IT4010 – Research Project - 2023

Topic Assessment Form

Project ID : TMP-23-044

1. Topic (12 words max)

"TeaBot" – Tea plantation preservation using an intelligent robot.

2. Research group the project belongs to

Autonomous Intelligent Machines and Systems (AIMS)

3. Research area the project belongs to

Robotics (R)

4. If a continuation of a previous project:

Project ID	
Year	

5. Team member details

Student Name	Student ID	Specialization
Leader: Gunawardana I.I.E	IT19973470	SE
Member 2: Bamunusinghe G.P	IT20011970	SE
Member 3: Premathilake H.T.M	IT20265410	IT
Member 4: Perera P.V.Y	IT20382476	DS

6. Brief description of the research problem including references (200 – 500 words max) – references not included in word count

In large-scale tea estates, ensuring proper watering, and fertilizing tea plants precisely has been a challenge. Despite attempts to improve this process through various techniques, these efforts have not achieved the desired results due to issues such as inefficient resource usage, high costs, and a shortage of labor [1]. Additionally, acquiring a large workforce drastically increases expenses. The task of accurately and punctually watering and fertilizing tea plantations with manual labor is not feasible and, in some situations, it has been inefficient.

A lot of manpower is required to maintain large-scale tea estates. Moreover, in some regions due to socialization, there are only a few people engaged as laborers, and high labor salaries, and irresponsible tasks done by the laborers have led to resource wastage. Carrying the day-to-day activities of a large-scale tea plantation has been a huge challenge due to these occurrences. Disadvantages are identified using an interview done with large-scale tea estate owners. A reference from a tea estate owner is attached. The economic crisis in Sri Lanka has led to huge expenses and resource utilization. Gaining a considerable amount of profit is harder.

Automatic watering systems have been implemented to overcome these matters and maintain tea plantations effectively. Such as Center Pivot Irrigation, Drip Irrigation. In the Center Pivot Irrigation system, the required services and maintenance must be supplied at the correct time, or else the system will break down, frequent replacement of sprinkler nozzles are needed, which involves a large amount of initial cost. For some soil conditions like clayey soil, some wheeled machines, there is a chance the wheels getting stuck [2]. When it comes to the Drip Irrigation system, implementing the system requires a high initial cost. Also, the short lifespan of pipes in this system needs frequent maintenance [3]. In the matter of fertilizing systems, also have negative impacts on large-scale Agri-fields.

An approach, manual robots are developed for fertilizer feeding and spraying, and harvesting but operating the robot manually requires trained employees, and the robot is only limited to fertilization and harvesting [4]. These robots are tested on flat and straight lands and are not suitable for varying environmental lands. Also, tea-plucking robots have been developed and human interactions are essential for robot navigation [5].

By considering all the facts of aforementioned systems also do not fulfill the requirements, so a novel system should be suggested to increase the process efficiently.

[1] S. A. O'Shaughnessy *et al.*, "Identifying Advantages and Disadvantages of Variable Rate Irrigation: An Updated Review," *Appl. Eng. Agric.*, vol. 35, no. 6, pp. 837–852, 2019, doi: 10.13031/aea.13128.

[2] A. Shilpa, V. Muneeswaran, and D. Devi Kala Rathinam, "A Precise and Autonomous Irrigation System for Agriculture: IoT Based Self Propelled Center Pivot Irrigation System," *2019 5th Int. Conf. Adv. Comput. Commun. Syst. ICACCS 2019*, pp. 533–538, Mar. 2019, doi: 10.1109/ICACCS.2019.8728550.

[3] B. Jayant, K. Dahiya, A. Rukhiyar, R. Raj, and R. K. Meena, "A REVIEW OF THE DRIP IRRIGATION SYSTEM," *J. Eng. Res. Appl.*, vol. 01, no. 01, 2022, doi: 10.55953/JERA.2022.1103.

