DATA TRANSMISSION SYSTEM BETWEEN DEVICES IN MOVEMENT FOR TRACKING A VEHICLE

A. S. Rodríguez-Valentín, J. F. López-Feliciano, P. Horstrand-Andaluz
Institute for Applied Microelectronics (IUMA)
Integrated Systems Design Division
University of Las Palmas de Gran Canaria (ULPGC), Spain
aythami.rodriguez106@alu.ulpgc.es

***Abstract*—The system presented in this work consists of a drone from the company Dji, capable of positioning itself automatically above an agricultural vehicle in continuous movement based on dynamic GPS coordinates given by a global positioning system mounted on the vehicle. LORA is the technology chosen to fulfil the requirements of long distance transmission in a remote field where network signal might not always be available. An application has been implemented in order to be able to track, represent and position the drone making use of the Xcode tool and Mobile SDK from Dji.**

Keywords: GPS, LORA radio, Dji, Bluetooth 4.0, Xcode 8.3, Mobile SDK.

I. INTRODUCTION

This Project falls within the European Project ENABLE-S3 (European Initiative to Enable Validation for Highly Automated Safe and Secure Systems), more precisely within the Use Case 13, about precision agriculture [1][2], in which the IUMA is involved. This area of research is based on harnessing the current technological advance to reduce the effort of the farmer and increase productivity in the agricultural fields. That is why this work proposes a system that allows the drone to follow the agricultural machinery in its movement (same speed, but at a certain height), so that in the future a hyperspectral or thermal camera installed on the drone can detect and identify the presence of a living obstacle and send a signal that causes the entire system to stop.

While it is actually true that current Dji applications are already able to perform tracking based on image processing, there are some situations in which that process fails due to adverse atmospheric conditions, for instance fog, or due to the dust that is being generated by the machine while performing the collecting process. Those are the main reasons for choosing a GPS based system.

On the other hand, the lack of communication networks in most of the agricultural fields makes necessary the use of alternative technologies that allow the transmission of GPS coordinates from the harvester to the drone. The adopted solution in this work incorporates LORA radio, which ensures communication distances up to few kilometres in open areas.

II. SYSTEM BLOCK DIAGRAM

The system is made of 7 elements. The first one is the GPS module, RPI GPS ADD-ON V2.0 [3], and is responsible for transmitting through the serial port the data frame according to the NMEA protocol in ASCII format. The second element is the ATmega32u4 microcontroller with LORA radio [4], the transmitting unit, which composes the data frame received in the serial port where the global positioning system is connected and transmits it through the transmitting unit at 915MHz towards the other ATmega32u4 microcontroller with LORA radio, receiver unit. The receiving unit forwards the information received from the transmitter to the serial port where the Bluetooth HM-10 is connected [5]. This is the fourth element and allows routing the information received towards the IPad. The fifth element is the IPad, which controls the drone flight from an application that has been developed from scratch in the programming environment Xcode 8.3 with the Dji SDK [6]. The sixth element is the drone remote control, which is connected to the IPad via USB. The last element is the drone itself, which will be constantly positioning itself over the corresponding coordinate point.

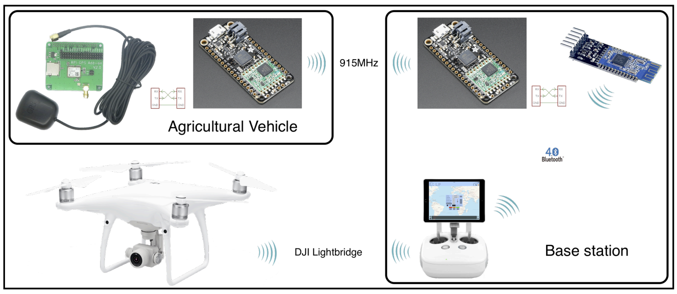

Figure 1. Elements of system

The diagram presented here fulfils all the goals that were set for this work and the European Project ENABLE-S3:

- The GPS positioning system is installed in the harvester together with the transmitting unit, the first ATmega32u4 microcontroller with LORA radio. The information is sent to the base station, located a few km away from the harvester. The base station comprises the second ATmega32u4 microcontroller with LORA radio, the Bluetooth HM-10, the IPad and the drone remote control. A supervisor will always be able to take over the control of the system in case of an emergency.

- It is a Dji cross-platform since it can be used for the Phantom 4 as well as for the Matrice 600, among other platforms from that company.

III. Application Design

The App comprises 3 storyboards. In the first storyboard a map is included to represent the last point received from the LORA radio, the positioning of the drone and the last position of the mobile device. Moreover, the trajectories of the GPS module, the drone and the mobile device are also depicted in the map as lines of different colours. In the second storyboard (top-right) a table is shown with the available peripherals, to which the user can connect or disconnect. The third storyboard (bottom-right) also represents a table but in this case is used to list the points received from the LORA radio with its associated information. This table permits to select, deselect, edit and delete the elements of the array. It does also incorporate a browser to search and find a specific point.

