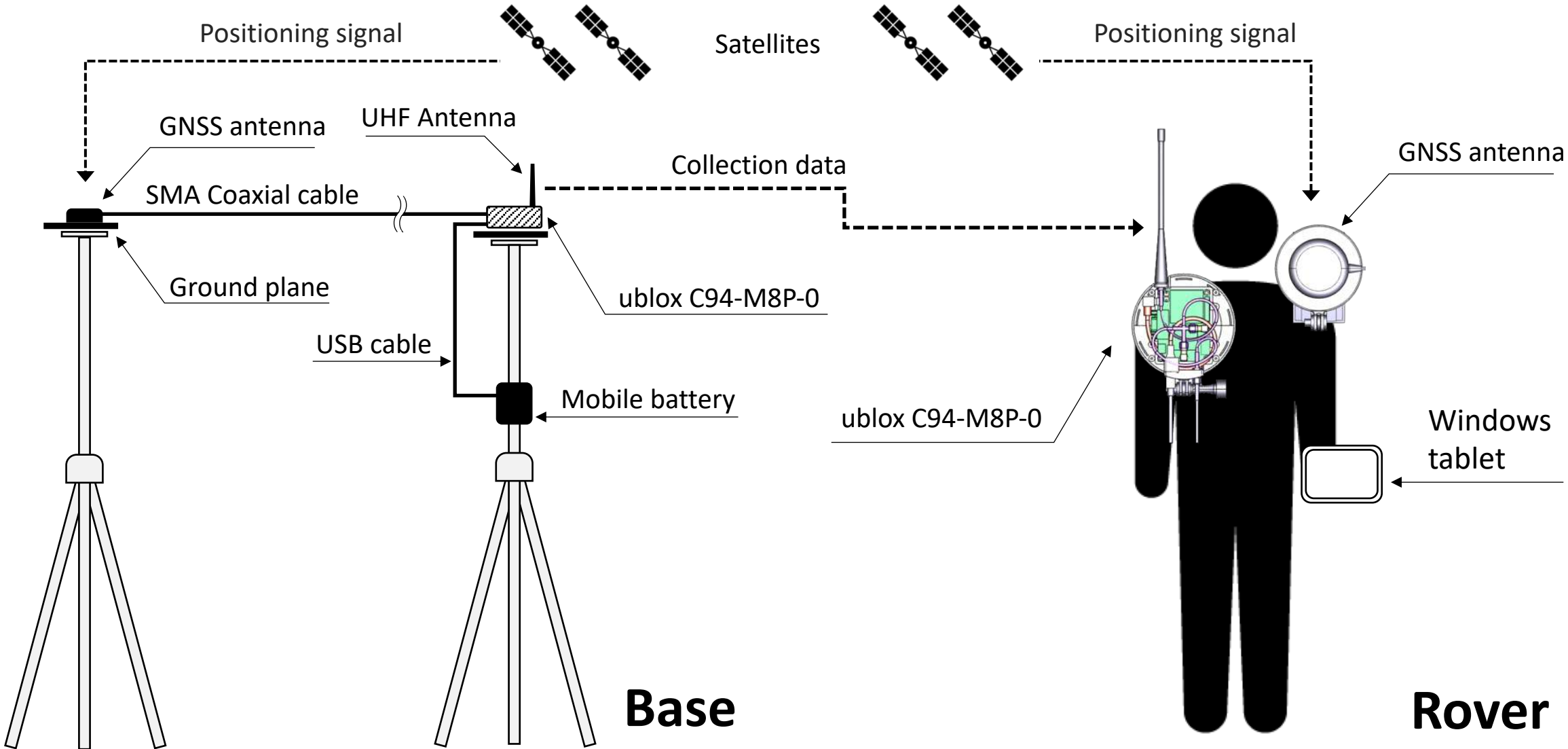


# Continuous observation and dialogue

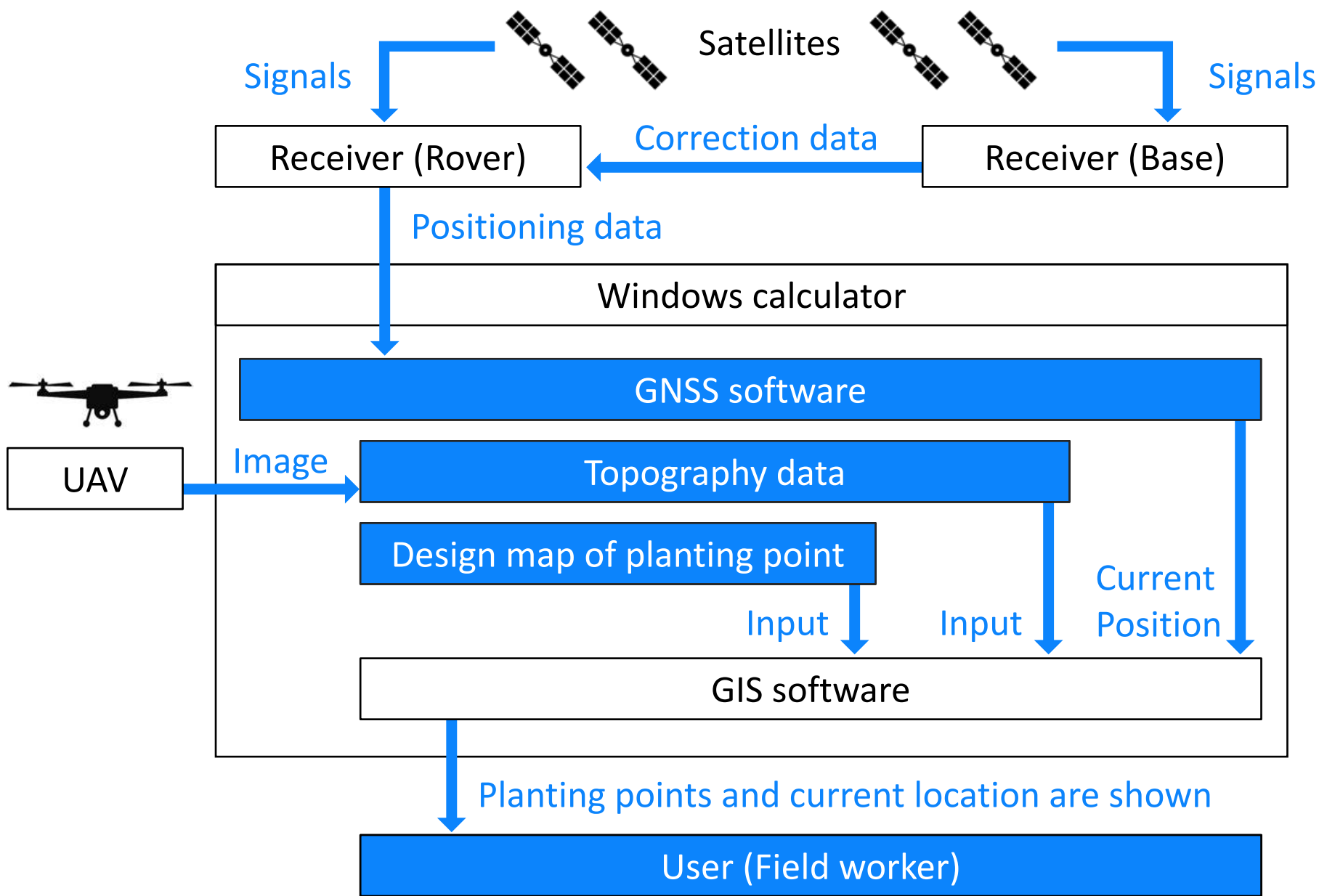




# Prototype structure



# System components



Processed UAV image



Planting point added



Current location on design map



# Prototype structure (cont.)



Simple installation / Reasonable cost

➔ The receivers are able to be relocated to a next spot after the replanting in a first spot is completed. **Spot-based RTK Positioning.**



