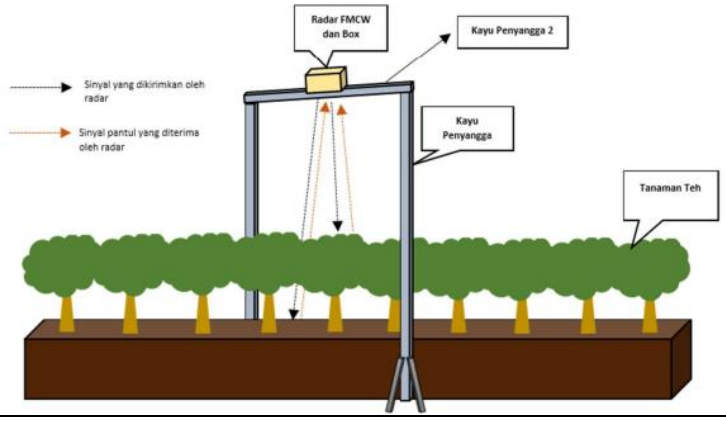
FMCW Radar for Soil and Water

Abstract (200-300 words)
In agriculture and plantations, water content greatly affects plant growth and survival. Plants need enough water, meaning not too much and not too little. Excess water content in the soil can make the quality of the plant decline due to waterlogged plant roots. Soil that contains little water can also cause permanent damage to plants due to drought. A number of studies on the method of detecting water content in the soil have been carried out. Elaboration of radar systems such as Ground Penetrating Radar (GPR) has the advantage of being used to collect data on large areas such as plantation areas because it can save time and money. In plantation areas, the presence of plants that are above the ground can act as a barrier during detection using a radar system. Plants can have a significant effect on the detection results. Plants can make the amplitude of the reflected signal from the ground decrease and cause a phase shift which results in a delay in detection, thereby reducing the accuracy of the detection results. Therefore, we need a method to reduce the reflected signal from plants so that the reflected signal from the soil can be seen more clearly. The Frequency Modulated Continuous Wave (FMCW) radar system is a radar system that has been widely developed and applied for various needs. Low power consumption in the use of FMCW radar can be utilized in the detection of large areas such as plantation areas. In addition, the FMCW radar can detect the distance of the target from the radar using the difference in beat frequency at the time of detection. This ability is useful in distinguishing two or more targets, so that it can be applied to soil conditions that have plants on it.

Planning	
Background	In agriculture and plantations, water greatly affects the growth and survival of plants, so the water content in the soil must be in accordance with its needs [1]. The water content in the soil can be determined using two methods, namely directly and indirectly. In large areas such as plantation land, indirect measurement is more suitable because it can save time and costs. These remote sensing methods include using satellite imaging [2], radiometric [3], Synthetic Aperture Radar (SAR) [4], Time Domain Reflectometry (TDR) [5], keywords up to 5 words Background research no more of 500 words containing the background and problems to be researched, specific objectives and feasibility studies. In this section, it is necessary to explain the description of the specification of the relationship between the scheme and the focus area or research strategic plan of PT. [6], and Ground Penetrating Radar (GPR) [7]–[10] which have been studied for mapping soil characteristics. Ground Penetrating Radar (GPR) is a radar system that works by utilizing electromagnetic waves to detect objects buried under the ground. Information on the level of soil moisture can be seen from the dielectric characteristics at the time of detection. Several GPR systems have been studied for their application and succeeded in detecting groundwater content, including the UWB Pulse Radar [11], Stepped Frequency Continuous Wave (SFCW) [12]–[14], and Frequency Modulated Continuous Wave (FMCW) [15]. To cover a large area, drones or other motion vehicles can be elaborated in the concept of a device that functions to bring the GPR system to take measurements at every point in the observation area. In measuring soil water content using a radar system, the object detected is soil. However, in more actual cases such as plantation areas, the presence of plants above the ground can act as a barrier at the time of detection. The condition of the presence of obstructions above the ground can be analogous to the case of Through Wall Radar (TWR) [16], [17]. In the case of TWR, the obstruction causes a decrease in the amplitude of the reflected signal from the target and causes a delay in detection. Based on this analogy, plants that are above the ground can have a significant influence, thereby reducing the accuracy of the detection results. Therefore, the reflected signal from plants needs to be minimized so that the reflected signal from the soil can be seen