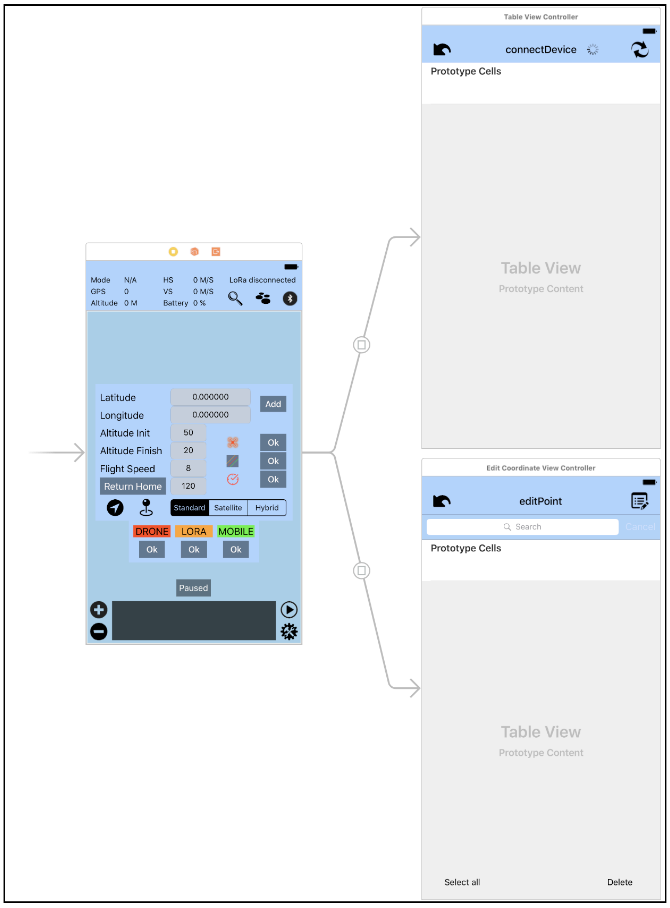

Figure 2. Storyboards of the application

A settings window can be deployed on top of the map of the first storyboard, in order to set the attributes of the mission as well as other visual settings.

IV. Obtained Results

In order to validate the implemented system, some tests have been performed and key variables measured. In the following lines the result of these tests are presented.

One of the key indicators of the performance of the LORAs radio is the RSSI (Received Signal Strength Indicator). In this first test performed in Las Canteras beach with the receiver standing at the Auditorium and the transmitter moving from the same starting point until the area of Peña La Vieja, the relationship between the RSSI and the distance between the two modules was evaluated. Figure 3 shows the obtained results for that test. As it can be seen, the RSSI values are always kept above -100dBm, which is within the operating range for this technology, this allows transmitting the coordinates stably and during the whole route with practically no signal loss.

The distance reached during the test was 1400m. However, this could have been further increased, since the manufacturer of these devices stablishes that they are able to operate in distances up to 2km, and the signal intensity can decay further to -137dBm. Furthermore, the inclusion of other type of advanced antennas will for sure increase this distance.

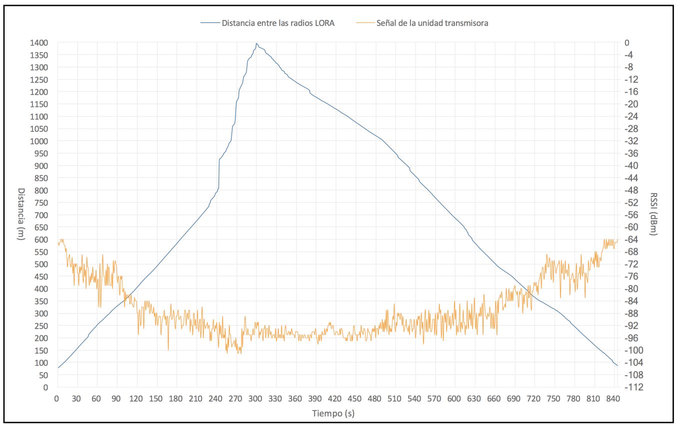

Figure 3. Graphical representation of the signal intensity drop of the transmitting unit and distance between both radio LORAs

As shown in figure 3, both in the way in and in the way back, the slope of the distance plot is fairly linear due to the fact that the signal transmission and reception was relatively stable. It is also proven that the signal intensity drop keeps a close relationship with the distance between both radios, but is not the only factor. There are others such as the wave propagation media, noise introduced to the signal, the distance between emitter and receptor, etc., which are out of the scope of this work.

The second test was performed at the football field of the University of Las Palmas de Gran Canaria, and it included the whole system altogether. The drone following the transmitting unit, while this circling the field, being carried by a person.

The distances covered in this test were much shorter than in the previous one as represented in Figure 4.