[4] R. Polvara, F. Del Duchetto, G. Neumann, and M. Hanheide, "Navigate-and-Seek: A Robotics Framework for People Localization in Agricultural Environments," *IEEE Robot. Autom. Lett.*, vol. 6, no. 4, pp. 6577–6584, Oct. 2021, doi: 10.1109/LRA.2021.3094557.

[5] Y. L. Lai, P. L. Chen, and P. L. Yen, "A Human-Robot Cooperative Vehicle for Tea Plucking," *7th Int. Conf. Control. Decis. Inf. Technol. CoDIT 2020*, pp. 217–222, Jun. 2020, doi: 10.1109/CODIT49905.2020.9263925.

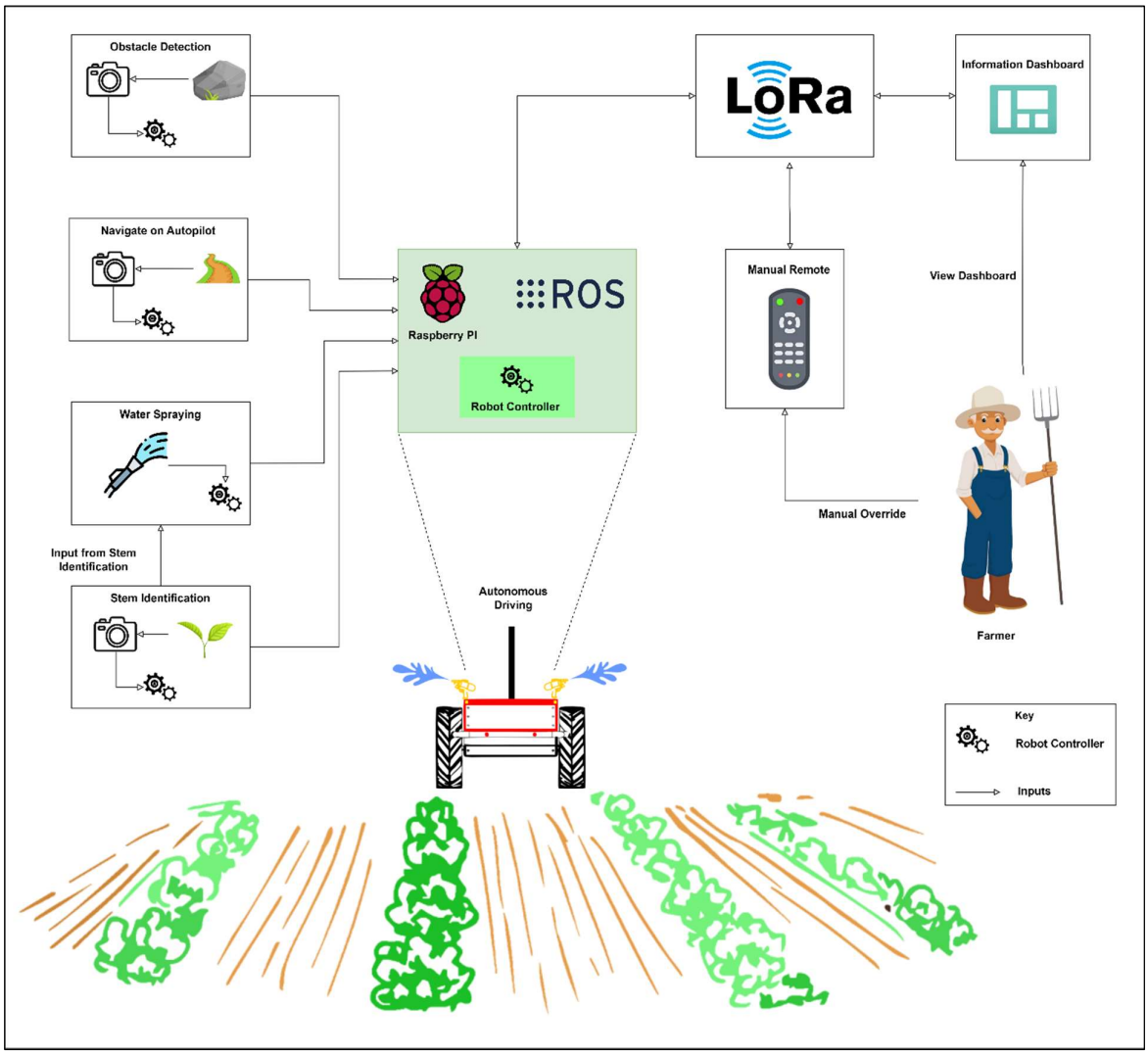
7. Brief description of the nature of the solution including a conceptual diagram (250 words max)