		more clearly. Several studies have reviewed its application and succeeded in minimizing the barrier effect [16]–[20]. The use of FMCW radar to detect groundwater content can potentially be done. Low power consumption in the use of FMCW radar can be utilized in large areas such as plantation areas [21]. The FMCW radar can detect the target's distance from the radar using the difference in beat frequency at the time of detection [22]. This ability is useful in distinguishing two adjacent targets so that it can be applied to soil conditions that have plants on it [21], [23]. The problem in the proposed research relates to a more actual case in detecting groundwater content in the plantation area. The presence of plants on the ground that act as a barrier has a significant influence on the accuracy of the detection results. Methods to overcome problems caused by obstructions are needed in an effort to improve the accuracy of the detection results. This method is used to reduce the effect of vegetation on the detection of soil water content. The purpose of the proposed research is to design a method used to reduce the effect of vegetation cover on the detection of groundwater content using the FMCW radar system, so that there are no errors in processing information on water content in the soil. The urgency of the proposed research is explained as follows. The influence of plants that are above the ground has a significant influence on the detection results, so that it has an impact on the inaccuracy of the detection results. This research was conducted so that the proposed method for detecting groundwater content can be applied to more actual cases, such as in plantation areas. The method of extracting groundwater content using the proposed FMCW radar will contribute to the development of technology for detecting groundwater content using a radar system. With this research, it is hoped that it can be applied to more actual cases, such as on plantation land with plants on the ground.
Subject (Names & titles)	Initiator(s)	ALOYSIUS ADYA PRAMUDITA
	Leader(s)	ALOYSIUS ADYA PRAMUDITA
	Team members	FIKY YOSEF SURATMAN
Environment	Nature/society	Frequency Modulated Continuous Wave (FMCW) radar system
	Industry/market	Plantation area community
	Government/others	-
Resources	Human requirements	Faculty of Electrical Engineering
	Financial requirements	Research program support by DIKTI
	Technological/other requirements	Frequency Modulated Continuous Wave (FMCW) radar system
Mechanism	Strategic options available	-
	Their relative importance	-
	Their sequences for execution	-
Content		In agriculture and plantations, water greatly affects the growth and survival of plants, so the water content in the soil must be in accordance with its needs [1]. The water content in the soil can be determined using two methods, namely directly and indirectly. In large areas such as plantation land, indirect measurement is more suitable because it can save time and costs. These remote sensing methods include using satellite imaging [2], radiometric [3], Synthetic Aperture Radar (SAR) [4], Time Domain Reflectometry (TDR) [5], keywords up to 5 words Background research no more of 500 words containing the background and problems to be researched, specific objectives and feasibility studies. In this section, it is necessary to explain the description of the specification of the relationship between the scheme and the focus area or research strategic plan of PT. [6], and Ground Penetrating Radar (GPR) [7]–[10] which have been studied for mapping soil characteristics. Ground

	Penetrating Radar (GPR) is a radar system that works by utilizing electromagnetic waves to detect objects buried under the ground. Information on the level of soil moisture can be seen from the dielectric characteristics at the time of detection. Several GPR systems have been studied for their application and succeeded in detecting groundwater content, including the UWB Pulse Radar [11], Stepped Frequency Continuous Wave (SFCW) [12]–[14], and Frequency Modulated Continuous Wave (FMCW) [15]. . To cover a large area, drones or other motion vehicles can be elaborated in the concept of a device that functions to bring the GPR system to take measurements at every point in the observation area. In measuring soil water content using a radar system, the object detected is soil. However, in more actual cases such as plantation areas, the presence of plants above the ground can act as a barrier at the time of detection. The condition of the presence of obstructions above the ground can be analogous to the case of Through Wall Radar (TWR) [16], [17]. In the case of TWR, the obstruction causes a decrease in the amplitude of the reflected signal from the target and causes a delay in detection. Based on this analogy, plants that are above the ground can have a significant influence, thereby reducing the accuracy of the detection results. Therefore, the reflected signal from plants needs to be minimized so that the reflected signal from the soil can be seen more clearly. Several studies have reviewed its application and succeeded in minimizing the barrier effect [16]–[20]. The use of FMCW radar to detect groundwater content can potentially be done. Low power consumption in the use of FMCW radar can be utilized in large areas such as plantation areas [21]. The FMCW radar can detect the target's distance from the radar using the difference in beat frequency at the time of detection [22]. This ability is useful in distinguishing two adjacent targets so that it can be applied to soil conditions that have plants on it [21], [23]. The problem in the proposed research relates to a more actual case in detecting groundwater content in the plantation area. The presence of plants on the ground that act as a barrier has a significant influence on the accuracy of the detection results. Methods to overcome problems caused by obstructions are needed in an effort to improve the accuracy of the detection results. This method is used to reduce the effect of vegetation on the detection of soil water content. The purpose of the proposed research is to design a method used to reduce the effect of vegetation cover on the detection of groundwater content using the FMCW radar system, so that there are no errors in processing information on water content in the soil. The urgency of the proposed research is explained as follows. The influence of plants that are above the ground has a significant influence on the detection results, so that it has an impact on the inaccuracy of the detection results. This research was conducted so that the proposed method for detecting groundwater content can be applied to more actual cases, such as in plantation areas. The method of extracting groundwater content using the proposed FMCW radar will contribute to the development of technology for detecting groundwater content using a radar system. With this research, it is hoped that it can be applied to more actual cases, such as on plantation land with plants on the ground.
Key points	GPR; FMCW; Soil Water Content; Vegetation; reduction.
Differences from traditional approaches	This project uses a new method or approach, resulting in better output. In addition, the application of information technology and IR 4.0 can increase efficiency and productivity.

Doing	
Launch date	
Responsible organization	Telkom University
Progress as of today	On Going
Problems in implementation	Excess water content in the soil can make the quality of the plant decline due to waterlogged plant roots. Soil that contains little water can also cause permanent damage to plants due to drought
Approaches to solve the problems	The Frequency Modulated Continuous Wave (FMCW) radar system is a radar system that has been widely developed and applied for various needs. Low power consumption in the use of FMCW radar can be utilized in the detection of large areas such as plantation areas
Completion date, if completed	
Seeing	
Impacts on students	-
Impacts on professors and university	-
Responses from industry/market	-
Responses from government	-
Measurable output	-
Cost-benefit analysis for effectiveness	-
Future Planning	
Where does the project go from here?	-
Miscellaneous	
Exhibits, pictures, diagrams, etc.	
Reports, mimeos, monographs, books, etc.	
Others which may help explain the project	