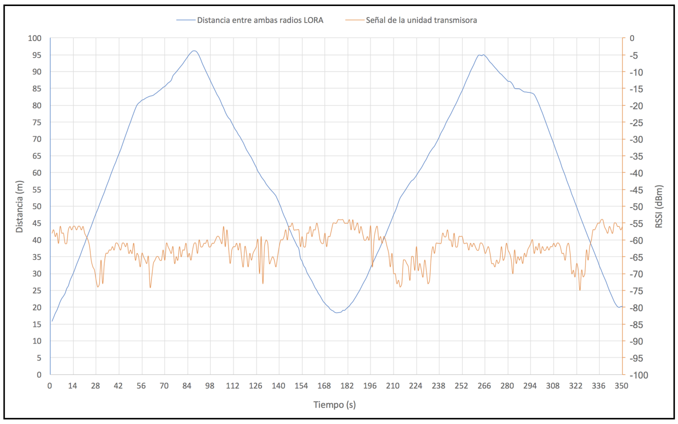

Figure 4. Graphical representation of the signal intensity drop of the transmitting unit and distance between both radio LORAs

Figure 5 represents the offset between the drone and the transmitting unit. As it can be seen, aside from the 2 peaks present in the plot that are the consequence of a short signal loss, the offset value is kept at an average of 2.4 metres, which is fairly good for the final application taking into account that the drone is flying at 20 meters of height.

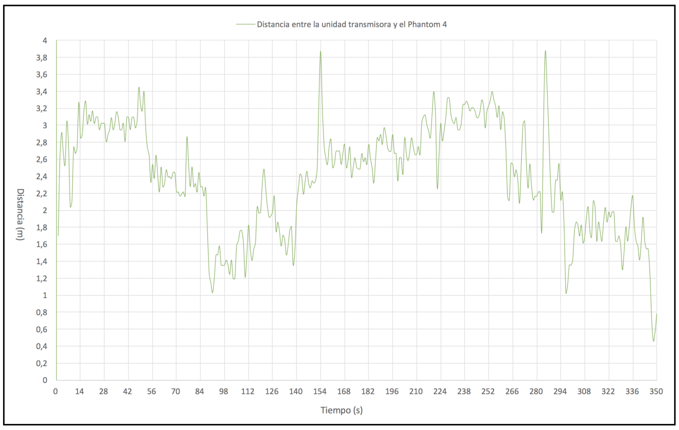

Figure 5. Graphical representation of the offset between the transmitter and Phantom 4

V. Conclusions

The developed system is capable of positioning a Dji drone, in this case a Phantom 4, over dynamic GPS coordinates through a global positioning system that is able to work in a range of distances over 1400 meters thanks to LORA technology, which is more than enough for the agricultural application that is being developed in the project ENABLE-S3. This solution copes with adverse situations that are caused due to low visibility in the ground such as fog or dust.

The application developed in Xcode, with the Dji Mobile SDK, monitors, represents and positions the drone. By running a mission whose parameters can be set or modify in the menu options, the drone is also automatically controlled to track the transmitting unit.

The application takes into account possible errors that can occur during the flight and brings back the drone to its starting position in any of the following circumstances: the signal of the transmitting unit is lost over a defined period of time, the battery level is less or equal 20%, or an error occurs during the mission.

The results obtained in the tests verify the proper operation of the system. The developed App was also successfully simulated with another Dji product, as it is the Matrice 600, which is the final platform to be used in ENABLE-S3.

Acknowledgment

ENABLE-S3 project is partly funded by the Ministerio de Economía y Competitividad of the Spanish Government under the Programación Conjunta Internacional del Programa Estatal de Investigación, Desarrollo e Innovación Orientada a los Retos de la Sociedad, in its call 2015-2.

References

[1] M. Teke, H.S. Deveci, O. Haliloglu, S.Z. Gurbuz, U. Sakarya, “A short survey of hyperspectral remote sensing applications in agriculture”, 6th International Conference on Recent Advances in Space Technologies (RAST), Estambul, Turquía, 12-14 junio 2013.

[2] R.N. Sahoo, S.S. Ray, K.R. Manjunath, “Hyperspectral remote sensing of agriculture”, Current Science, vol. 108, num. 5, marzo 2015.

[3] U-blox, NEO-6 series: https://www.u-blox.com/en/product/neo-6-series, date of the last visit 4 of July 2017.

[4] Adafruit Feather 32u4 LoRa Radio: https://learn.adafruit.com/adafruit-feather-32u4-radio-with-lora-radio-module/overview, date of the last visit 4 of july 2017.

[5] Technology Company, Bluetooth Low Energy, modelo HM-10, Datasheet V507 (2013): ftp://imall.iteadstudio.com/Modules/IM130614001_Serial_Port_BLE_Module_Master_Slave_HM-10/DS_IM130614001_Serial_Port_BLE_Module_Master_Slave_HM-10.pdf, date of the last visit 4 of july 2017.

[6] Dji Developer: https://developer.Dji.com/, date of the last visit 4 of july 2017.