DEVELOPMENT OF AN HYDRAULIC PENETROMETER DATA ACQUISITION SOFTWARE

Emanuel Rangel Spadim[1], Kleber Pereira Lanças[2], Saulo Phillipi Sebastião Guerra[3], David Casiero[4] e Indiamara Marasca[5]

[1] Granduando in Electrical Engineering, University - Campus Bauru SP Brazil.
[2] Professor Faculty of Agricultural Sciences - UNESP, Botucatu-SP Brazil.
[3] Assistant Professor, Faculty of Agricultural Sciences - UNESP, Botucatu-SP Brazil
[4] MS in Agronomy
[5] PhD in Agronomy

Summary: Currently, in addition to increased production, the costs reduction are focused in order to increase efficiency in production, so the modern agriculture intent to find planting methods which extract the maximum possible data about the used area for making possible to do this preparation in the most appropriate manner, considering the shortcomings of evaluating these data. This method is contained in the concepts of an agricultural practice that has been steadily growing, the "Precision Agriculture", which covers, among many other factors, soil preparation. The soil penetration resistance is a feature that can show the condition of compression and hence allow to evaluate the soil as this will promote the development of the growing. Considering that the development of the root system is strongly related to a better efficiency in production and also is directly linked to the resistance that the soil offers to its development, it was considered reasonable to create , through this work, a simple and accessible tool for obtaining this information. The objective was to create a software for data acquisition which can be adapted to any penetrometer that represents the magnitudes "strength" and "position" in the form of analog voltage signals. The software was tested on UMAS - Mobile Unit Sampling Soil, belonging to NEMPA – Agroforestry Machinery and Tires Test Center, located at FCA - College of Agricultural Sciences - UNESP Botucatu. UMAS is a trailer equipped with an hydraulic valve that controls an hydraulic double way actuator, controlled manually and having at its end a spindle on which a load cell is trapped and positioned between the actuator and a rod with a conical tip with standardized dimensions, thus constituting an hydraulic penetrometer. The displacement of this rod is measured by a multiturn potentiometer that is installed as a voltage divider and thus provides a position as an analog signal. The applied force is measured by a load cell with a maximum load measurement of 2000Kgf giving an output signal of 2mV / V. The software was created in "LabView", a "G" language development environment. The hardware used was the "USB6009" data acquisition device that communicates with a laptop computer by USB port. After the software development, the system was tested in a soil with deep tillage and controlled traffic. The software proved to be easily managed and represented in a coherent and satisfactory way the soil compression characteristics.

Introduction: Agriculture has been gaining importance in view of human beings since ancient times, when they start to grow their own food. Faced with this condition man has always sought to improve their planting techniques, from the selection of seeds to improve the chemical and physical soil conditions. Soil preparation started already some thousands of years, where the man removed the soil with artifacts of wood, bone and stone, passing later, already having a certain field of metal fabrication techniques, using manual and then plows those of animal traction. This process continued up until very recent times (some decades ago), when they arrive to industrial revolutions and allow ease of access to machines with internal combustion engines, conferred by series production. Currently, besides increasing production-value also decreases the costs in order to increase the production efficiency, thus the search for modern agriculture plantation methods which extract the maximum possible data on the region to be used, so you can make the preparation of this more appropriately to the needs presented in the studies of these data. This method is contained in the concepts of an agricultural practice that has been steadily growing in the "Precision Agriculture", which covers, among several other factors, soil preparation. Soil compaction can be evaluated through various soil attributes. Among the existing stand out soil density and soil resistance to penetration. According Folegatti et al (1990) penetration resistance depends on the moisture, texture, type of clay mineral, the amount and type of aggregate and soil porosity. The resistance to penetration is a physical property of the soil directly related to plant growth (LETEY, 1985). This soil property also determines the behavior of root penetration of the installed culture, and promote better absorption and greater aeration and water retention in the soil. According SPEARS (2002), the current process of tillage spends large amounts of energy, especially in cases where the subsoil is needed, which came to be the largest energy consumption between agricultural operations. Given these conditions, it is reasonable to perform this preparation areas and depths where this work really deemed necessary, and in this case is that precision agriculture applies optimization of tillage, therefore, a prior study of penetration resistance can show the shortcomings of the land. The "soil penetration resistance" is an indicator of the need for tillage and can be measured using devices called "penetrometers," which are composed of a stem that contains a cone of standard dimensions at your end. Reading this device is given in units of pressure. To determine this pressure, measures the force applied to the rod so that it penetrates the ground and this force is divided by the area of the base of the cone contained within the shaft.

Material and Methods: The software was tested on UMAS - Mobile Unit Sampling Soil, belonging to NEMPA – Agroforestry Machinery and Tires Test Center, located at FCA - College of Agricultural Sciences - UNESP Botucatu at the experimental farm "Lageado". The software was developed in a way that makes the data acquisition UMAS - Mobile Unit Sampling Soil (Figure 1 and 2), a trailer equipped with a penetrometer powered by the hydraulic system of a tractor.

Figure 1. UMAS being transported by car.

Figure 2. UMAS pulled by a tractor in the field.

The penetrometer installed in ONES consists of a double-acting hydraulic actuator where a rod is fixed in cone standardized format, in this case by the standard ASAE S313.2 (1997). The penetrometer is driven by a directional valve 5/3 Way lever that moves the rod at a speed of 30 mm / s, also defined by that standard (Figure 3).

Figure 3. Collecting data with visualization of the load cell.

