Design implementation of wireless multimedia sensor networks for dryland agriculture

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Abstract. This study discusses the application of Wireless Sensor Network (WSN) technology to specific dry land agriculture because it was founded in the Province of East Nusa Tenggara (NTT) and a small part of Maluku. Its uniqueness has become a comparative advantage for the regions, especially for the academics of the University of Nusa Cendana (Undana). In general, the use of WSN in agriculture is still basic, relying on analog and manual sensors to obtain information on land conditions and vegetation in the land. Also generally still using scalar data and not optimizing the use of multimedia data, especially data based on videos and images. The contribution and novelty of this research are: (a) The application of multi-sensor technology with the Wireless Multimedia Sensor Network (WMSN) will optimize various data from land conditions so that it is hoped that more analysis of monitoring data results is expected, precise and efficient; (b) The application of WMSN with Internet-of-Thing (IoT) will be applied to the dry land agriculture. This research produces a design for implementing WMSN technology on dry agricultural land which is expected to increase agricultural yields in the area.

1. Introduction
The use of Wireless Sensor Network (WSN) has increased significantly in the last decade. Various fields have used it, ranging from household needs to large industries, both personal and organizational. The need for multiple input data and parameters in the form of multimedia has led to multi-input WSN on various objects and areas/land to be sensed/monitored. This condition presents a new scheme for WSN, namely Wireless Multimedia Sensor Networks (WMSN). Various types of data in the form of text to image and
video are united in a WMSN transmission with an IoT (Internet-of-Things) connection and Big Data technology that provides an integrated and efficient monitoring system.

Unique agricultural land for dryland islands is a condition that can only be found in the province of East Nusa Tenggara (NTT) and a small part of Maluku. Its uniqueness and uniqueness have become a comparative advantage for the region, especially for the University of Nusa Cendana (Undana). So it is not an exaggeration if the archipelago's dry land becomes Undana's leading research, including those that are the focus of research.

Although the use of WSN in agriculture has been implemented a lot, generally, it is still conventional using by relying on analog and manual sensors to obtain information about land conditions and vegetation in the land. Also, they usually still scalar data and not optimizing the use of multimedia data. Agricultural land utilizing WSN technology is also common, which no one has yet tried to do on the dry land.

The advantages and the novelty of this research are (a) The design implementation of multi-sensor technology with WMSN will optimize various data from land conditions so that it is hoped that the analysis of monitoring data results is more precise and efficient; (b) The implementation of the prototype IoT and Big Data technology is expected to contribute significantly to increasing the productivity of agricultural products for superior vegetation on archipelagic dryland.

The use of WSN in various fields is increasing. The use of WSN is well-reviewed in Borges et al. [1], where it is stated that the agricultural sector has the potential to be developed with WSN assistance. The application of WSN technology in agriculture has been surveyed in Fernandes et al. [2]. In Shi et al. [3], the use of images in monitoring agricultural land has been carried out. In López et al. [4], proposed a low-cost agricultural monitoring structure and scheme using WSN. Lazarescu [5] resulted in the design and validation of a WSN monitoring prototype in an agricultural environment, taking some time. In Bandur et al. [6] reviewed the energy use of WSN for agricultural monitoring. In Rajeswari et al. [7], an intelligent system in the agricultural sector with the application of WSN is proposed. The use of monitoring technology using the Raspberry Pi device has been reviewed in Tzounis et al. [8], where the WSN is connected to a local server that is connected to the Raspberry Pi device. Especially for the development of WSN in dryland agriculture, it has been used but only not optimally, including in Kodali et al. [9] where agricultural products and water availability in agricultural land are the focus of research and in Ranquet et al. [10], which focuses on low-cost sensors and schemes. The resulting developed from various studies that we have done, such as in Rantelobo [11] and Rantelobo [12], where we have implemented WMSN to monitor people and move objects. This research will also utilize WiFi sensing [13] and Channel State Information (CSI) methods [14], which will enable the communication system on the WSN to be adaptive. The result that we will apply and develop in the scheme to propose for dryland agriculture.

