THE MISSION OF BIOSENSE INSTITUTE, NOVI SAD: DIGITAL TRANSFORMATION OF AGRICULTURE

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Abstract:

Agriculture is facing enormous challenges. Not only does it have to provide enough safe food for the growing population, it also needs to leave a minimal environmental footprint and combat climate change. The available natural resources are limited and the conventional agricultural technologies do not provide sufficient means to address these challenges. On the other hand, a number of key enabling technologies have matured in the recent decade, including nano and microelectronics, material science, remote sensing, communications, and artificial intelligence. However, although some of these technologies have already created a significant impact in various aspects of human life and wellbeing, they have not yet delivered their full impetus to the agrifood sector.

Agriculture needs to be optimized. More (higher quality) yields need to be produced with less input (water, fertilizers, labor, energy…) and with less risks (related to weather, pests, market conditions, etc.). However, agriculture is a very complex biosystem, and its optimization presents a significant challenge as it requires full understanding of all underlying processes and their correlations. The first step in this process is to develop and deploy various sensors that will provide as much information as possible about the plant itself, the soil, the atmospheric and meteorological conditions. Namely, as the quality of any measure or action to be taken to optimize agriculture directly depends on the quality of input data, it is necessary to develop devices that will provide reliable and precise data of interest to agriculture, whether in-situ, proximally or remotely. To that end, our research in nano and microelectronics and material science aims to develop novel sensors that detect and measure various biological, physical and chemical properties and processes. We develop molecular, optical, micro and nanofluidic, solid state, acoustic, photonic and nano and microelectronic sensing applications with the goal to enable sensing of previously unattainable parameters or provide solutions more accessible than the existing ones (e.g. faster, cheaper, smaller). In addition, various remote sensing technologies, including thermal, microwave, terahertz, multispectral and hyperspectral imaging obtained from various sensing platform ranging from ground, through UAV to satellites, enables us to discover qualitative and quantitative analytical data based on the interaction of electromagnetic radiation with living and non-living matter (e.g. NDVI, LAI, evapotranspiration, photosynthesis, etc.).

Finally, to discover actionable information from sensing data, we deploy multisensor data fusion, feature engineering, deep learning and big data analytics. Sufficiently large sets of reliable data combined with AI algorithms have already proven their potential in optimizing agriculture. For example, one of the most common challenges in agricultural production is crop structure planning. Namely, each year, a decision needs to be made on which crop to plant at which location to maximize profits, reduce yield and price risks, to obey crop rotation, group crops to save fuel, and reduce the use of fertilizers and pesticides. On a farm of 6000 ha comprising of 70 fields grouped at 4 locations, where all five major crops are to be grown, the number of crop combinations is around 10 quindecillion, far beyond the scope of any agriculture domain knowledge. By using AI-based crop structure planning solutions, with no additional investment whatsoever, increase of more than 60% in profits (with 10% reduction

of compound risks) can be achieved, which, for a 6000ha farm translates to additional profits of around 1.2 million € annually.

Keywords: digital transformation, sensing technologies, artificial intelligence, agriculture