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

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Outcome of the study

BEOFRE

Manual based land survey

AFTER

RTK-GNSS positioning

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

Design research

Answers;

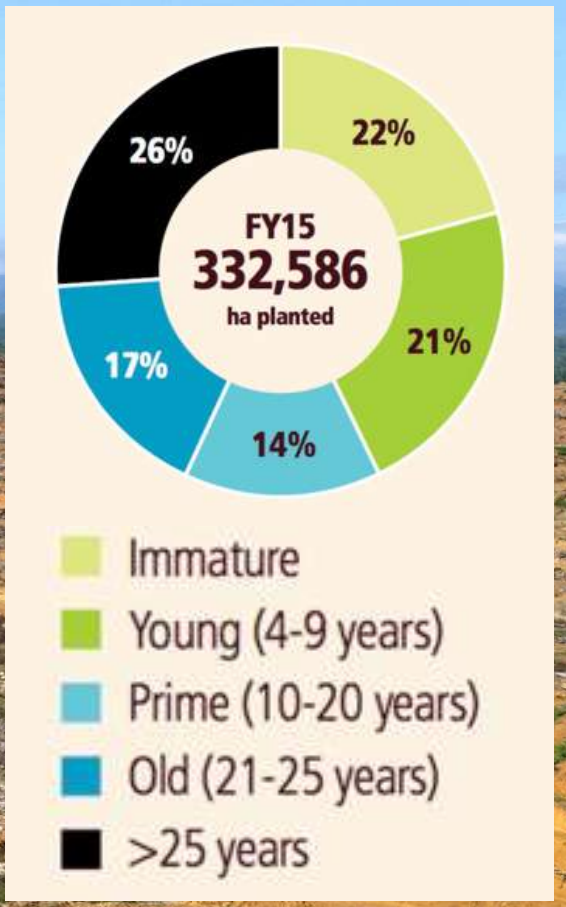
- Who are system end-users?
- What problems the users have?
- How the users use a service/product