The TeaBot robot is proposed as a solution to overcome the above problems. The agricultural robot will be mainly developed in a reliable and adaptable manner to maintain the watering and fertilizing processes. Additionally, the TeaBot robot can be defined as versatile because it can perform a wide range of tasks. Such as irrigation to maintain growth, health, and fertilization to maintain soil fertility even during dry periods. The fertilization process will be performed with water to make the process more effective.

The robot will be driven in off-road conditions with the given coordinates by the computer vision, maintain the power consumption, and identify the hazards(Obstacles on the navigating road). The robot will precisely detect the tea plantation rows and give the coordinates to the robot controller.

The robot also will identify the end of the stem, which is needed for the watering and fertilizing process. The robot will be able to navigate the water nozzles with the relative movement of the robot to water and fertilize the plants efficiently.

- **Conceptual Diagram**



8. Brief description of specialized domain expertise, knowledge, and data requirements (300 words max)

The main categorization of this research project can be divided into four subcategories.

1) The robot-controlling process, and object detection for emergency situations.
   Eg: Obstacles in the navigation path (branches, stones)
2) Detecting the correct path for automatic navigation and identifying signs.
   Eg: Identify the end of the path.
3) Identification end of the stem for the watering spraying.
4) Water spraying by intelligent nozzles with respect to the relative movement of the robot.

Additionally, the robot controller will be developed using ROS (Robot Operating System). In addition, LoRaWAN (Long Range) will be used to capture the real-time information at the administrator end and to control the robot manually if necessary. Angular, and spring-boot will be required for the development process. The Raspberry Pi will be used to do the computing and the embedded process. In addition, BTS7960 43A motor drivers will be used to drive the high-capacity motors.

It is, moreover, detecting the path to navigate and identifying the end of the stem. Then the water nozzles are controlled with the given coordinates by the stem identification algorithm. The navigation process will be carried out with computer vision. At the initial stage, the robot with three mounted cameras(Front, Left, Right) will manually go through the track and gather the required data images and video footage. Initial datasets from Kaggle will be collected and to deliver more precise outcomes both manually created datasets, and Kaggle datasets will be used to train the machine learning models.

Through the academic sessions, some of the content is not covered. Hence, we are planning to self-study those areas, using internet resources.

9. Objectives and Novelty

Main Objective To implement a smart robot for the tea plantation to water and fertilize the tea plants in an efficient way.			
Member Name	Sub Objective	Tasks	Novelty
Gunawardana I.I.E	To develop an algorithm for the robot controller to navigate the robot with the coordinates given by the computer vision and identify hazards.	1)Creating the robot chassis and the mechanical parts. 2)Creating the PID(Proportional Integral Derivative) controller to navigate the robot. 3)Identify the background hazards using object detection algorithms. 4)Creating the manual controller for the robot.	Navigate the robot in off-road fields with the given coordinates by the computer vision and maintain the power consumption more efficiently and provide the required power when motors need more torque. Identify the background hazards and notify the administrator.

Bamunusinghe G.P	To develop an algorithm to operate the water spraying function in real-time with respect to the relative movement of the robot.	1)Creating the hardware mechanism for water spraying. 2)Tuning the water spray motors according to the robot's motion. 3)Spraying water to the plants according to the relative velocity of the robot by using the 4 nozzles (nozzles will be controlled with stepper motors) to the groups of plants.	Navigate the water nozzles with the relative robot movement to cover the plants in an optimum manner.

