



Bridging the Digital Divide: Designing Inclusive Wireless Systems for Elderly Users in Rural Areas

Iñigo Cuiñas* ⁽¹⁾, Manuel García Sánchez ⁽¹⁾, Pablo Picallo ⁽¹⁾, and Franciso González Castro ⁽¹⁾

(1) Universidade de Vigo – atlantTic Research Center, Vigo, Spain; e-mail: inhigo@uvigo.gal

The digital divide in today's world is not only evident between developed and developing nations but also within affluent countries, where certain regions have limited access to new technologies [1]. Expanding communication systems into remote rural areas poses significant challenges, particularly for elderly populations with limited technological experience. This study adopts a user-centered Design Thinking [2] approach to develop an inclusive and accessible wireless solution using LoRaWAN technology. Conducted within the Digital4Rural project, the research seeks to enhance safety and connectivity in small villages by addressing the unique technological needs of elderly users through a simplified, autonomous tracking system.

Fieldwork in rural communities revealed key usability concerns, including discomfort with complex interfaces, difficulty handling small device components, and apprehension regarding digital interactions. Many elderly individuals in these villages live alone and rely on walking outdoors for both mobility and well-being, increasing the risk of getting lost or encountering emergency situations. Furthermore, limited or non-existent mobile network coverage exacerbates these risks, making traditional communication solutions ineffective.

These insights informed the iterative development of a wireless network featuring user-friendly controls, GPS tracking, and emergency alert functionalities. The primary objective was to ensure that the proposed system could function autonomously, minimizing reliance on external infrastructure while providing reliable tracking and emergency support. Prototypes were deployed in multiple villages, with feedback guiding refinements such as improved charging mechanisms, simplified alert activation, and the introduction of tablet-based monitoring applications to support caregivers and community members [3].

Findings emphasize the necessity of designing electronic solutions that prioritize autonomy, ease of use, and social impact. Elderly users prefer larger, more intuitive interfaces and benefit from devices that integrate seamlessly into their daily lives without creating additional burdens. The study demonstrates that participatory, empathetic design fosters technological adoption and contributes to bridging the digital divide in rural areas. Moreover, the research highlights the broader implications of digital inclusion, as enhancing accessibility in these communities can have secondary benefits such as supporting rural sustainability and mitigating depopulation trends.

By incorporating elderly users' perspectives from the outset, the project highlights the importance of socially responsible engineering in developing sustainable, inclusive communication solutions. Future research directions include further enhancements in energy efficiency, alternative communication protocols for extreme connectivity constraints, and broader scalability of similar user-centered solutions. The integration of artificial intelligence for predictive assistance and extended battery life solutions could further enhance usability and adoption in rural communities. Ultimately, this study serves as a model for how technological innovation, when approached with empathy and inclusivity, can generate meaningful social impact.

1. K. Chetty, U. Aneja, V. Mishra, N. Gcora, J. Josie, "Bridging the digital divide in the G20: Skills for the new age," *Economics - The Open-Access, OpenAssessment E-Journal*, vol. 12, pp. 1-20, 2018
2. I. Cuiñas, M.J. Fernández Iglesias, "Design Thinking for Engineering. A practical guide", *The IET*, 2023
3. P. Picallo, J. Núñez Bon, M. García Sánchez, I. Cuiñas, "LoRa Application for Improving Autonomy of Rural Elderly Inhabitants", *IEEE Antennas and Propagation Symposium*, Florence (Italy), 2024

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