When this cone is inserted into the ground by pushing the pneumatic actuator, the instantaneous force required for penetration is measured by a load cell model "PR2000" brand "Leader, where the signal of the order of millivolts, is brought to a conditioning amplifier and a sensitive track to the data acquisition device (0-10 Vdc). Through the software, these values are recorded every 50 ms and converted to units of force. This assessment can be done in different layers (arbitrarily defined) soil, and for this, we must also record the position of the rod tip at each time of sampling (Figure 4).

Figure 4. Collecting data by viewing the sampler penetration resistance of the soil.

To this end, each comprises a multi-turn potentiometer attached to a gear that rotates by the movement transferred by a rack which moves jointly with the penetrometer (Fig. 5) shaft.

Figure 5. Sensor depth.

This potentiometer is installed in the form of a voltage divider and provides a voltage signal proportional to the depth of the rod. The records of force and displacement suffered by the stem of this (soil depth) are made simultaneously to each registry software and stored side by side on the data sheet, which is updated with these data every amostrage. The software creates a file in the root of your hard drive and saves the data for each sample in the same file, until it is removed from the root or have its name changed. The data is saved in text format and can be easily ported to a spreadsheet that can be subsequently analyzed and worked as needed by the user (Figure 6).

Figure 6. Visualization of the behavior of individual information collected.

The software was developed in "G", a graphical language used in the developer "Labview" the "National Instruments" language. The data acquisition is done by "USB 6009", a device for acquiring data also "National Instruments" that communicates with a laptop computer through the USB port. The "USB 6009" has differential analog inputs with 14 bit resolution.

Results and discussion: The work intends to contribute to the academic environment and any other readers who are interested in the subject, providing the possibility to observe new ways of doing a job that, despite dealing with a topic already widespread among professionals the agricultural area, it presents technological deficiencies in regard to the integration of automation agronomic knowledge. Created a software for data acquisition that can be adapted to any penetrometer representing the magnitudes "strength" and "shift" in the form of analog signals. The software is capable of operation by any person with basic computer knowledge. The system was tested in a hydraulic penetrometer elementary operation (Figure 7).

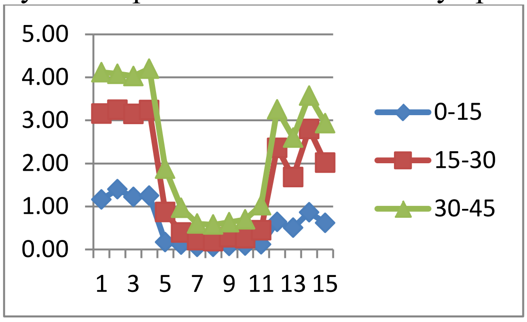

Figure 7. Transept with the data collected.

It has the aim of contributing to the research related to the active area (electrical engineering and related sciences to the creation of software), but also to those who can use the direct benefit of technology (agricultural sciences area). Better use of energy is now one of the biggest concerns of engineering, therefore a job that presents efficiency in processes that require energy generates more profit, less environmental impact and still makes the price of the most affordable products, topics closely related to the current agricultural production . The fossil energy plays a vital role in agricultural production systems and its price affects all the costs of the production chain (FLUCK, 1979). Currently, with the extensive use of machinery in agricultural activities, much of the energy used comes from petroleum fuels. Thus it is considered important contribution to a technology that enables mapping and optimizing the activity of soil preparation. The software showed satisfactory performance in preliminary tests, and was able to receive the data from the load cell and the penetrometer and convert them into standard units of measurement, as well as generate a snapshot graph of point collected. It is hoped that the work proposed here results in a low cost tool and easy operation that will streamline the process of determining the penetration resistance of the soil through instant data delivery and ease of manipulation in these cases where you want to make analyzes more complex, contributing to precision agriculture. A program used by Campos et al., (2013) showed that other programs like this should be used in man-machine interaction, "PROCOLD" successfully accomplished the acquisition, processing and storage of simultaneous data from up to four independent GNSS receivers and analog sensors at once. The "PROCOLD" generated reliable for reporting, in addition, the data obtained from the GNSS receivers, after processed by the "PROCOLD" could easily be applied in the preparation of thematic maps georeferenced information. Soil compaction can depend on the location and intensity of machinery traffic, and many producers use as a solution scarifying the area to break the layer that reduces plant growth (MARASCA et al, 2012). This software can be used reliably determining data compression agricultural or forest soils.

Conclusion: The software proved to be easily managed and represented in a consistent and satisfactory way the compression characteristics of the soil.

References

FLUCK, R.C. Energy productivity: a measure of energy utilization in agricultural systems. Agricultural Systems, Essex, UK, v.4, n.1, p.29-37, 1979.
FOLEGATTI, M. V., SILVA, A. P. da, DE MARIA, I. C. Avaliação da resistência do solo utilizando penetrômetro e penetrógrafo em XIX Congresso Brasileiro de Engenharia Agrícola, p.525. Piracicaba: 1990.
LANÇAS, K.P. Subsolagem ou escarificação. Revista Cultivar Máquinas, n.14, p. 34-38, 2002.
LETEY, J. Relationship between soil physical properties and crop production. Advances in Soil Science, v.1, p.277-294. 1985.
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS. ASAE S313.2: Soil Cone Penetrometer. St. Joseph, MI, 1997. 2 p.
CAMPOS, F. H.; PADOVANI, C. R.; MARASCA, I.; WAR, S.P.S.; SPEARS, K.P. Software for data acquisition, processing and storage of GNSS receivers and analogical sensors.Tekhne and Logos, Botucatu, SP, v.4, n.1, April 2013.
MARASCA, I.; SPEARS, K.P.; SILVA, R. B.; ASSISI, RL Load bearing capacity and soil density in areas of the till with and without scarification. Energ. Agric., Botucatu, vol. 27, n.4, October-December 2012, p.81-91.

© 2014 ISPA. All rights reserved.