Premathilake H. T. M	To develop an algorithm to precisely identify the end of the stem.	1)Initially identify the data requirements. Gather the dataset. 2)Develop the machine learning algorithm to precisely detect the end of the stem of the tea plant. 3)Train the machine-learning model. 4)Testing the model. 5)Optimize the model.	Identify the end of the stem and provide the stem coordinates more precisely to the water spraying controller and identify the water spraying accuracy.
Perera P.V.Y	To develop an algorithm to detect the tea plantation rows more accurately for the navigation of the robot, deciding the end of the path, and the signs.	1)Creation of the dataset 2)Developing the machine learning model to detect crop rows more accurately in various environmental conditions. 3)Training the model to detect the crop rows. 4)Testing the model. 5)Optimizing the model.	Study the front lane detection and provide more precise coordinates to the robot controller in an optimum manner. Identify the end of the path using existing environmental conditions.

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Topic Assessment Form

10. Supervisor checklist (supervisors should fill sections 10 and 11)

a) Is this research problem valid?

Yes	✓	No	

b) Is the proposed research group correct?

Yes	✓	No	

c) Is the proposed research area correct?

Yes	✓	No	

d) Do the proposed sub-objectives match the students' specialization?

Yes	✓	No	

e) Is the required domain expertise, knowledge, and the data available either through the supervisor or external supervisor?

Yes	✓	No	

f) Is the scope of the solution practical?

Yes	✓	No	

g) Do all sub-objectives have sufficient novelty?

Yes	✓	No	

11. Supervisor details

	Title	First Name	Last Name	Signature
Supervisor	Ms.	Shashika	Lokuliyana	
Co-Supervisor	Ms.	Narmada	Gamage	
External Supervisor	Mr.	Rajitha	De Silva	

Summary of external supervisor's (if any) experience and expertise
He is a Ph.D. Scholar at the University of Lincoln. He is reading his Ph.D., in agricultural robotics.

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Summary Sheet

The topic evaluation panel will use the summary sheet to evaluate the suitability of the project

1. Brief description of research problem including references (200 – 300 words max)

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A lot of manpower is required to maintain large-scale tea estates. In some regions, there are only a few people engaged as laborers, requiring high salaries. Also, irresponsible tasks done by the laborers have led to resource wastage. Disadvantages are identified using an interview done with large-scale tea estate owners. The economic crisis in Sri Lanka has led to huge expenses and resource utilization. Gaining a considerable amount of profit is harder.

Automatic watering systems have been implemented to overcome these matters and maintain tea plantations effectively. Such as Center Pivot Irrigation, Drip Irrigation. In the Center Pivot Irrigation system, the maintenance must be supplied at the correct time, or else a breakdown might happen, frequent replacement of sprinkler nozzles is needed, which involves a large initial cost. For some wheeled machines, there is a chance of wheels getting stuck [2]. The Drip Irrigation system requires a high initial cost. The short lifespan of pipes requires frequent maintenance [3].

Moreover, manual robots are developed for fertilizer feeding, spraying, and harvesting but operating the robot manually requires trained employees, and the robot is only limited to fertilization and harvesting [4]. These robots are tested on flat and straight lands and are not suitable for varying environmental lands. Also, tea-plucking robots have been developed and human interactions are essential for robot navigation [5].

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2. Brief description of the nature of the solution (150 words max)

The TeaBot robot is proposed as a solution to overcome the above problems. This will be mainly developed in a reliable and adaptable manner to maintain the watering and fertilizing processes. The TeaBot robot can perform a wide range of tasks. Such as irrigation to maintain growth, health, and fertilization to maintain soil fertility even during dry periods. Fertilization will be done with water for better results.

The robot will be driven in off-road conditions with the given coordinates by the computer vision, maintain the power consumption, and identify the hazards(Obstacles on the navigating road). The robot detects tea rows and sends coordinators to the controller.

