Design and implementation of a real-time kinematic network for the sugarcane industry in Colombia

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Abstract We conducted a technical study in 244,000 ha planted with sugarcane located in the Cauca River Valley (Colombia) to define the number, location, characteristics of GNSS base stations and compatibility of GNSS receivers, in addition to evaluate radiofrequency (RF) and cellular signal coverage. We found that the design should consists of 17 sites where it is proposed to install 7 GNSS permanent stations, 5 radio stations and 10 radio repeaters, distributed in the study area. According to the test of GNSS RTK signal coverage, one of the limiting factors to implement the RTK network (RTN) is the low coverage of cellular signal in rural areas. We will implement a network of dual signal (radio and cellular) with coverage of 100% of the area planted with sugarcane to provide RTK signal to tractors and cane harvesters mainly through radio and in some areas through cellular signal.

Key words Precision agriculture, real-time kinematic network (RTN), sugarcane

INTRODUCTION

In the last 5 years the numbers of precision agriculture (PA) equipment in the agribusiness sector of sugarcane in Colombia has doubled, producing an increasing number of portable GNSS real-time kinematic network (RTK) stations. The main problems associated with portable stations are the high cost of each, the limited range coverage (3 km in line-of-sight installed at 10 m height), and the difficulty to georeference the cartography generated. One solution is to install permanent GNSS RTK stations at fixed points to transmit reliable, stable, continuous quality RTK signals (Gakstatter 2009). There are two methods to broadcast RTK signal: radiofrequency (RF) and Internet. Because the Internet coverage in rural zones in Latin-American countries is low, it is necessary to design a RTN that transmits both methods. The advantages of a RTN are the transmission of an accurate GNSS RTK signal, coverage in all sugarcane areas, avoidance of fixed control points, ensuring repeatability of the GNSS RTK signal and allowing interconnectivity between AP equipment (in the case of Internet broadcast) (Bays 2012). Limiting factors are the high installation cost, poor Internet coverage, correction of GNSS RTK only for the horizontal position and high risk of theft of equipment. The first RTN appeared in the US in 2003. It is estimated that in the United States more than 80 public and private RTN are installed and there are more than 200 worldwide (Gakstatter 2014). Among the uses of RTN are GNSS RTK geodetic and hydrographic surveys, road construction, civil engineering, mining, transport and agriculture.

Here, we aimed to design a RTK network for the sugarcane area of the Cauca Valley in Colombia.

MATERIALS AND METHODS

In the design of spatial configuration of base stations in the RTN were used the following criteria: coverage in 100% of area cultivated with sugarcane in the Cauca River Valley; RTK Network with dual broadcast of RF and Internet. For RF, two ranges of frequencies are needed: 430-470 MHz (Topcon and Trimble PA equipment), and 900-902 MHz (John Deere equipment). For each station, the radio coverage of RTN for Internet has to be 30 km and for RF has to be 15 km. For RF the broadcast (430-470 MHz) format will be CMR and for the Internet it will be NTRIP.

In addition, an economic study was conducted to determine the total cost of project and the best of five business scenarios: 1. Satellite GNSS correction (annual subscription); 2. Shared investment between users and manufacturer of technology (annual subscription); 3. investment by users with consultancy in GNSS installation; 4. investment by users without consultancy; 5. Shared investment and use of GNSS RTK signal by the manufacturer of the technology.
RESULTS AND DISCUSSION

According the criteria mentioned above, we designed a system of 17 sites where it is proposed to install 7 GNSS permanent stations, 5 radio stations and 10 radio repeaters, distributed across the area (Fig. 1).

The cost of the RTK network depends on controllable design factors (number of base stations, signal transmission signal, location of stations) and uncontrollable external factors (exchange rate, availability of local technology, etc.). According to quotes delivered by several bidders, the estimated cost of implementing the RTK network is USD 500.000. Business scenario selected was number 3 (investment by users with consultancy in GNSS installation).
CONCLUSIONS AND PROJECTIONS

Following our recommendations, it is proposed to implement a RTK network with dual communication (RF and Internet) with 7 permanent stations GNSS, 5 radio stations and 10 radio repeaters distributed across the Cauca River Valley and covering 100% of area planted to sugarcane.

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REFERENCES


Conception et mise en œuvre d'un réseau cinématique en temps réel pour l'industrie sucrière en Colombie

Résumé. Nous avons conduit une étude technique sur 244 000 ha plantés en canne à sucre dans la Vallée de la Rivière Cauca (Colombie) pour définir le nombre, l'emplacement, les caractéristiques de stations de base GNSS et la compatibilité des récepteurs GNSS, évaluer la radiofréquence (RF) et la couverture cellulaire du signal. Nous avons trouvé que le dispositif doit comporter 17 sites où il est proposé d'installer 7 stations GNSS permanentes, 5 stations radio et 10 récepteurs radio, distribués dans la zone d'étude. Selon le test de couverture du signal GNSS RT, un des facteurs limitants pour mettre en œuvre le réseau RTK (RTN) est la faible couverture du signal cellulaire en zones rurales. Nous implantérons un réseau à signal double (radio et cellulaire) avec une couverture à 100 % de la zone plantée en canne à sucre pour fournir le signal RTK aux tracteurs et récolteuses de canne essentiellement par radio et dans quelques zones par cellulaire.

Mots-clés: Agriculture de précision, réseau cinématique en temps réel (RTN), canne à sucre

Diseño e implementación de una red cinemática en tiempo real para la industria de caña de azúcar en Colombia

Resumen. Nosotros llevamos a cabo un estudio técnico en 244.000 ha cultivadas con caña de azúcar localizadas en el Valle del río Cauca (Colombia) para definir el número, localización y características de estaciones bases GNSS y su compatibilidad con receptores GNSS en campo, además de evaluar la cobertura de radiofrecuencia y señal de telefonía celular. Nosotros encontramos que el diseño debería consistir de 17 sitios donde se propone instalar 7 estaciones GNSS permanentes, 5 estaciones de radio y 10 repetidoras de radio, distribuidas en toda el área de estudio. De acuerdo a las pruebas de cobertura de señal GNSS, uno de los factores limitantes para implementar la red RTK (RTN) es la baja cobertura de señal celular en áreas rurales. Nosotros implementaremos una red de señal dual (radio y telefonía celular) con cobertura en el 100% del área cultivada con caña de azúcar para proporcionar señal RTK a tractores y cosechadoras principalmente, a través de radio y en algunas zonas a través de señal de celular.

Palabras clave: Red RTK, GNSS, agricultura de precisión, caña de azúca