# Navigation screen

**Moving direction**

**Target lat/lon**

**Target selection**

**Zoom in/out**

**Distance range to a target**

**Distance to a target**

**Distance to a target**

**Target**  
LAT 35.5522372  
LON 139.6468582  
T13

**Origin**  
LAT 35.5519815  
LON 139.6479125

**GPS**  
LAT 35.5522483  
LON 139.6468447

**Status**  
PASS 0  
NOT PASS 31

1.000 m

14:03:06.0 STD GPS LAT 35.5522483 deg LON 139.6468447 deg DIR 103.7 deg

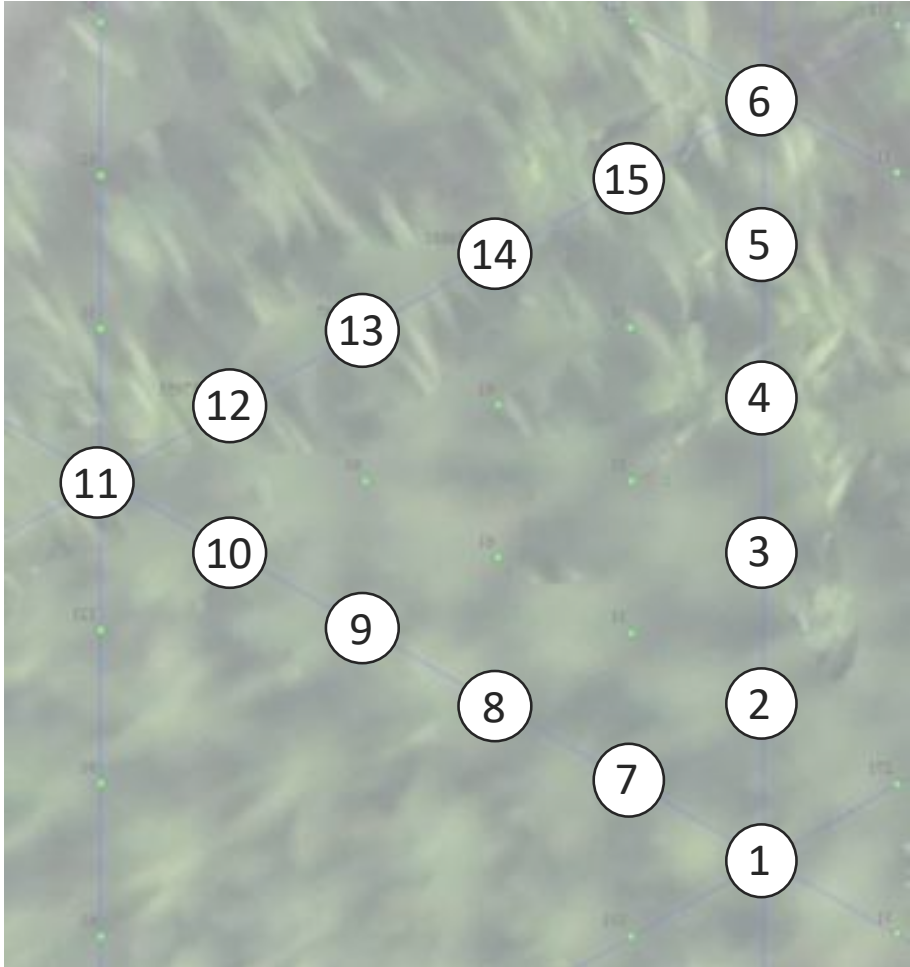


# Navigation



# Evaluation of the prototype

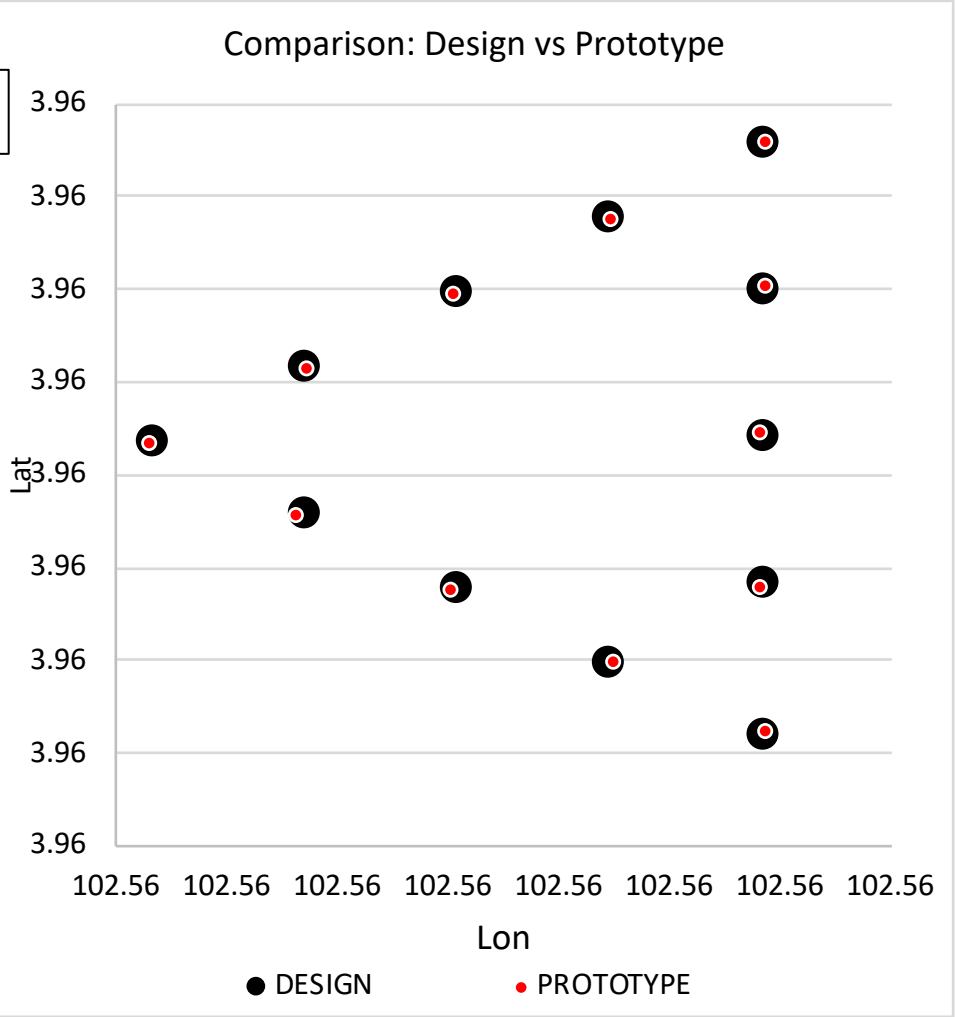
Item	Description
Location	Felda Krau2, Pahang, Malaysia
Purpose	Evaluate an accuracy of pointing by using the prototype
Partner	FGV R&D and Agri Services Cluster