The robot will identify the end of the stem, which is needed for the watering and fertilizing process. The robot will be able to navigate the water nozzles with the relative movement of the robot to water and fertilize the plants efficiently.

3. Objectives and novelty

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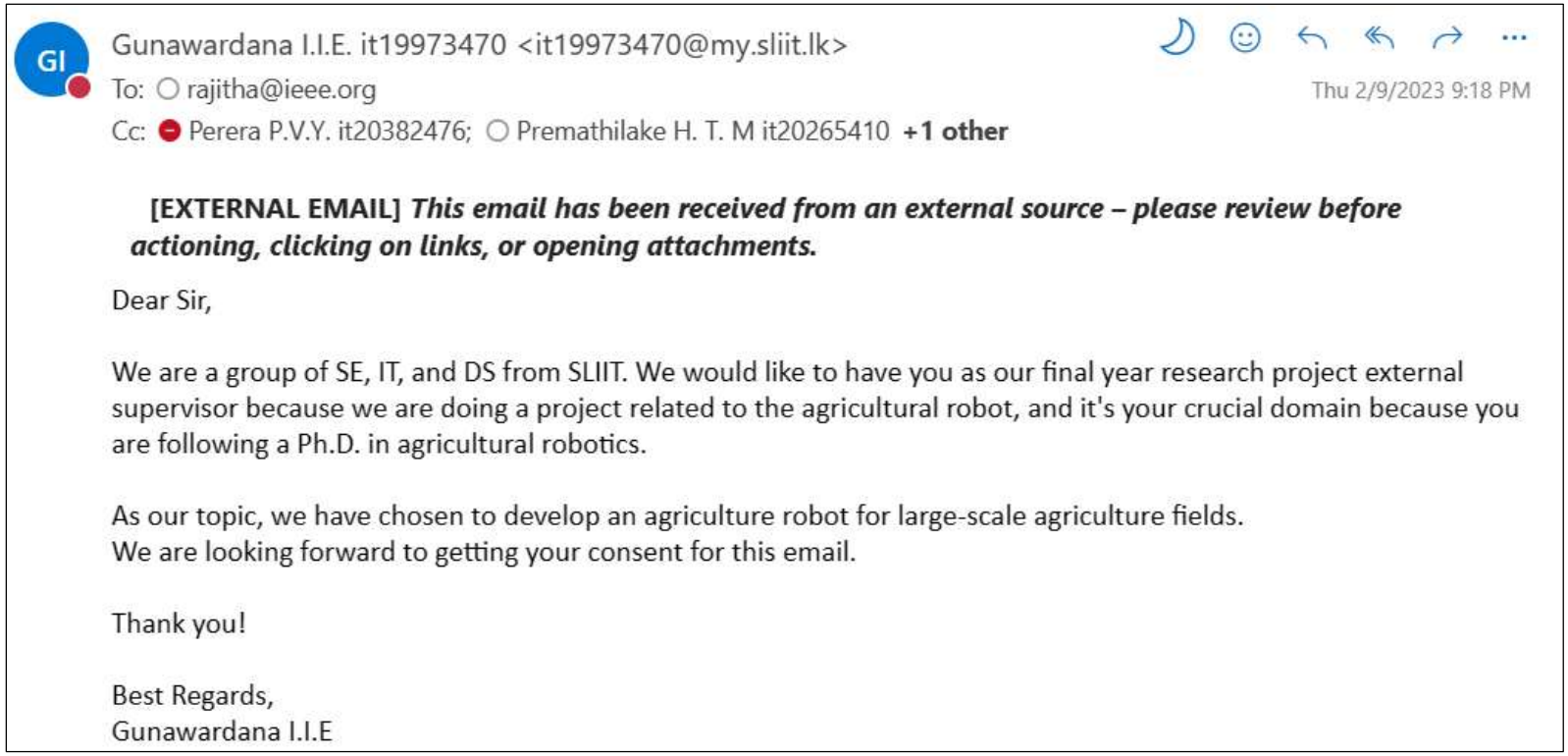
- **Appendices**

