Mobile Robotic Platform Architecture Adaptable to Several Agricultural Applications

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ABSTRACT

This study presents the adaptability to several agricultural applications of an ongoing developed architecture of an autonomous mobile robotic platform, three-wheeled, with omnidirectional maneuverability.

1 Introduction

Humanity is facing a continuous rise in food demand in parallel with the negative consequences of the global warming. These two challenges are included within big initiatives such as the Sustainable Development Goals (SDG), more specifically SDG 2 (zero hunger), SDG 8 (decent work and economic growth) and SDG 12 (responsible consumption and production). Being aware that the major part of the global food production and agricultural industries are settled in the developed countries, the implementation of Key Enabling Technologies (KET) defined within the paradigm of Industry 4.0 in agricultural applications seem a good solution to achieve SDG. The agricultural industries from developed countries still have a long way to go in implementing these KETs and reach what is so-called Agriculture 4.0 paradigm. One of these KET is autonomous mobile robotics, also referred as Unmanned Ground Vehicles (UGV).

Rondelli et al. [1] have presented an overview of available UGV developed by universities and research groups specifically designed for agricultural tasks; cost reduction is identified as one of the most critical aspects for farmers. Yépez-Ponce et al. [2] have reviewed the recent state of mobile robotics implemented in agricultural applications and have concluded that it is necessary to provide solutions with lower cost and more scalable capability. Oliveira et al. [3], in their review in agriculture robotics, have identified the locomotion systems as one of the four major areas that need future research work.

The main locomotion systems for UGV are: wheels, tracks, or legs. Most of the UGV are prototypes and use as a locomotion system a four-wheels architecture (4W), despite knowing that 4W robots are strongly affected by soil characteristics. Legged robots are an interesting alternative to deal better with unstructured environments, but then cost and complexity increase. An interesting alternative between legged robots and 4W robots, is the three-wheels architecture (3W), which are little reported [3], and offers a trade-off between cost and performance in unstructured agricultural environments. One of the scarce 3W architecture of UGV for agriculture is Fendt Xaver provided by AGCO/Fendt, which is a ready-to-market solution. A different 3W architecture for agricultural applications, is the one presented in this study, named AGROMOBY.

2 Methodology and results

AGROMOBY is based in a patented solution developed by one of the authors [4], which is an already commercial solution deployed for industrial logistic applications. Figure 1 shows the CAD and the schematization for AGROMOBY. Table 1 summarized its main characteristics.

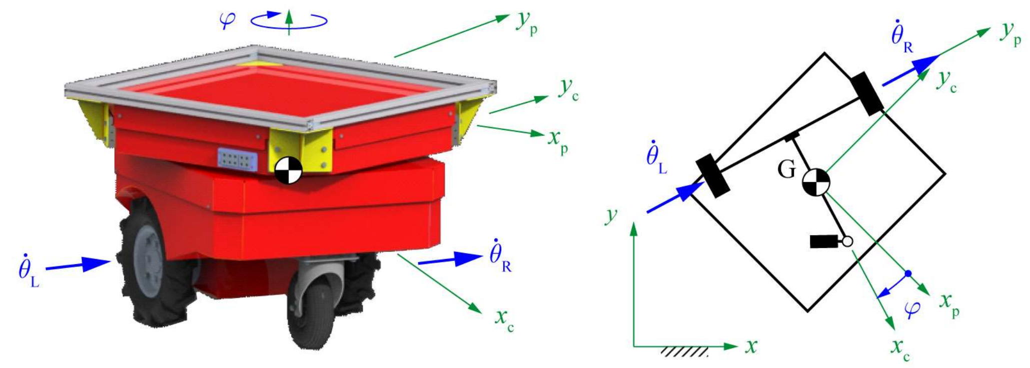

Figure 1: AGROMOBY CAD and schematization

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Table 1: AGROMOBY main characteristics

Dimensions	925x960x672 mm	*Caster wheel radius*	130 mm
Approximate weight	300 kg	*Navigation*	Autonomous-GPS, Lidar, RGB-D, IMU
Maximum load	400 kg	*Communication*	Ethernet, Wifi, 4G
Maximum speed	10 km/h	*Battery*	48 V, 50 A
Drive wheels radius	210 mm	*Autonomy*	8 h

AGROMOBY is divided mainly in two main systems, the mobile base or chassis and the rotating platform, which together provide the omnidirectional maneuverability. The mobile base with two degree-of-freedom (2 DOF) is governed with two brushless DC servomotors actuating in two offset differential drive standard wheels (θ_R, θ_L); a passive caster wheel is added for stability reasons. The rotating platform with a 1 DOF (φ), also governed with a DC servomotor, can rotate relative the platform from the mobile base or chassis. The behavior is explained further in [5].

Figure 2a shows the design as a harvester helper (carry the load on the field and deliver it to a storage place). Figure 2b and Figure 2c show two customizations of the rotating platform for carrying different sensors, such as a ground penetrating radar (GRP) for subsoil water detection, and sensors for monitoring crops and PhotoVoltaic (PV) panels from below in an Agri-PV environment.

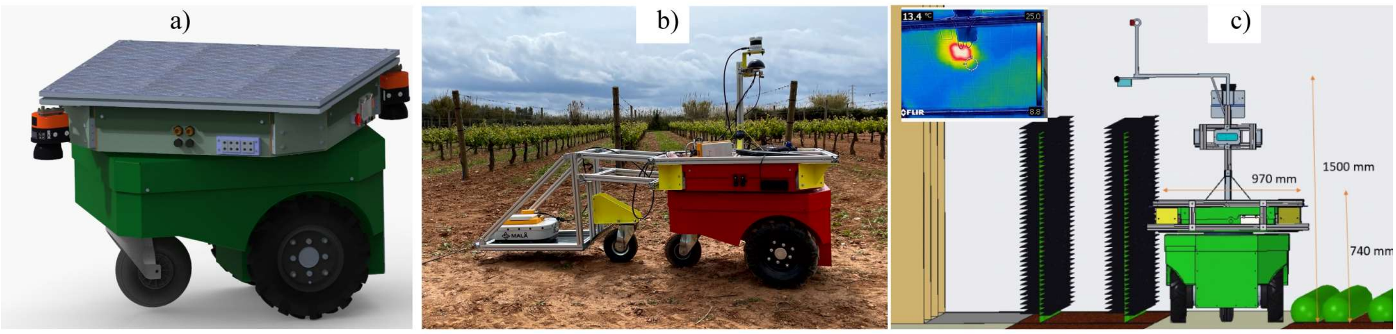

Figure 2: Several AGROMOBY customizations for agricultural applications

3 Conclusions

AGROMOBY is being developed to showcase the benefits of implementing robotics (UGV) in agricultural applications with a clear will to be cost-affordable and with a high grade of customization and flexibility of use.

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