IOT TRACKING DEVICES REVOLUTIONIZING PRECISION AGRICULTURE

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Abstract

Using IoT (Internet of Things) devices for real-time tracking of vehicles and instruments on a farm can provide valuable data that can inform and improve farm management strategies. With IoT devices, farmers can track the location of equipment, monitor soil moisture and nutrient levels, and even track the movements of livestock. This data can help farmers optimize their operations, reduce waste, and increase yields. In addition, IoT devices can provide real-time alerts for potential problems, allowing farmers to address issues quickly and efficiently. Overall, the use of IoT devices in farm management is a promising trend that has the potential to revolutionize the way farms operate. This paper aims to identify the most sustainable methods of collecting field data in an accurate and up-to-date manner by comparing different types of devices. Overall, the integration of IoT devices proved to be a valuable addition to the data collection process, and further emphasized the importance of utilizing technology in modern data collection techniques.

Key words: farm management, precision agriculture, artificial intelligence

For years, GPS technology has been increasingly present in agriculture, allowing farmers to precisely locate in a field and accurately map the different characteristics of soil and crops.

Precision agriculture (Khanal S. *et al*, 2017) is an intelligent farming approach based on monitoring, computing and giving response to the field variabilities in crops and crop field. Due to the promising capability of improving agricultural productivity, minimizing damage to the environment and reducing production cost, PA is continuously replacing existing empiric-based farming system to automatic, modern, information-based and sustainable agriculture. This new dimension of agricultural system takes advantage from the emergence and integration of recent technologies (Zhang N. *et al*, 2002)

Major machine manufacturers such as John Deere, Trible, AGCO and others are also producing precision and guidance devices for tractors to increase the efficiency of the work by reducing human factor intervention, to optimize the work path and reduce downtime and fuel savings.

In such situations, the tractor driver only intervenes when turning, or in the event of obstacles to be avoided. Such devices are also used to retrieve tractor data, but few transmit this data to a cloud or management application to help manage the farm.

They are usually focused only on a 1 to 1 experience with the tractor user. For such situations, external hardware devices have been created, capable of reading countless data circulating on the can bus (fuel rate, engine RPM, cool temperature, etc.), data that are generally accessible only to the driver until recently. These devices have been and are popular in the transport industry, being very effective in tracking freight trucks, but also in the driver experience, giving company managers the ability to assess driver efficiency in relation to delivery time, but also vehicle wear and tear.

Integrating sophisticated chips and sensors into the physical devices that we use, extracting valuable information, processing it, giving it a relevant structure and using it to get better or enhanced results is what the Internet of things is all about. IoT will increase the versatility of the Internet by integrating every object for interaction via embedded systems, which will lead to a highly distributed network of devices communicating among each other as well as with human beings (Abraham S. *et al*, 2018).

Such advanced technology allows the devices to interact and share data amongst themselves and compile everything together to be meaningful and serve some purpose. Perceiving such a mechanism with respect to the Agricultural Industry, the backbone of European economy, a lot of innovation could be done. One of the major applications is smart farming which uses modern Information and Technical Communications (ICT) as the Internet of

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Things to bring about whats called as the third green revolution (Stoces M. *et al*, 2016)

In recent years, farmers' desire to know exactly where their tractors are at a certain time, or how efficiently that tractor worked a parcel, has grown. The sizes and shapes of such devices are diverse, but also the prices. A device capable of reading as much telemetry data as possible, providing a precise position can start at 200 and reach 1000 euro, depending on the manufacturer and its functionalities.

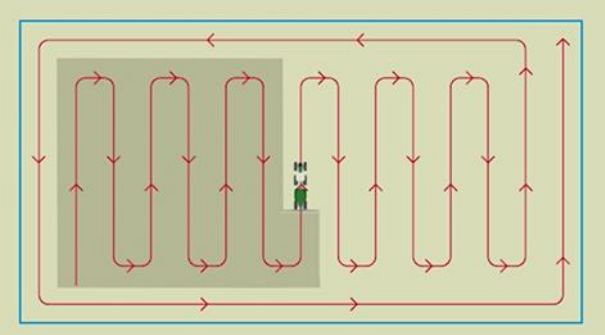

Figure 1 **GPS for automatic guidance of FENDT tractors (www.fendt.com)**

In other words, IoT (Brewster C. *et al*, 2017) is creating a new dimension for technology to revolutionise many industries, including aspects of food safety and production as well as agriculture. IoT offers a suitable solution for smart crop filed monitoring and management system, although, especially in these times when access to the internet can be done from anywhere on the planet.