"**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

Manual-dependent surveying for positioning

⬇ Time consumption

⬇ Human error

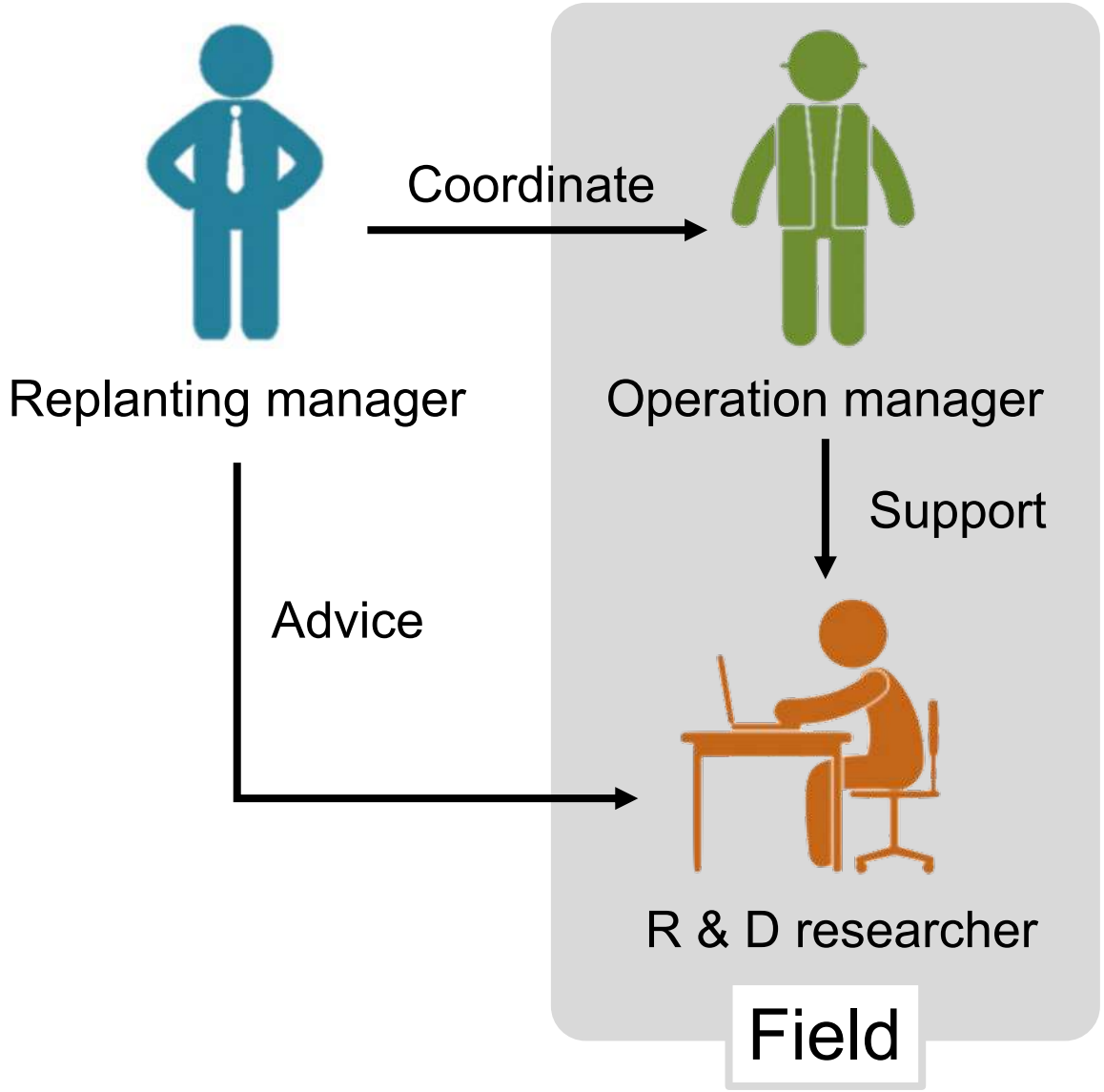
2 Low Productivity

Design **136** tree/ha ➡ Actual **115** tree/ha

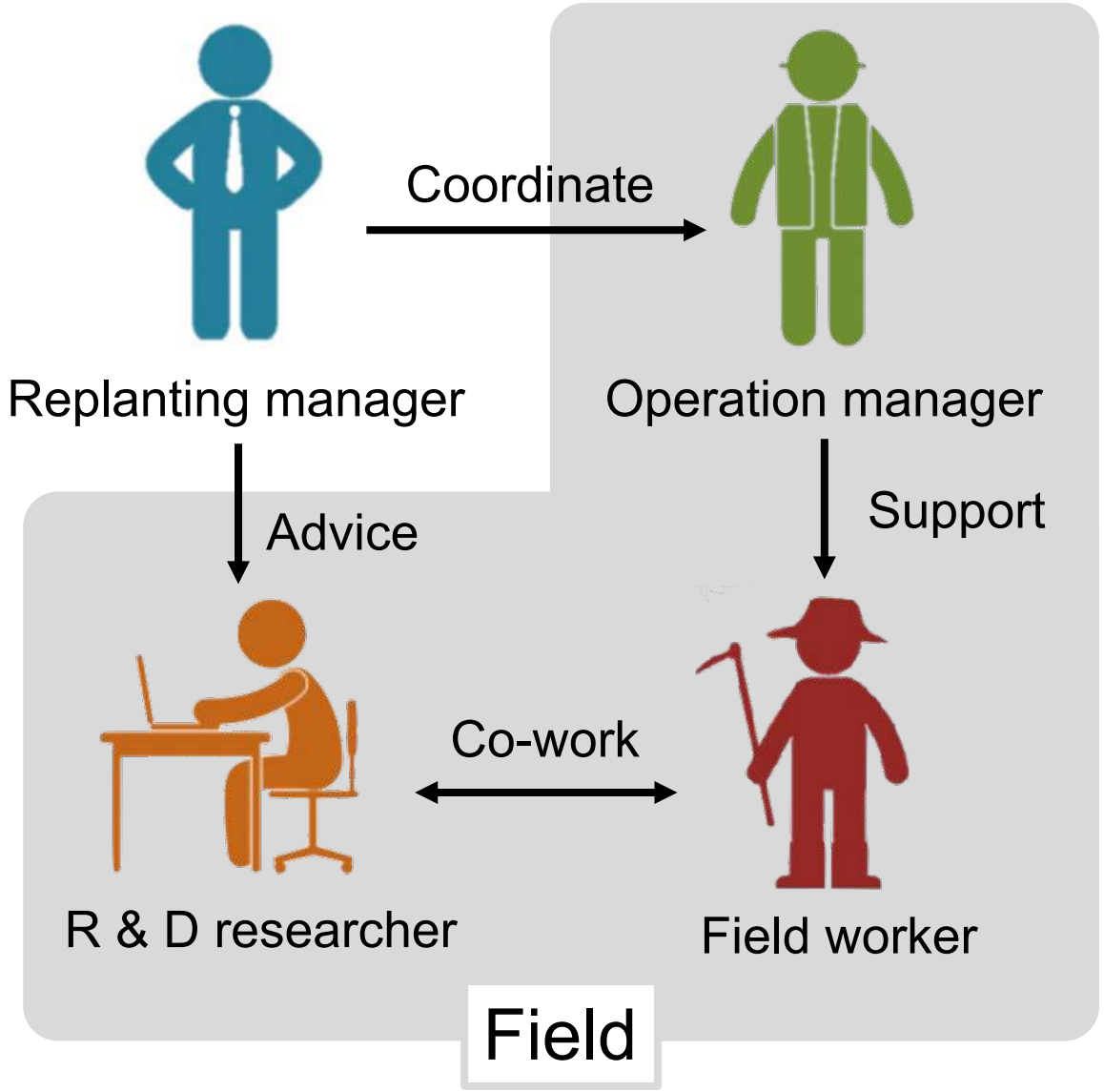
(*Example: FELDA's plantation*)