  Confirmation mail of the external supervisor



GI

Gunawardana I.I.E. it19973470 <it19973470@my.sliit.lk>

To: rajitha@ieee.org

Thu 2/9/2023 9:18 PM

Cc: Perera P.V.Y. it20382476; Premathilake H. T. M it20265410 **+1 other**

[EXTERNAL EMAIL] ***This email has been received from an external source – please review before actioning, clicking on links, or opening attachments.***

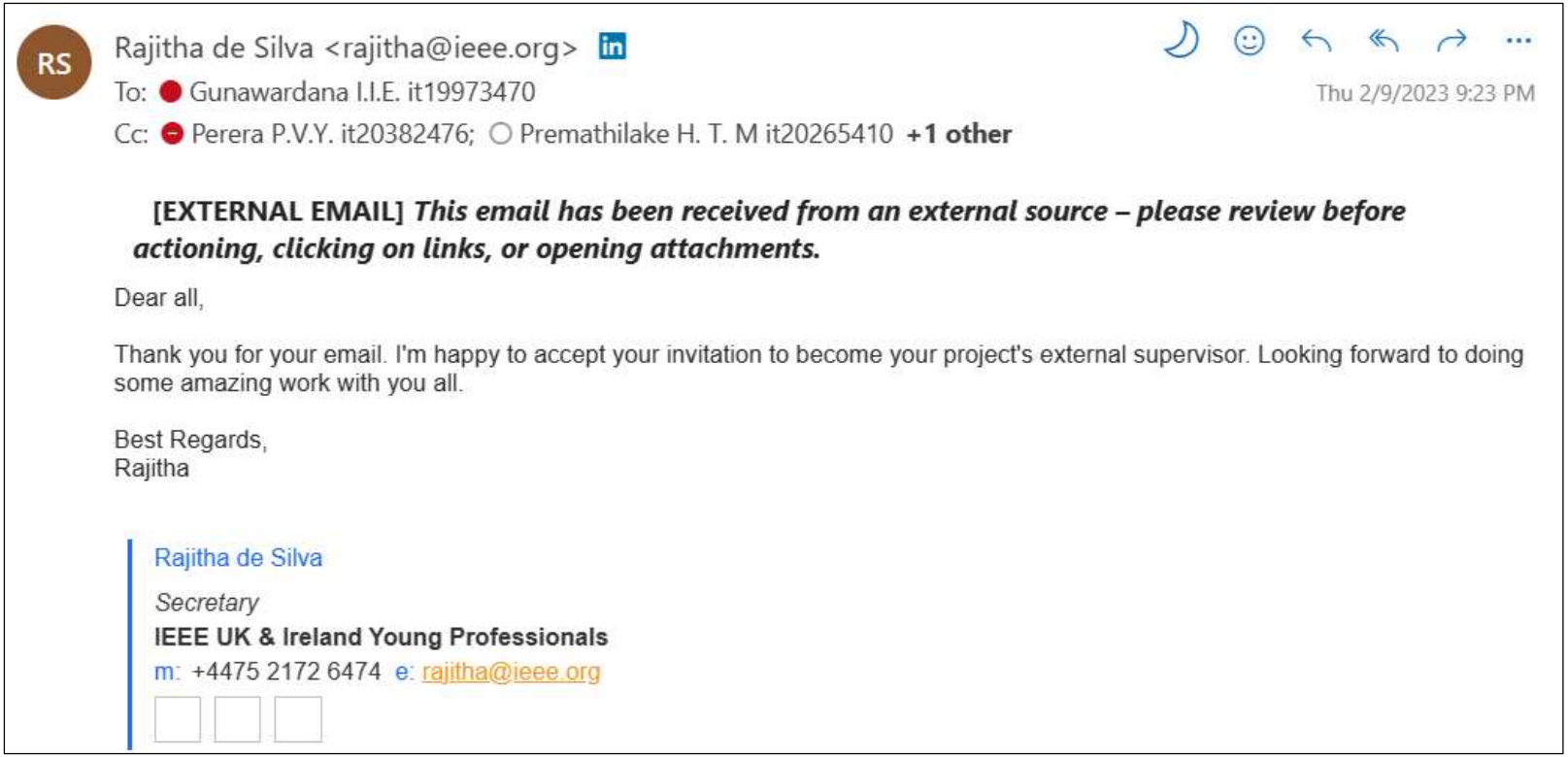
Dear Sir,

We are a group of SE, IT, and DS from SLIIT. We would like to have you as our final year research project external supervisor because we are doing a project related to the agricultural robot, and it's your crucial domain because you are following a Ph.D. in agricultural robotics.

As our topic, we have chosen to develop an agriculture robot for large-scale agriculture fields.
We are looking forward to getting your consent for this email.

Thank you!

Best Regards,
Gunawardana I.I.E



RS

Rajitha de Silva <rajitha@ieee.org>

To: Gunawardana I.I.E. it19973470

Thu 2/9/2023 9:23 PM

Cc: Perera P.V.Y. it20382476; Premathilake H. T. M it20265410 **+1 other**

[EXTERNAL EMAIL] ***This email has been received from an external source – please review before actioning, clicking on links, or opening attachments.***

Dear all,

Thank you for your email. I'm happy to accept your invitation to become your project's external supervisor. Looking forward to doing some amazing work with you all.