The use of IoT generally utilizes the internet network as a link with a centralized monitoring system so that it is easy to control. From the use of WSN in agriculture above, generally, it is still basic by relying on WSN sensors to get information about land conditions and vegetation in the land. Also generally still scalar data and not yet optimizing the use of various Multi-Sensor-based data, especially multimedia data. Agricultural land utilizing WSN technology is still common, where no one has tried to do it on dry land in the archipelago. So this research proposal proposes the use of a WMSN in archipelagic dryland agriculture, which is the leading field of the University of Nusa Cendana (Undana).
2. Application and monitoring using Wireless Multimedia Sensor Networks (WSN) in dryland agriculture

WSN technology has been widely used in monitoring and sensing, especially concerning natural conditions and phenomena [1]. WSN-based sensing activities developed in the agricultural sector are increasingly diverse and consist of various schemes and vendors [15]. Figure 1 shows the basic schematic and structure of a WSN system on agriculture. In this research, WSN is used to get scalar data input and multimedia data from the data collection location. Its transmitted it to the data processing and analysis center for real-time WSN-based monitoring that is connected to the internet using IoT (Internet of Things) and Big Data, as in Figure 1 [15,16]. In principle, there are 4 (four) main parts of a WMSN system; that is:

a. Sensor Node; a part that captures both scalar and multimedia which consists of multi-sensors of a phenomenon or natural condition/location or object that is directly monitored;
b. Gateway Node (connecting with internet network); namely a module consisting of various electronic components and devices so that a sensor can receive signals and transmit/distribute them to a centralized network; connecting or receiving signals from sensors to be forwarded to a centralized network or the internet;
c. User, namely parties that will utilize multi-data from the WMSN system via the internet (IoT) and Big Data.

Utilization of Internet of Things (IoT) technology with Big Data in the process of sending data from a WSN system is intended to facilitate data/information to be processed and disseminated optimally and efficiently [16]. Mainly for agricultural land, WSN has been used for various monitoring on various land conditions and parameters. The resulting information and data, both scalar and multimedia, direct (real-time) and on-demand, increase agricultural output in an integrated manner [17].

In Cao-hoang and Duy [18], monitoring of the agricultural environment with various uses sensors, soil, vegetation, and air/climate conditions. WSN for land monitoring is combined with beekeeping to produce a productive agricultural system integrated with various fields [19]. In Flores et al. [20] proposes using multimedia data using the Raspberry Pi device and sensor, which is the latest technology in the image and video-based monitoring. The use of IoT technology was proposed by Gondchawar et al. [21], who developed a smart integrated system with various fields. In Rantelobo et al. [12]; developing IoT-based WMSN for
security and safety monitoring. The integration of agricultural products with the food industry developed by Garcia et al. [22].

This research proposal will develop WMSN based on multi-sensor scalar and multimedia. Several parameters to be monitored/sensed are humidity, air, and soil humidity, soil conditions, leaf and tree image, temperature and air pressure, and the level of solar lighting. Sensing treatment depends on vegetation and land conditions. This combination of data is expected to provide significant results for the increase in superior vegetable production in the dry land. The WMSN design prototype that will be developed based on multimedia data can be seen in Figure 2, where this prototype has been applied by the Proposing Team to human monitoring (people counting) in a room [11].

Figure 2. WMSN prototype with Raspberry Pi device [11].

3. Design proposed
The pilot project that will be used to conduct this research, namely a Field Project at the Archipelagic Dryland Center of Excellence Universitas Nusa Cendana as potential user partners. Various parameters include humidity, air, and soil humidity, soil conditions, image of leaves and trees, temperature and air pressure, as well level of sunlight. This research aims to validate the results of the empirical analysis and the results of direct observations in the dryland agriculture field. Furthermore, it will produce a WMSN model and prototype, which will also be evaluated at the pilot project location (outside the Green House conditions). It is hoped that the evaluated of the results will result in the stage of implementing the WMSN prototype, which can make a significant contribution to increasing the yield of superior vegetation productivity of archipelago drylands. The algorithm of the schema in the outline can be seen in Figure 3.
4. Results and discussion

The provisional results resulted from the previous research scheme using the sensing method and monitoring moving objects on the visual sensor using the Raspberry Pi device's camera. Furthermore, testing on moving object monitoring schemes is simplified by testing simple and complex objects such as cars and moving people. Tests were also carried out using analog data equipped with multimedia data. The results showed that in general (preliminary results), the proposed scheme promises to contribute to the application of WMSN in the field of dryland agriculture, where a visual sensor in the form of a camera with 640x480 pixels can send and receive images/object data was monitored. The WMSN model and prototype in the outline can be seen in Figure 4.

Figure 3. Algorithm schema for proposed.

Figure 4. The design and prototype proposed for dry land agriculture.
The use of the communication system on WMSN with the development of WiFi sensing and the CSI method is expected to provide optimum results on data transmission from sensors to the IoT network. This method's application is expected to give a more significant increase in pixels for sending better visual and detailed images of objects and data proposed in this research.

5. Conclusions
The research can run on the proposed scheme with a $640 \times 480$ pixel limit as a preliminary result. In this study, the application of WMSN for dryland agriculture (especially in the East Nusa Tenggara region) will be carried out. The IoT and Big Data technology implementation for design and schemes will be implemented. The future works are the implementation of WiFi sensing and CSI method in video/data transmission.

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