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

Problems in conventional replanting method



Previous approach

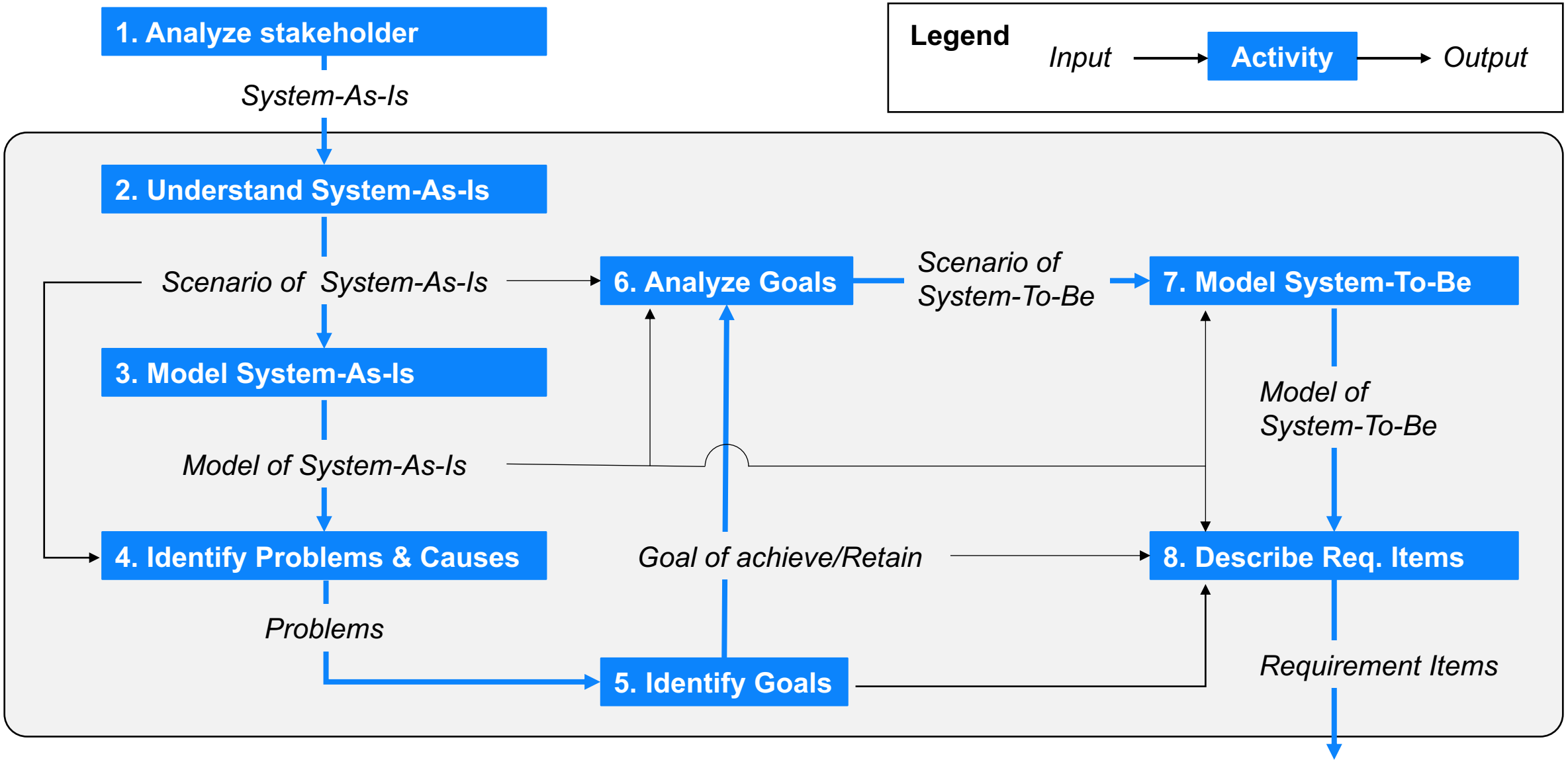


Proposed approach

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)*"