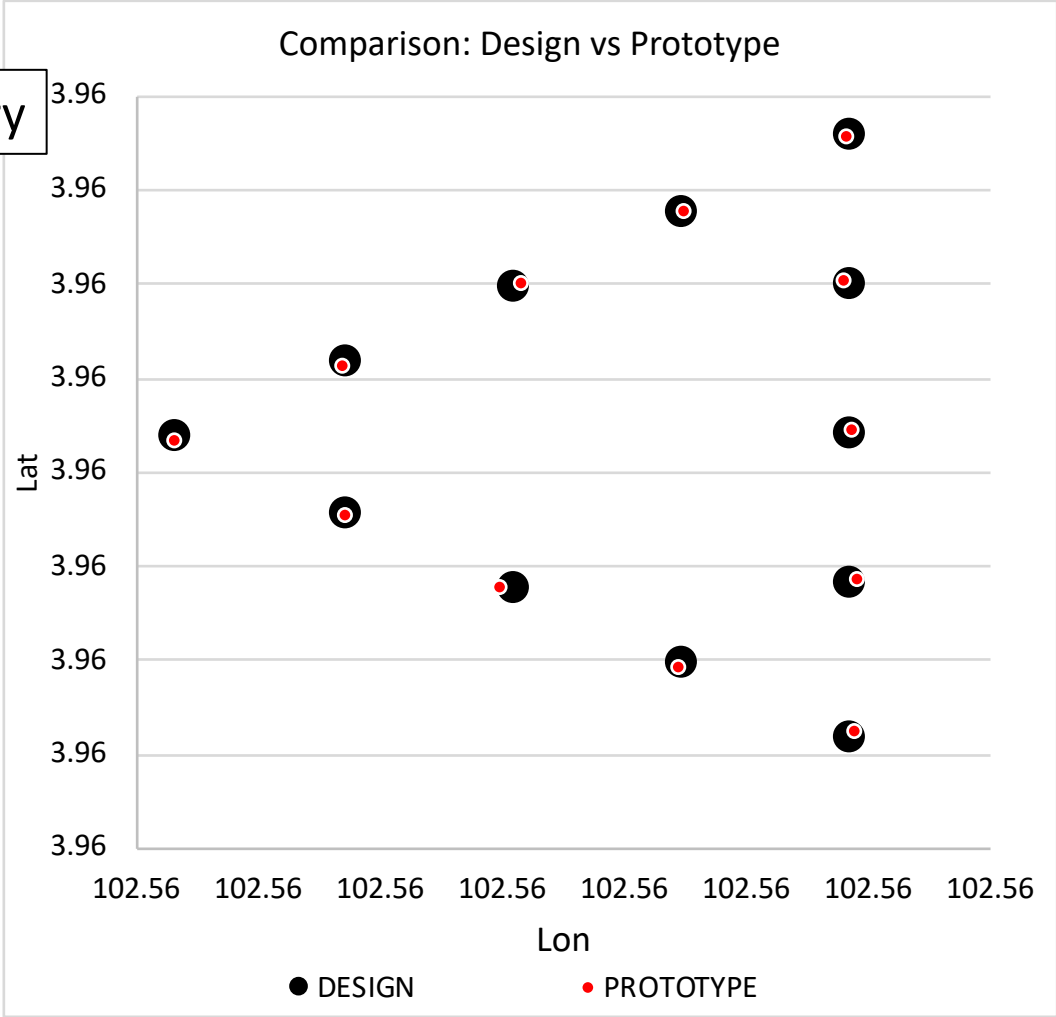
# Evaluating the prototype

1<sup>st</sup> try



Ave. error **24cm** < 30cm

2<sup>nd</sup> try



Ave. error **29cm** < 30cm

**Satisfies 30cm accuracy at open sky atmosphere**

# Efficiency: Delivery (Time required)

Table Comparison between conventional and new method				
Process	Method	Time (sec.)	Number of markers	Time (sec.) / Marker
Pre-lining	Conventional	711	14	50.79
	Prototype	819	14	58.50
Terrace lining	Conventional	409	10	40.90
	Prototype	514	10	51.40

Table Comparison between conventional and new method					
Process	Method	Efficiency			
		Number of worker	point/group/day	ha/group/day	ha/man/day
Pre-lining	Conventional	5	567	4.17	0.83
	Prototype	2	492	3.62	1.81
Terrace lining	Conventional	3	704	5.18	1.04
	Prototype	2	560	4.12	2.06

 **New method took longer time than conventional but required less number of workers.**



# Summary

## Prototype development with design research

Developed RTK GNSS solution for improving agricultural operation in oil palm plantation and evaluated that it satisfied required accuracy of planting point's marking.



## Detailed cost investigation

Cost is one of the most important factor to the plantation operator. It is needed to analyze cost improvement by applying the new method.

## Investigation for other replanting processes

There are more processes other than "Pre-lining" and "Terrace lining" that High-precision positioning technology can contribute to improve their efficiency and productivity.

Our initiative has become actual service with FGV →

**FGV GEOTAGGER®**   **FGV**

**Product Description**  
The FGV Geotagger® is an invention that aims to improve the conventional method of oil palm replanting programme. FGV Geotagger® tool has replaced the manual positioning methods for designing planting points, road design, mechanisation paths, drainage, etc for replanting programme to avoid missed lining and positioning. The tool is part of the new method for a system