MATERIAL AND METHOD

This manuscript represents a comprehensive study on the collection of information from multiple IoT devices on vehicles and equipment. The research was based on a combination of qualitative and quantitative methods, including experimental studies and data interpretation.

The main objective of the study was to identify the most efficient methods for collecting data in this field. To achieve this goal, a variety of methods of study and complementary analyses were employed, resulting in multiple series of data being collected, analyzed, and compiled over several years.

The findings of this paper have significant implications for the field of data collection, as they provide valuable insights into the most effective ways to collect information from vehicles and equipment. This paper incorporated data from several Internet of Things (IoT) devices. These devices were strategically placed on vehicles and work equipment to capture additional data points related to their operation and movement.

The IoT devices provided real-time data on a variety of factors, including speed, location, and fuel consumption. This data was then integrated with the other data sources to create a comprehensive understanding of the performance and operation of the vehicles and equipment. The inclusion of IoT devices added a new layer of insight into the data collection process and provided additional opportunities for analysis and optimization.

RESULTS AND DISCUSSIONS

In our experience, choosing the right device is quite difficult because many factors are to be taken into account. From the accuracy of the position coordinates, or the number of parameters it reads from the tractor, to the GSM frequency band in which it operates or its internal memory. It should be discussed why each point is important when choosing to use such data acquisition devices.

In terms of position, it should give us coordinates to as many decimal places as possible. Most of them have GPS modules with 5 or 6 decimal places (47.493148, 27.323081) that provide pretty good and almost accurate accuracy.

Those that offer fewer decimal places are not recommended if we want to make tractor location and tracking effective. It happens that we have tractors that have GPS modules automatic guidance for carrying out operations, and in this case the tractor path will be straight, without deviations from the axis of movement as shown in *figure 2*, and then the data acquisition devices can provide the most accurate position data.

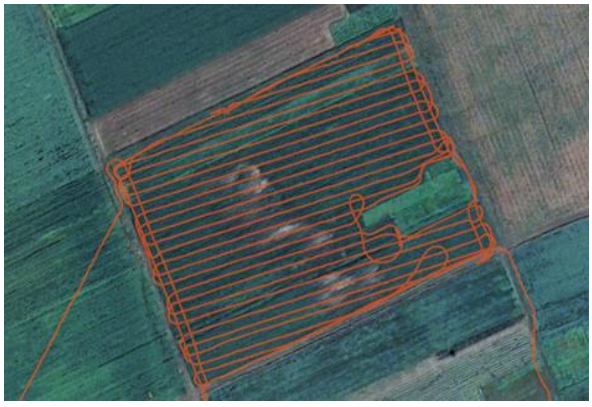

Figure 2 **Tractor with automatic guidance**

But what do we do when the tractor does not have such an automatic guidance device? The driver must maintain an imaginary axis, but the line will never be perfect, but we will have quite large deviations, as in *figure 3*.

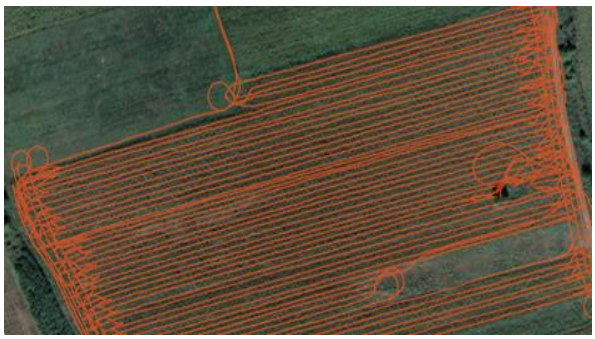

Figure 3 **Tractor without automatic guidance**

From the analysis of the 2 situations we see that the ratio of the lines is different, but in the first situation the distance is equal, while in the second situation we have situations where the distance is equal and situations where the lines are very close or sometimes even overlapping. It is worth noting that each line represents the tractor's route, which means that the machine behind may have different dimensions.

Each tractor driver has its own driving style and this can be seen both during the completion of a job and in the total consumption of the tractor used. In order to be able to perform accurate analyzes of the tractor's working in the field, we need to know how much the tractor was in demand, what consumption it had, and other important parameters.

That is why it is very important to have such a data collection device that gives us accuracy as close to accuracy as possible to observe these differences and to be able to improve the way we work. In agriculture normally when working on a plot, there is an overlap of tractor movement of almost 10 to 50 cm in the cases of those tractors with automatic guidance.