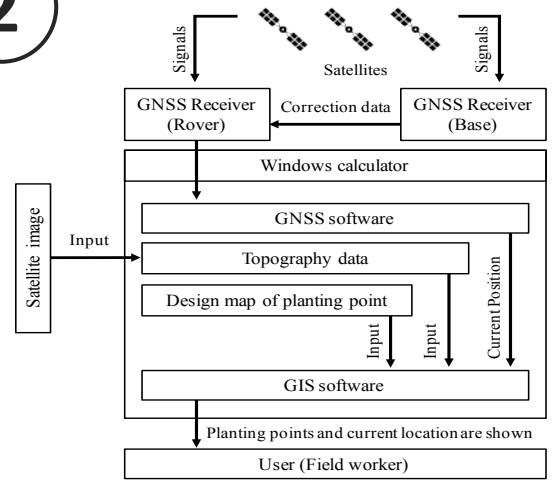
Study process

1

Observation

Understand problems of a conventional method

2



Prototype development

Develop a new method to improve a conventional one

3

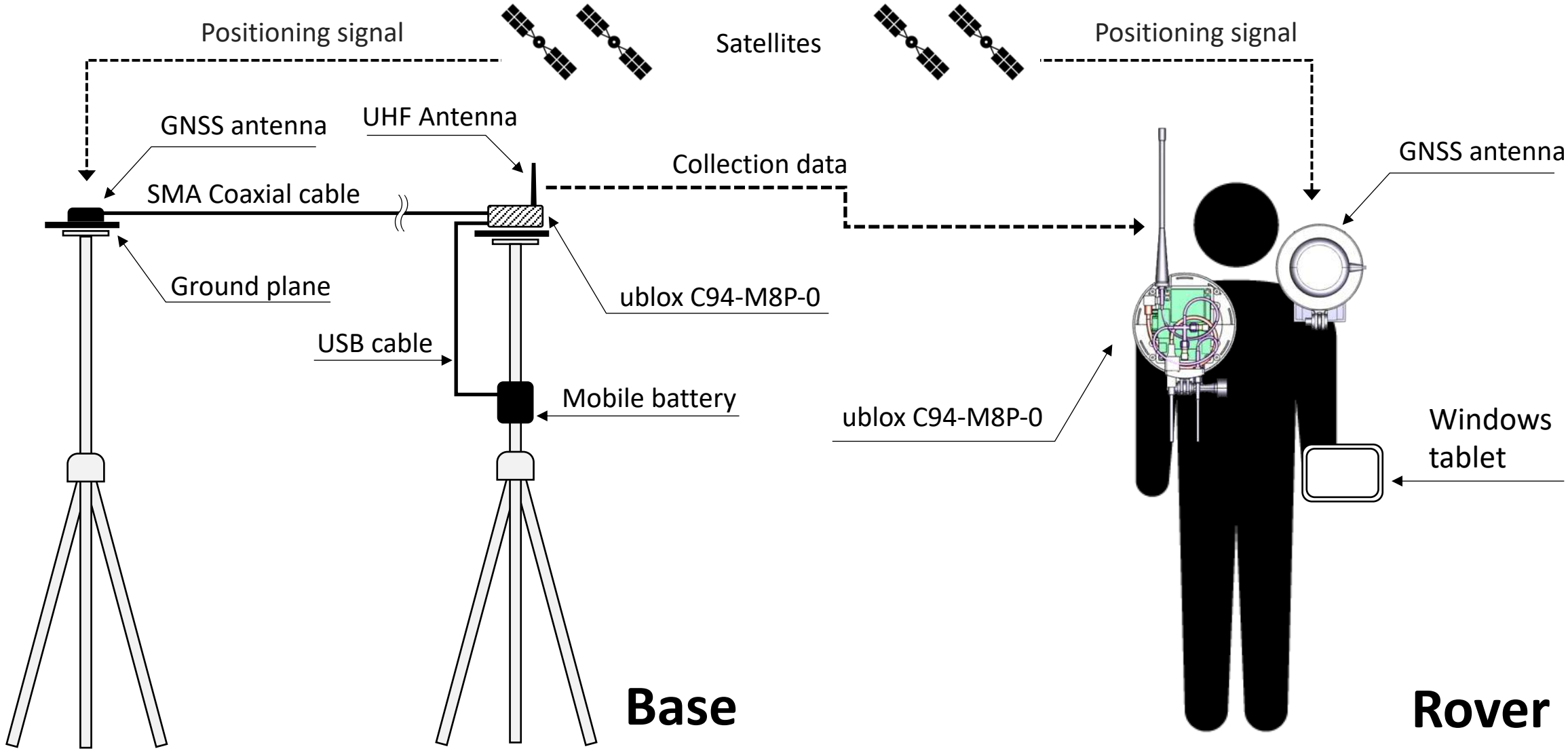
Investigation

Examine efficiency of the new replanting method

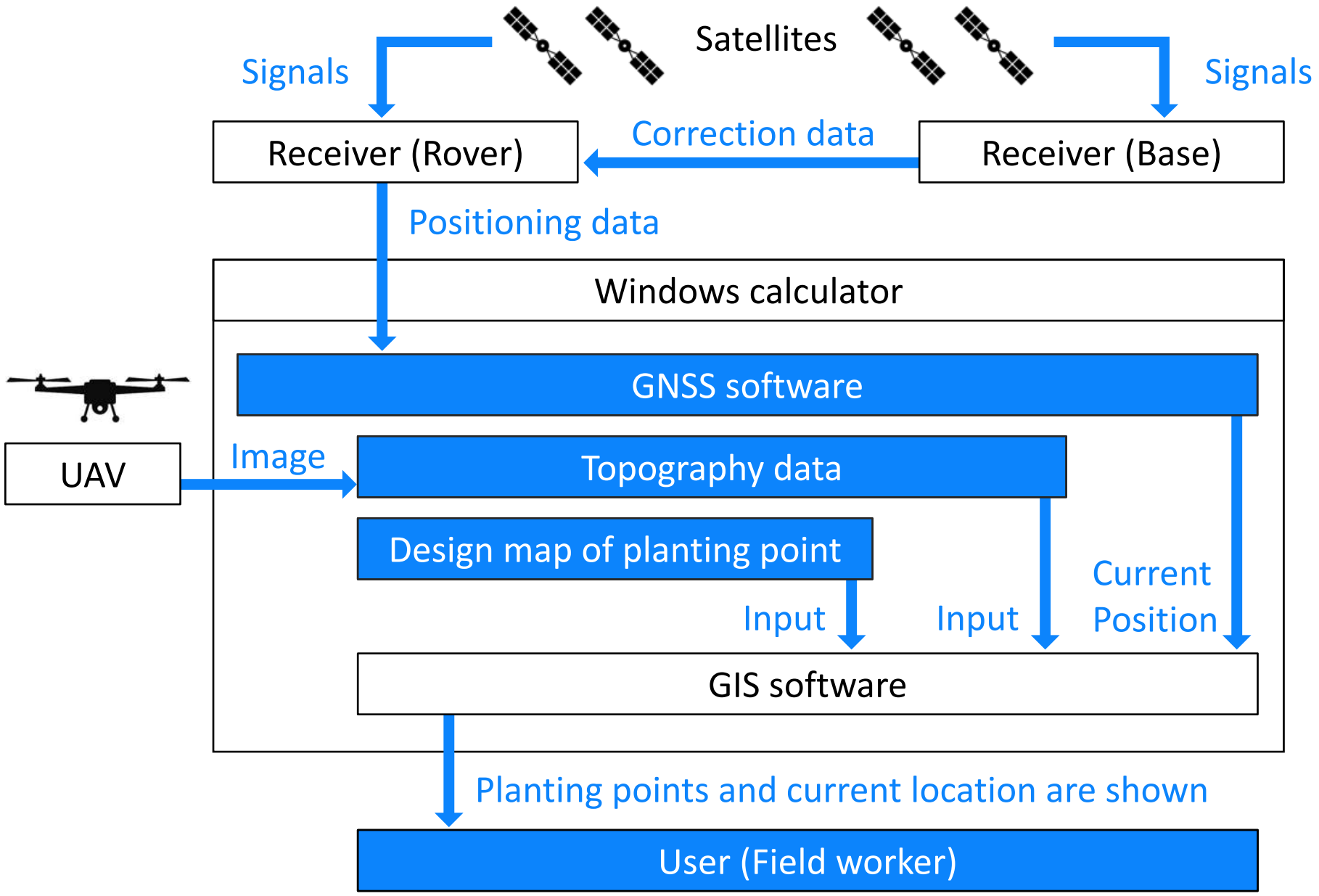
Iterating among each process to improve the requirement elicitation

