KENYA SPACE AGENCY

Possibilities beyond our skies

2021-2022

SMALL-SCALE CROP MAPPING USING ARTIFICIAL INTELLIGENCE/MACHINE LEARNING

TERMS OF REFERENCE

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1. Background

The Space Industry has evolved over the years and is currently among the fastest growing industries in the world, creating new innovations and job opportunities every day. Space technology plays a critical role in support of socio-economic development and data-driven decision making. In developing countries, space technology has the potential to foster development and advancement in higher education, science, technology, research and innovation. As a developing country, Kenya is keen to tap into this potential.

The Kenya Space Agency (KSA) is a State Corporation that promotes, coordinates and regulates space related activities in Kenya. Since 2020, the KSA has been implementing a Research Chairs (RC) program in Kenyan universities to contribute towards Kenya's socio-economic development by promoting capacity building and linkages between academia and the Space industry. The Agency is keen to continue building on this legacy by encouraging and offering support to our public universities. In this regard KSA will be offering research grants for THREE projects in FY2021/2022, one of which is the Small-scale Crop Mapping using Artificial Intelligence/Machine Learning.

2. Introduction

As Kenya Space Agency, we are keen to tap into the technical resource prevalent in our Higher Institutions of learning and research and have introduced the Research Chair on Small-scale Crop Mapping using Artificial Intelligence/Machine Learning (AI/ML). One of the most important goals of the Kenyan Government is to ensure that there is food security. For this to be met, embracing technological advancement will be essential towards achieving this goal.

Remote Sensing technologies is one of the technologies that has had rapid growth over the recent past. For example, the European Copernicus developed a very ambitious satellite program which runs on Sentinel 1A/1B and Sentinel 2A/2B. The data from these satellites have relatively high spatial resolution of 10 metres. Moreover, the capability of Sentinel 1A/1B being Synthetic Aperture Radar to collect data regardless of the weather and time of day has increased the capabilities and applications of remote sensing data in agriculture. The Kenya Space Agency strategic plan for 2020-2025 envisions the use of satellite data and technology in informing the decision making process.

Small-scale crop mapping using Space data is one of the most effective ways in estimating the crop area, crop yields and assess the food security situation in the country. This can be achieved by processing and analyzing Remote sensing data. This data, however, require high processing techniques with complex mathematical processes. The field of AI/ML uses data

and algorithms to imitate the way that humans learn, gradually improving the accuracy of the results. The major focus of AI/ML is to extract information from data automatically by computational and statistical methods. Over the last decade there has been considerable progress in developing a AI/ML methodology for a variety of Earth Observation applications.

The processes of Small-scale crop mapping can be incorporated to build an application with a Graphical User Interface (GUI) that can be used by users either with expertise and those with little expertise in the Geographical Information Systems (GIS) and remote sensing fields. This would be of importance to policy makers with no background in GIS and remote sensing to generate products and derive statistics from different areas of application. This can be achieved by the use of Google Earth Engine or other platforms with the same capabilities.

3. Project Objectives

The main objective of this project is to build capacity and promote the process of developing Small-scale Crop Mapping application using AI/ML and subsequently develop a user interface tool for generating crop products.

The specific objectives of this project include;

a) Provide an application that should be able to conduct crop type classification with an appropriate AI/ML algorithm.
b) Provide an application that should be able to estimate crop area, crop yield and monitor crop health.
c) Provide a documentation of the scripts and the processes that have been used in the development of the application.
d) Develop a budget that will support the implementation of this project.
e) Use AI/ML as a catalyst in promoting Geography, Science, Technology Engineering and Mathematics (Geo-STEM) in the country.

4. Scope of Work

The project team will be required to develop a system that can be adopted to conduct crop mapping in the country. The system should comprise of an application that runs crop mapping functionalities and a user interface tool that enables one to input, filter, retrieve, display and download results. The project should be able to produce a system that can monitor crop health, produce crop statistics on the type of crops, crop coverage extent, and the amount of crop produce for the various crops being mapped.

The project will majorly focus on GIS, Remote sensing and Computer programming skills. The team will be composed of SIX (6) members from each of the beneficiary university comprising of (3 Remote Sensing/GIS students and 2 IT/Computer Science students or any

other related course such as Geography/Environmental Sciences etc.) and ONE (1) Faculty lead.

Project Deliverables

The success of the project will be measured upon the development of a Graphical User Interface (GUI) tool that can be able to give products which can be used in Small-scale crop mapping. The deliverables will be measured upon completing a web based platform with the following capabilities:

a) **Acquire satellite data.** Users should have the ability to select satellite imagery that they intend to use. These data include; Landsat data, Sentinel 2A/2B and sentinel 1A/1B Synthetic Aperture Radar (SAR) etc.
b) **Filter and process satellite data**. The interface should also have the capability to allow the user to specify the filtering processes which they intend to use. Some of this process include, but not limited to, cloud masking, cloud percentage cover, date of image acquisition, filter to bounding box, polarizations, instrument modes and orbital properties to use in case of SAR data and clip the data using the area of interest.
c) **Have data import and export functionalities.** The system should have capabilities to import and export data inform of Shape files, csv files and TIFF formats.
d) **Choose an appropriate machine learning algorithm that can identify various land cover features.** From the interface the user should be able to choose a machine learning algorithm that they wish to apply for the classifier.
e) Be able to monitor crop health. The system should have the ability to use AI/ML to continually monitor the health of the crops over time. This should include ability to detect the areas that have been infested with pests and diseases, water requirements among other factors that determine crop quality.
f) **Conduct data analysis and display output results.** The GUI system developed should be able to display the output at the end of the process which includes; Land use land cover maps, graphs showing the areas occupied by the types of crops, estimate the areas occupied by each crop, change detection map elements and any other information that is important in Small-scale crop mapping.

5. Budget

The proposed Research Chair award on the Small-Scale Crop Mapping using AI/ML will be worth Ksh 2Million and with FOUR beneficiary Universities each to receive Ksh 500,000. It will be expected that each University will use the Google Earth Engine platform and create a GUI to generate the products. The Administrative cost should not exceed Ksh 100,000. At the end of project development cycle, the Universities shall submit report and all records of their financial expenditure.

6. Responsibilities

The universities selected for the project shall bear the responsibility of choosing the project members who shall consist of the respective university's teaching staff and student faculty. The students are to be the key developers involved in the Small-scale Crop Mapping application using AI/ML. The KSA shall monitor the progress of the project, with a scheduled mid-term review for the purposes of a progress report detailing the challenges faced, team professional experiences, budget accountability and to discuss any concerns that might affect project timelines or standards.

8. Timelines

The proposed timelines are as follows;

No.	Activity	Dates
1.	Announcement of the opportunity	Wednesday, 8th September, 2021
2.	Submission of Letter of Intent	Wednesday, 15th September, 2021
3.	Briefing session with Faculty team leads	Friday, 17th September, 2021
4.	Submission of the concept note	Friday, 1st October, 2021
5.	Completion of evaluation of concept note	Friday, 15th October, 2021
6.	Symposium and awarding of winners	Friday, 22nd October, 2021
7.	Disbursement of the Funds	Friday, 29th October, 2021
8.	Mid-Term Review	Friday, 28th January, 2022
9.	Completion and submission of the reports and the Small-scale Crop Mapping Application	Thursday, 31st March, 2022

It is estimated that the full duration of development of the Small-scale Crop Mapping application using AI/ML will take approximately FIVE months from the announcement of the opportunity to the final submission of the report. The KSA expects the completion and submission of the final report by Thursday, 31st March, 2022.

9. Points of Contact

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