for layout planting of tree crops. Our new system of replanting has incorporated geospatial technology, including the use of satellite, drone imaging, GIS (Geographical Information System), and FGV Geotagger® tool (multi-GNSS RTK device). The new method has offers advantage in the ease of preparing a digital replanting blueprint, execution of the replanting programme, and monitoring replanting work. This is to ensure that the replanting programme is adhered to replanting blueprint and follow the highest standard of Good Agriculture Practices (GAP) in oil palm replanting.

**Key Features**

- Tracks GPS / GLONASS / BeiDou / Galileo
- Fast RTK convergence
- LoRa module
- 22 hours battery life
- Multi-feed antenna with multipath rejection
- NTRIP and VRS support, works with RTCM3
- IP55 Water Resistant and Dustproof

• Intensified research in digitalisation and mechanisation to increase productivity in our estates and mills

Price is 2x cheaper than Multi-GNSS device in the market.

Average Cost savings RM135/ha

Average accuracy is around 2-10cm

Intellectual Property Protected:

- Utility Innovation - Patent pending
- Industrial Design - Copyright
- Trademark Registered

**Benefits of FGV GEOTAGGER®**





- Land Use Optimization
- Precise Planting Design
- Reduce Manpower
- Cost Saving
- Minimizing Error
- Effective Monitoring

**PRODUCT INVENTORS**

Azaini Aizat Abd Jalil, Dr. Akira Kodaka, Dr. Lee Yang Ping, Mohd Najib Abd Rasid, Haryati Abidin, Mohd Naim Samad, Muzaffar Tajuddin, Prof Abd Rashid Sharif, Prof Naohiko Kohtake, Tomoaki Masuma

FGV flow studios Kein University

Contact us at:  
FGV R&D SDN BHD - RESEARCH MANAGEMENT UNIT  
PT. 35377, Lengkuik Teknologi  
71760 Bandar Enstek, Negeri Sembilan, MALAYSIA  
☎ +606-799 8085 📧 rmu.rd@fgvholdings.com

FGV Holdings Berhad    



Akira KODAKA,<sup>1)</sup> Naohiko KOHTAKE,<sup>1)</sup>

*1) Graduate School of System Design and Management, Keio University, Japan*

*akira.kodaka@sdm.keio.ac.jp*