Continuous observation and dialogue

Prototype structure



System components



Processed UAV image

Planting point added

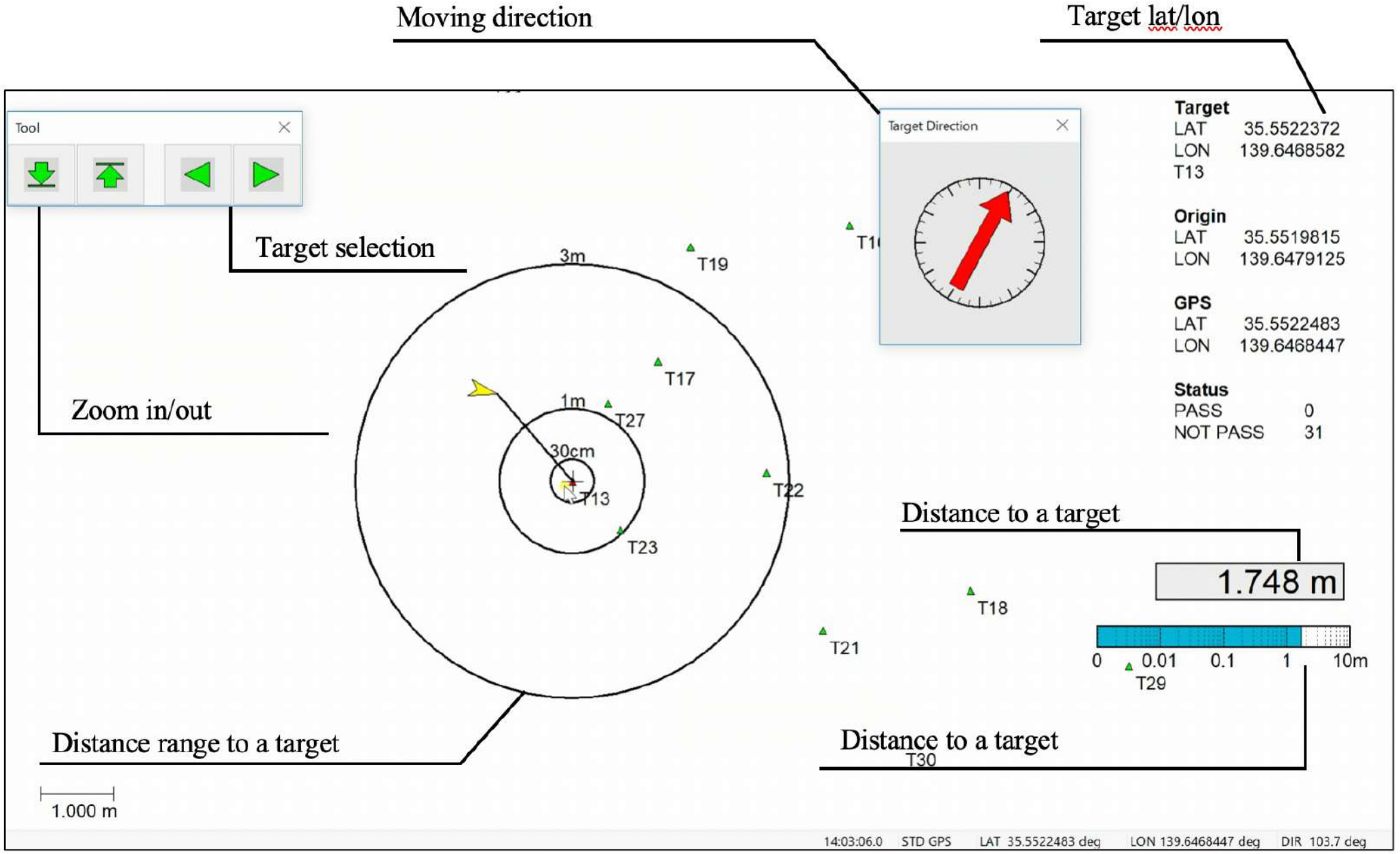
Current location on design map

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**.