But when we don't have guidance the overlays can be larger, which means that the unit behind the tractor will pass through the same place several times. This already represents diesel and wear expenses and low work efficiency.

Thousands of messages circulate on the can bus 10 times per second, which is thousands of data per minute. The only devices that are able to read all messages so quickly are diagnostic ones. But in order to carry out effective analysis, we can have data read every second.

A good device must be able to read everything that runs on the can bus, but they are very rare and quite expensive.

Most agricultural devices are basic, providing information about total hours, engine speed, vehicle speed, PTO speed, accelerator pedal position and more, but some can also be customized to read or get only certain parameters.

Each message circulates under a specific id, in the case of CANBUS ID the UL is called PGN (Copperhil, onsite; VDMA, onsite) (parameter Group numbers), and in some situations the same message circulates on different PGN. An example is total vehicle hours, which in some tractors run on 65255 and in others on 65253. This is why it is good to have a complex device that is able to distinguish these differences.

Often the work areas are covered by the GSM network, sometimes the signal is very weak or does not exist, and this prevents us from having real-time data. But what do we do with this data, after all, the tractor does some operations, consumes and we have no way to do analysis without this data.

The most efficient way is for our data acquisition device to have an internal memory, which stores the data while the tractor is in the signal-free zone and transmits it as soon as the tractor returns to the signal, at the same time as the data being read at that time.

It also matters a lot the frequency band in which the device is set to work, because we do not always have 4G LTE signal, and if the device stops transmitting data when we have 3G or 2G, this may present a problem and does not help the user to view in real time what the tractor is doing or how it is doing.

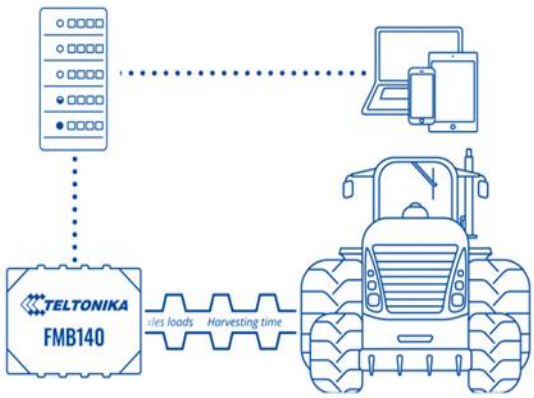

Figure 4 **Example of communication scheme for that devices (www.teltonika-gps.com)**

By using this approach, individuals are able to gain a clear understanding of the specific tasks that were carried out in each domain, enabling them to strategize and make informed decisions. This approach is all-encompassing and essential, leaving behind the archaic and problematic "pen and paper" methods.

CONCLUSIONS

While data collection is important, how data is accessed and analysed is even more important. It is essential to ensure that the data collected is accurate, reliable, and easy to access. This means that it should be stored in a cloud-based system and analyzed through the use of algorithms or applications that generate useful reports. By doing so, the data becomes more meaningful and can be used to gain valuable insights into a range of different areas, from business operations to customer behavior.

The availability of real-time data has become increasingly important, and the ability to access it quickly and easily can make all the difference in making informed decisions. Ultimately, how data is accessed and analysed can be the key to unlocking its true value, and can help organizations to optimize their resources, improve their operations, and stay ahead of the competition.

Accurate and reliable data collection is essential for effective data tracking in agriculture. However, it can be challenging to ensure data quality due to factors such as human error, sensor malfunctions, and environmental variability. These devices can help to efficiently manage the production fleet: tractors, agricultural machinery, even the working hours management of the employed staff.

Good tracking data management can bring an improvement in the production norm, which streamlines the management of a farm and helps to decrease expenses.

Checking machine wear and reading to determine technical problems, even before they get worse, by reading the errors directly from the can is a plus for precision farming. because farm managers or those responsible remotely follow how they behave and what the condition of the machine is without the presence of him or a mechanic.

In addition to these aspects, with these devices we collect position data and can determine the concrete area worked by analogy with the consumption and time spent in the work process. Using these types of devices can only benefit those who want to implement them.

ACKNOWLEGMENTS

This research is co-financed by the European Regional Development Fund through the Competitiveness Operational Program 2014 – 2020, project “Establishment and implementation of partnerships for the transfer of knowledge between the Iasi Research Institute for Agriculture and Environment and the agricultural business environment”, acronym “AGRIECOTEC”, SMIS code 119611.

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