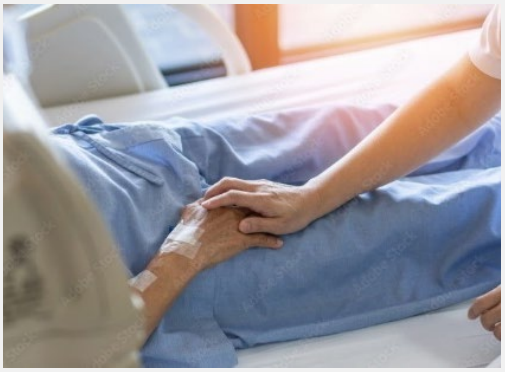
CASE STUDY:

Introducing RFID into Next-Gen Automated In-Vitro Diagnostic Testing to Enhance Workflow Precision and Accuracy

Introduction

Medical laboratories are tasked to provide the analytical basis for highly critical medical decisions. “According to official data, 60–70% of clinical decisions about hospitalization, discharge, and prescription are based on laboratory results.”[1] In the context of public health, any error rate plays a significant indicator as to the quality of these decisions. However, total quality is an interconnected property in workflows and from initial steps all analytical stages must be under monitoring and quality control.



Within the laboratory, analytical workflow errors can be segmented into three stages: the pre-analytic, analytic and post-analytic phase errors. “Pre-analytical errors are reported to be up to 70% in various studies.”[1] These early-stage errors jeopardize further analytical steps and reduce quality decision making based on those results.

The general solution to these dangerously high error rates is to streamline the laboratory workflow using technology that reduces or eliminates human involvement and enhances information capabilities between systems. Ideally, a completely automated system would be human-error free in the system, and capable of high-capacity throughput.

To those ends, the latest developments shaping laboratory automation include Artificial Intelligence (AI), Internet of Things (IoT), modular laboratory automation systems, Cloud-based systems, customizable software, Electronic Health Records (EHR) integrations, and importantly Radio Frequency Identification (RFID).

RFID, which has typically not been used in these workflows, is a key technology introduced into the world's first fully automated high-capacity in-vitro diagnostic testing solution. RFID can deliver a much greater amount of information than barcodes used on traditional labels. RFID can help to locate items (like test tubes) efficiently and precisely within short distances (sometimes up to 20m). RFID streamlines information flow by effortlessly transferring information to laboratory information systems (LIS) via radio waves without the need to input data manually between stages, particularly helpful to prevent the shortcomings of traditional labels which can detach from tubes, be illegible, or have missing information.

Situation

A leading OEM of medical laboratory equipment set out on an ambitious project to introduce a fully automated high-capacity in-vitro diagnostic testing solution to market. Product conceptualization began several years ago and would include an ecosystem of modular products. Because of their in-house expertise, their initial approach was to design and develop the entire solution themselves.

[1] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4049056/

The OEM immediately identified RFID as a key technology that would help enable their solution's automation and eliminate significant human error within the system. Their design was modular, allowing users to set up workflows to fit their unique configurations and expand their capacity as needed. The hands-free information sharing enabled by RFID would easily track samples as they moved through each module.

Despite their initial enthusiasm, the OEM's aspirations were thwarted by technical hurdles. While RFID was the right choice, implementing it was not nearly as straightforward as the OEM first thought. Technically, the tight physical spacing with multiple RFID tags in a tight read range required custom engineering. Additionally, robotics used within the workflow presented unique design challenges.

Solution

After the initial design attempt and equally quick realization of their RFID challenges, the OEM resolved to find another, reliable and immediate solution. The alternative was to either continue attempting to develop the expertise in-house, using off-the-shelf parts, or shop the project around to expert custom engineering firms that could help them leap-frog the challenges. The OEM chose to engage a trusted partner they had an existing relationship with, JADAK, a custom engineering firm specializing in many automatic identification technologies including RFID. JADAK began collaborating with the OEM on a feasibility study to prove how RFID could work within their unique automated testing solution.

Feasibility to Largest Base Worldwide

The need for automated laboratory solutions with high-capacity throughput was made clear by the shift in public health needs in 2020. JADAK was engaged to initially mockup and present the feasibility of reading unique tray cartridges using RFID within the OEM's modular system. JADAK went to work developing an initial solution that demonstrated the multiplexing read of several closely positioned targets in a tight read space. Their feasibility designs overcame the OEM's challenges of limited space for operations and antenna mounting, tight read targets in close proximity, robotic movement challenges, and custom antenna tuning.

As JADAK presented its feasibility, proving that RFID was both feasible and a significant contributor to the value proposition of the OEM, the OEM was faced with deciding the next phase, would they continue with JADAK to elevate the feasibility study into a production solution? The answer was yes.

JADAK expertise was able to fulfill both the technical requirements of the OEM beyond feasibility, but also sufficiently addressed their BOM/revision control and continuity of supply concerns for the future 15 years.

Result Technical

Problem statement:

JADAK addressed the OEM's challenges of designing RFID for a limited physical space within modular designs and overcoming limited in-house expertise about engineering for complex RFID parameters.

Solution:

JADAK provided a series of custom solutions for the OEM that included all hardware (circuit boards & custom antennas), firmware, and an extended software API with extended parameters that will be used as the customer interface.

The main solution relies on the verbose ThingMagic module platform outfitted on a custom board with custom antenna designs to overcome limited spacing and tight fitting components. To maintain a short-read range and directed antenna, the ThingMagic module was ideal. NFC tags were chosen for their small form-factor, while the custom antenna was designed and tuned for the tag mounted on reagent containers. In addition, robotics were enabled with an RFID antenna to perform reads, writes, and reagent inventory on-the-fly.

About JADAK

JADAK, a business unit of Novanta, is a market leader in machine vision, RFID, barcode, printing, and color and light measurement products and services for original equipment manufacturers. The business designs and manufactures custom embedded detection and analysis solutions that help customers solve unique inspection, tracking, scanning and documenting challenges. JADAK is based in Syracuse, New York, with sales and technical locations across the globe. For more information, visit https://www.jadaktech.com.

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