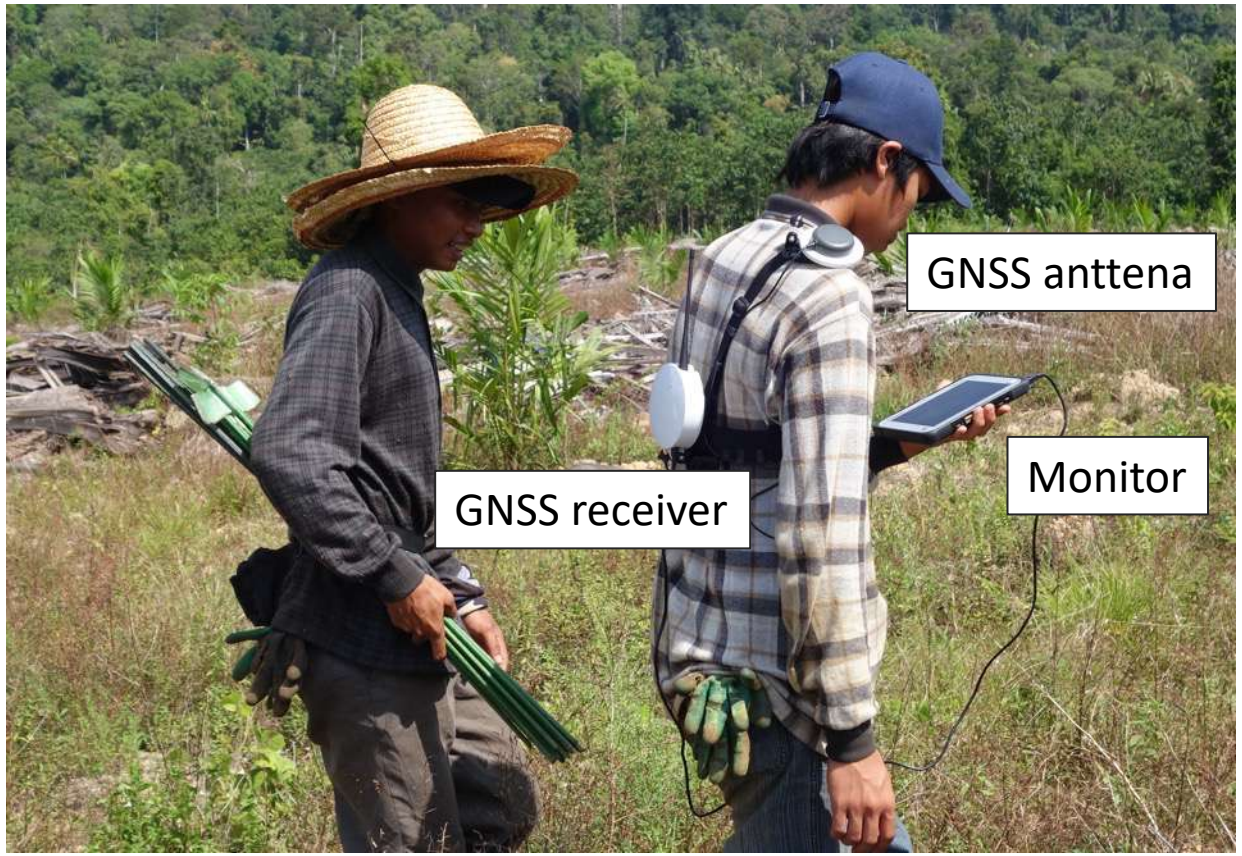
Navigation screen

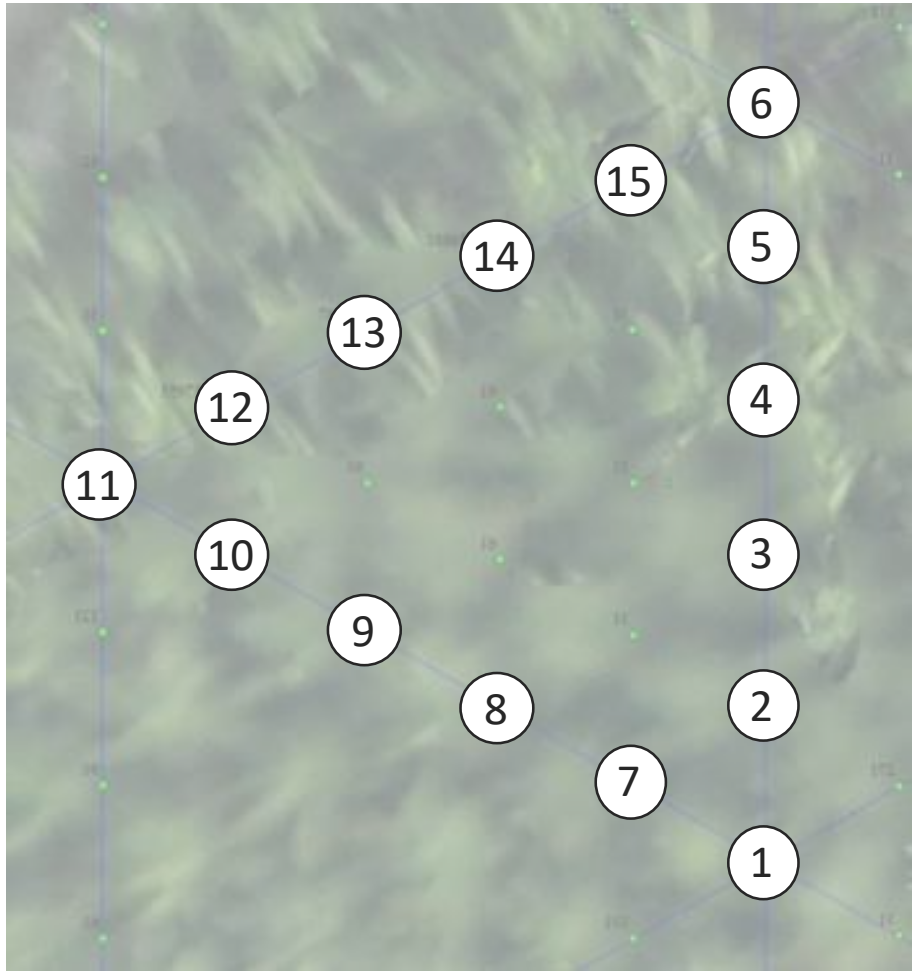


Navigation

Evaluation of the prototype

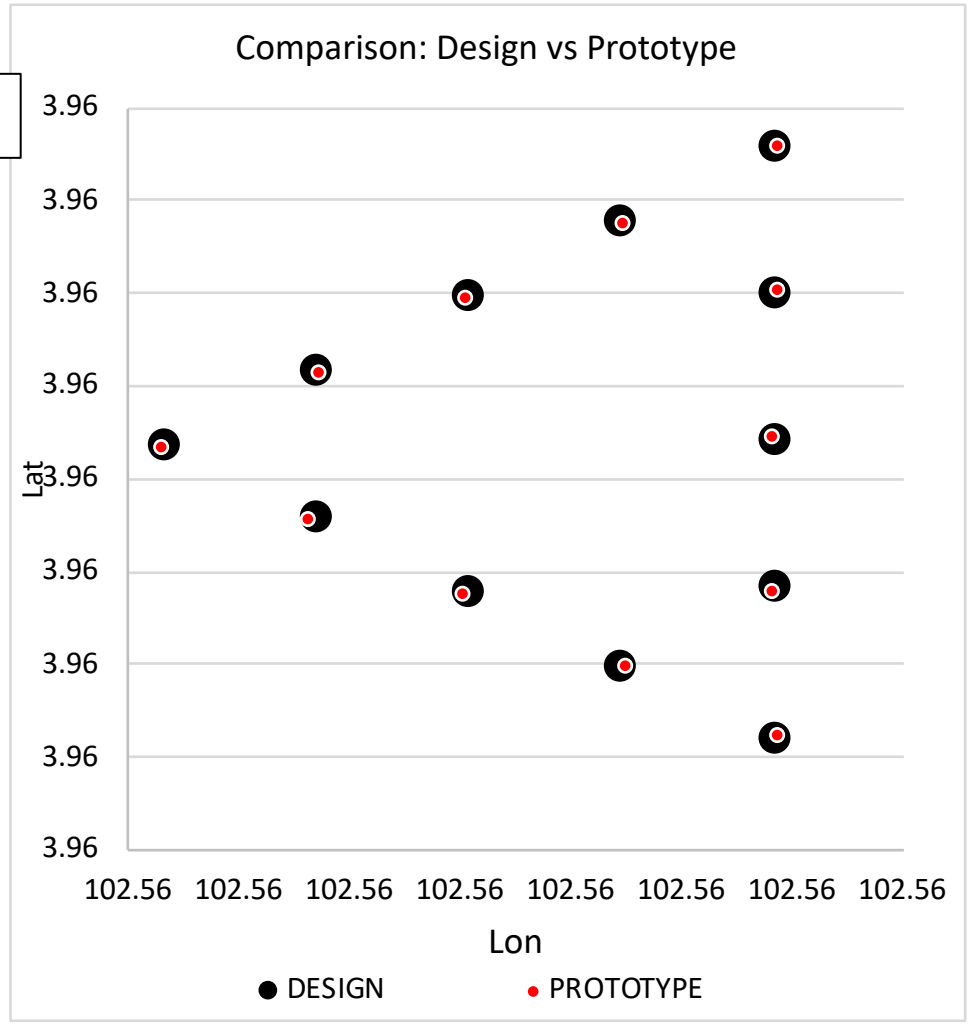
Item	Description
Location	Felda Krau2, Pahang, Malaysia
Purpose	Evaluate an accuracy of pointing by using the prototype
Partner	FGV R&D and Agri Services Cluster





