Robotic Platform for Remote Control and Teleservice in Agricultural Environments

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Introduction

Interdisciplinary competences are of high importance for new technologies, which is especially true for research and education. Thus, for example, the authors have recently integrated an industrial robot, a vision system and user interaction for teaching purposes (Lammen 2004). In order to inspire innovative interdisciplinary concepts and technologies especially in agriculture, the international Field Robot Event has been initialised by Wageningen University (The Netherlands), where autonomous robots navigate in real maize fields. The field robot optoMAIZER (Klose 2005) has been designed by the authors for these purposes and has been successfully applied in the competition in 2005. Figure 1 shows the field robot in the process of autonomous navigating between maize rows.

Figure 1: Autonomous field robot optoMAIZER, designed for the Field Robot Event for navigation and counting purposes (Klose 2005).

Moreover, the strongly increasing usage of new technologies in agricultural equipment as well as precision farming methods have shown the complexity and high importance of process data acquisition and communication (Rothmund 2004, Altieri 2004). The development and the usage of such systems – including wireless control (Lätti 2004) - is a high challenge for all people involved, thereby including educational and service point of views. Thus the idea came up by the authors to extend the complex robotic system – already designed for agricultural environment – as a platform for remote control and data exchange.

System Architecture of the Field Robot optoMAIZER

The system architecture of the autonomous field robot optoMAIZER (see figure 2) consists of a microcontroller-based technology and the implementation of the real time system RTXtiny. The online information for the corresponding tasks of the Field Robot Event – such as row guidance, turning at the end of a row and plant counting – is based on 21 sensors (8 different types) including a low-cost camera CMUcam2 with on-board image processing capabilities. The concept of sensor fusion has already been applied by the authors in the previous development of a sensor-based intra-row weed control actuator (Ruckelshausen 1999). On one hand the realisation of the concept is complex, on the other hand it is of high flexibility being important for variations of plant or environmental conditions.

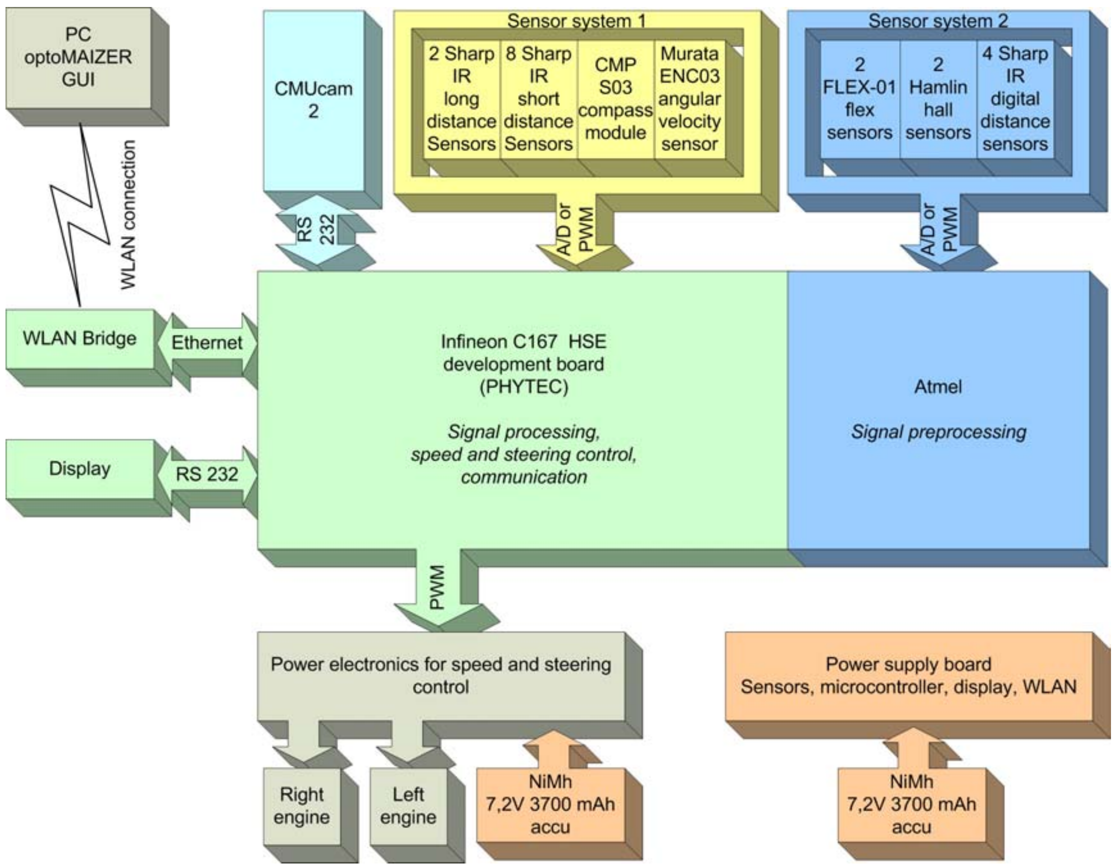

Figure 2: Architecture of the autonomous field robot optoMAIZER including system technology, sensors, actors, user interface and WLAN.