Best Regards,
Rajitha

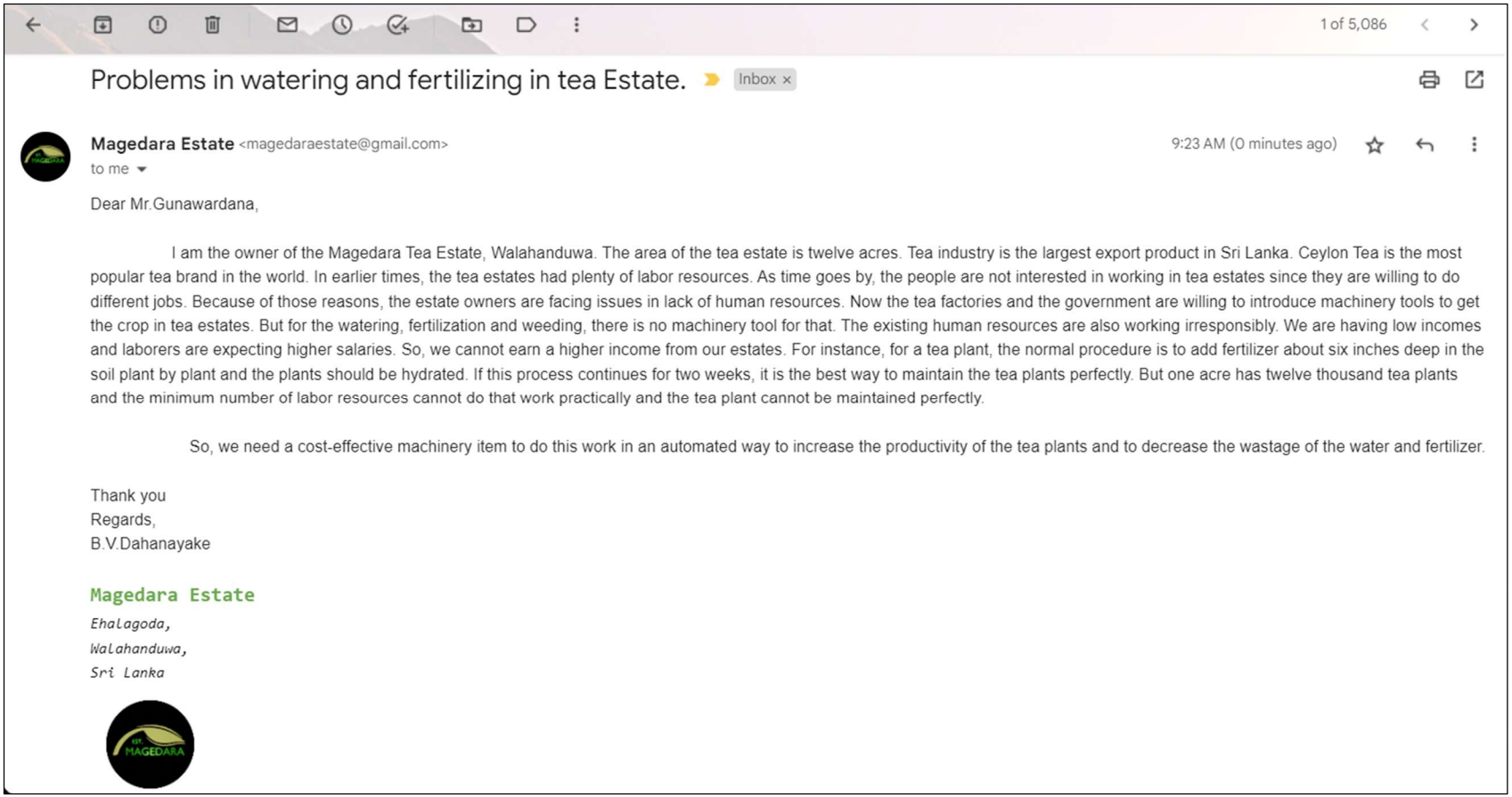
Rajitha de Silva

Secretary

IEEE UK & Ireland Young Professionals

m: +4475 2172 6474 e: rajitha@ieee.org

Confirmation mail of the Magedara Estate, Walahanduwa



1 of 5,086

Problems in watering and fertilizing in tea Estate. Inbox ×

Magedara Estate <magedaraestate@gmail.com> 9:23 AM (0 minutes ago)

to me

Dear Mr.Gunawardana,

I am the owner of the Magedara Tea Estate, Walahanduwa. The area of the tea estate is twelve acres. Tea industry is the largest export product in Sri Lanka. Ceylon Tea is the most popular tea brand in the world. In earlier times, the tea estates had plenty of labor resources. As time goes by, the people are not interested in working in tea estates since they are willing to do different jobs. Because of those reasons, the estate owners are facing issues in lack of human resources. Now the tea factories and the government are willing to introduce machinery tools to get the crop in tea estates. But for the watering, fertilization and weeding, there is no machinery tool for that. The existing human resources are also working irresponsibly. We are having low incomes and laborers are expecting higher salaries. So, we cannot earn a higher income from our estates. For instance, for a tea plant, the normal procedure is to add fertilizer about six inches deep in the soil plant by plant and the plants should be hydrated. If this process continues for two weeks, it is the best way to maintain the tea plants perfectly. But one acre has twelve thousand tea plants and the minimum number of labor resources cannot do that work practically and the tea plant cannot be maintained perfectly.

So, we need a cost-effective machinery item to do this work in an automated way to increase the productivity of the tea plants and to decrease the wastage of the water and fertilizer.

Thank you
Regards,
B.V.Dahanayake

Magedara Estate
Ehalagoda,
Walahanduwa,
Sri Lanka

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Topic Assessment Form

<u>This part to be filled by the Topic Screening Panel members</u>

Acceptable: Mark/Select as necessary

Topic Assessment Accepted	
Topic Assessment Accepted with minor changes (should be followed up by the supervisor)*	
Topic Assessment to be Resubmitted with major changes*	
Topic Assessment Rejected. Topic must be changed	

* Detailed comments given below

Comments

The Review Panel Details

Member's Name	Signature

Important:

1. According to the comments given by the panel, do the necessary modifications and get the approval by the **Supervisor** or the **Same Panel**.
2. If the project topic is rejected, identify a new topic, and request the RP Team for a new topic assessment.
3. The form approved by the panel must be attached to the **Project Charter Form**.