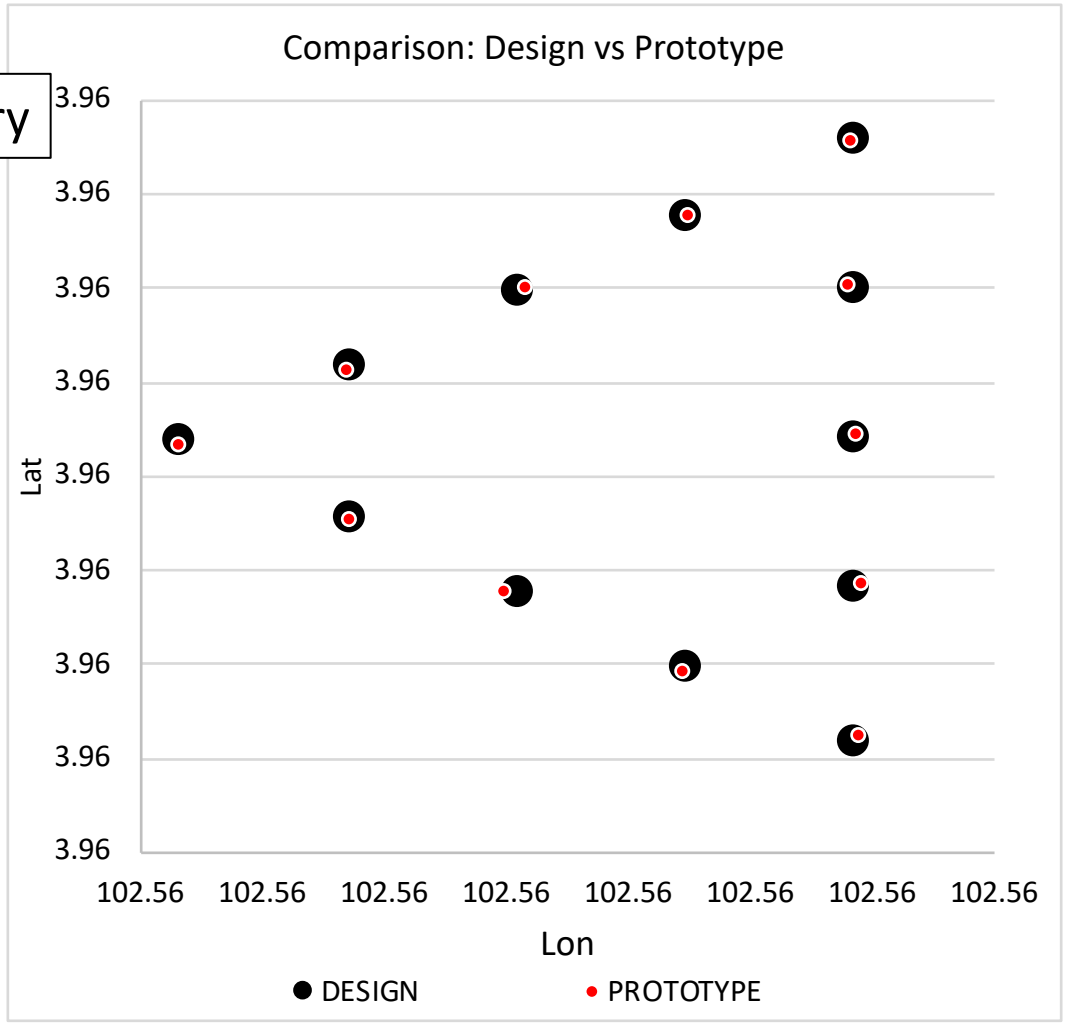
Evaluating the prototype

1st try



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

2nd 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.

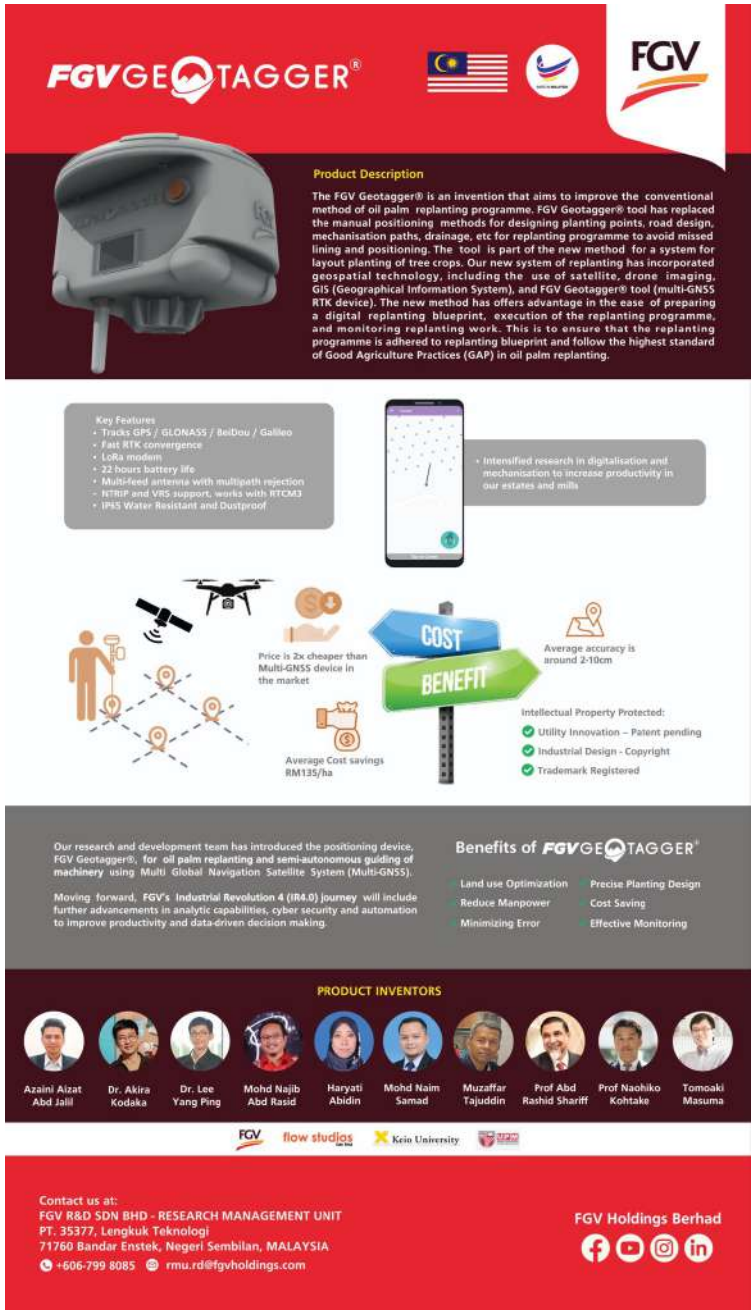
Detailed cost investigation

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 →



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