Moreover, power electronics for speed and steering control of 2 engines as well as power supply is integrated in the system architecture. As a bidirectional interface a touch display has been implemented for direct (and fast) user access, such as starting the robot or selection of navigation strategies or parameters.

The integrated WLAN is a powerful tool for developing and characterizing the field robot, since the integration of sensor fusion and actor control results in complex real time algorithms. As for example, all data for a test run are stored and analysed off-line, thereby resulting in a new algorithms, which can be retested. In case of a malfunction the corresponding reason can be determined based on complete data information.

Applications and Conclusions

The status of the robot including the sensor information and the usage of algorithms can be controlled via remote users via WLAN, a PDA or Internet (see figure 1).

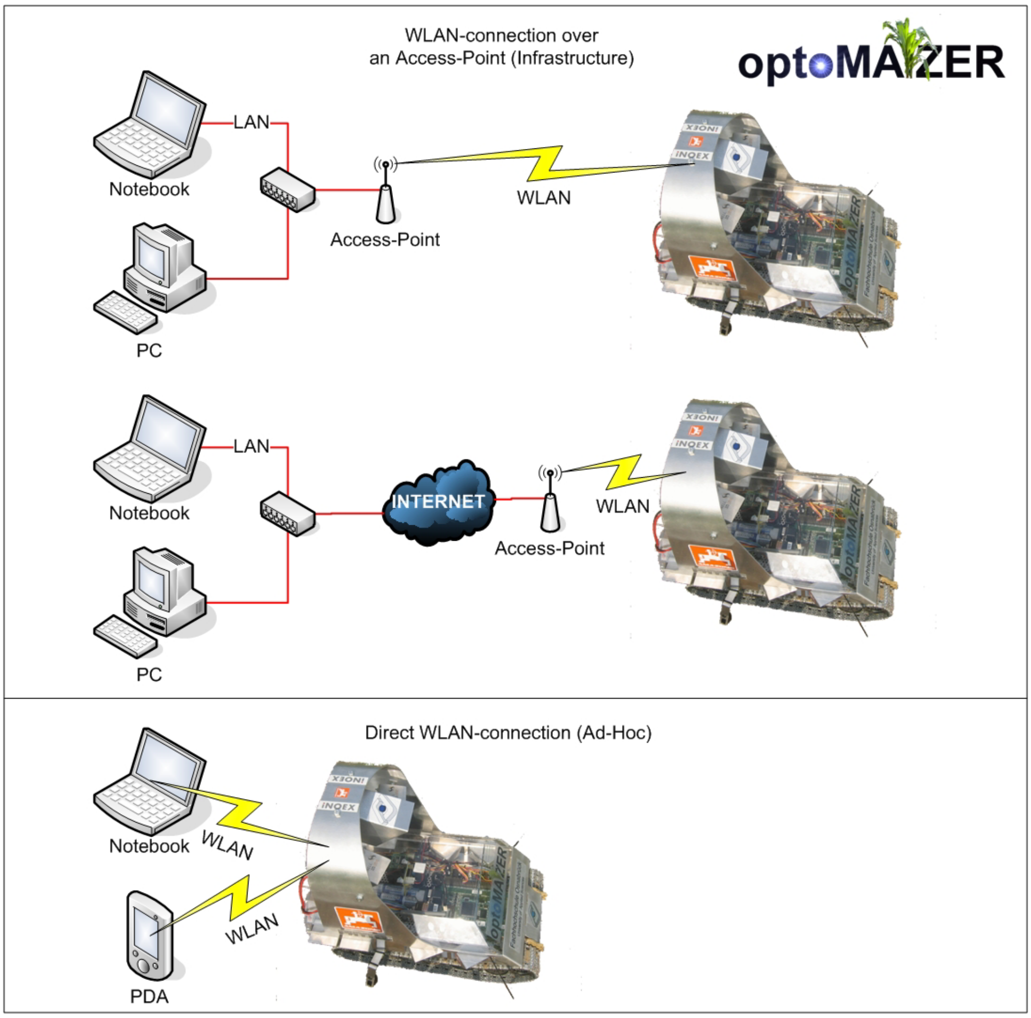

Figure 3: Different communication paths between the autonomous field robot optoMAIZER and remote users.

This technology offers several application options, such as navigating the computer with the key pad of the external user, remote loading of new algorithms or data acquisition of sensor information. Figure 4 shows examples of the graphical user interface for remote services. Further video information (in both directions) of the corresponding environments can be given by standard low-cost web-cameras.

Figure 4: Examples of the graphical user interface for remote services: information of an angle sensor (top), mode selection and error information (bottom).

To summarize, knowledge and experiences in the fields of sensors, actors, remote technologies and user interaction can be extended, which is of high importance for teleservice and electronic documentation in agricultural applications. Moreover, a complete hardware, software and communication platform is available for the implementation of new technologies and educational purposes.

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