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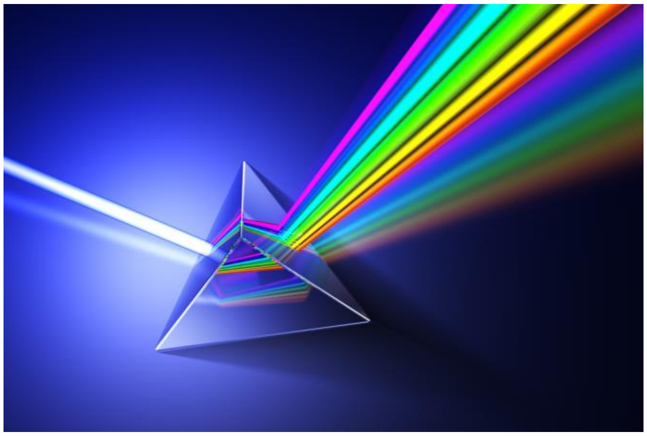

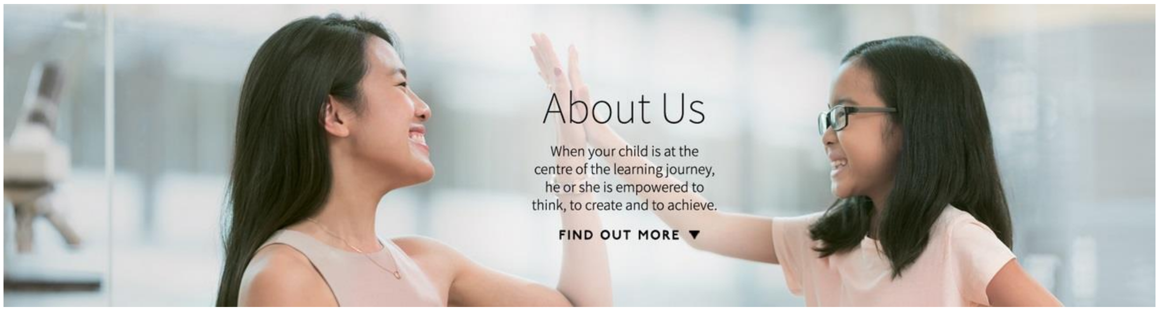
About Us
When your child is at the centre of the learning journey, he or she is empowered to think, to create and to achieve.
FIND OUT MORE

By Bus

Alight at either bus stop located ***in-front*** or ***opposite*** of ***Glad Tidings Church***, as indicated by the ***2 Red Dots*** ●.
(Bus Services : **80, 81, 82, 101, 107, 112, 113, 119, 136, 153**)

Upon reaching the building "***Seah Construction, 1007A Upper Serangoon Road***", please use the ***staircase*** → located by the side of the building to get to the ***2nd floor*** where BAIZONN Learning Centre is located.


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Staircase
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Serangoon Junior College
NE13 KOVAN MRT
Upper Serangoon Road
Glad Tidings Church
Heartland Mall Kovan
Tampines Road
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Hougang Street 31

By Car

Drive along ***Upper Serangoon Road*** towards ***Sengkang***.

As indicated by the ***Red Arrow***, turn left into Florence Road and turn right into carpark located behind "***Seah Construction, 1007A Upper Serangoon Road***",

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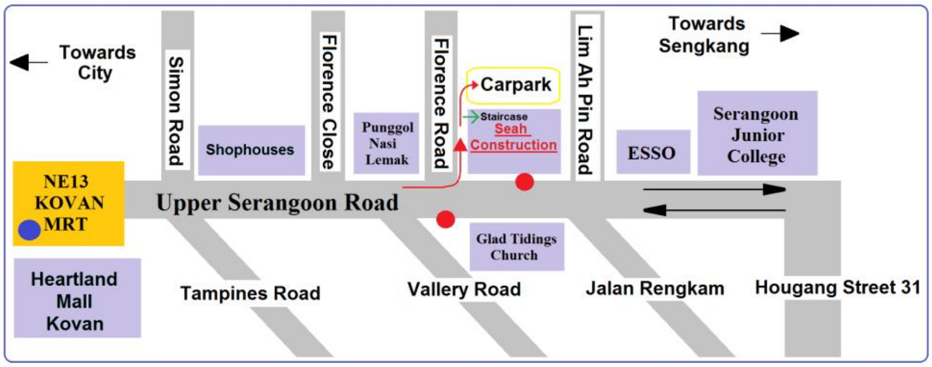
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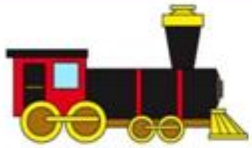
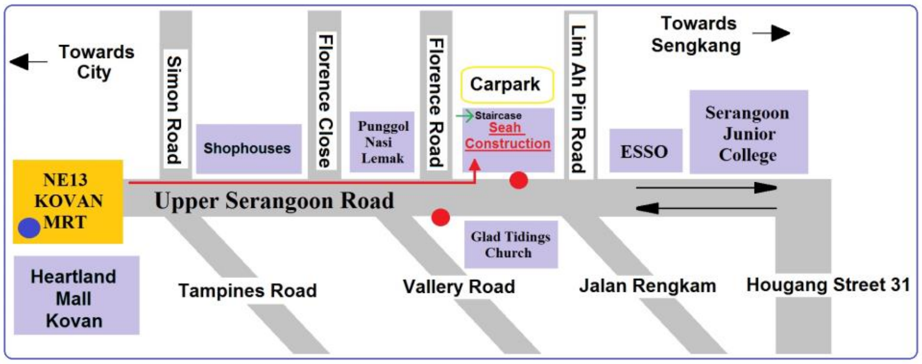


By Train

Board the train on ***North-East Line*** and alight at ***NE13 Kovan Station***, as indicated by the ***Blue dot*** ●.

Take ***Exit A*** and walk to "***Seah Construction, 1007A Upper Serangoon Road***", as indicated by the ***Red Arrow***.
(By-passing **Simon Road**, ***Florence Close***, ***Florence Road***)

Upon reaching the building, please use the ***staircase*** → located by the side of the building to get to the ***2nd floor*** where BAIZONN Learning Centre is located.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Our Teaching Philosophy

- We focus on building a strong foundation on understanding and grasping maths and science principles.
- Upon the strong foundation, students will apply their understanding through customised topic worksheet and assessment
- Students will gain confidence to surpass their current abilities to reach the top of Science, Technology, Engineering & Maths (STEM) tertiary education and profession

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Our Teachers

- Our teachers are graduates and doctorates from engineering and science fields
- We are dedicated to help students build good maths and science foundation to succeed in higher studies in the future.

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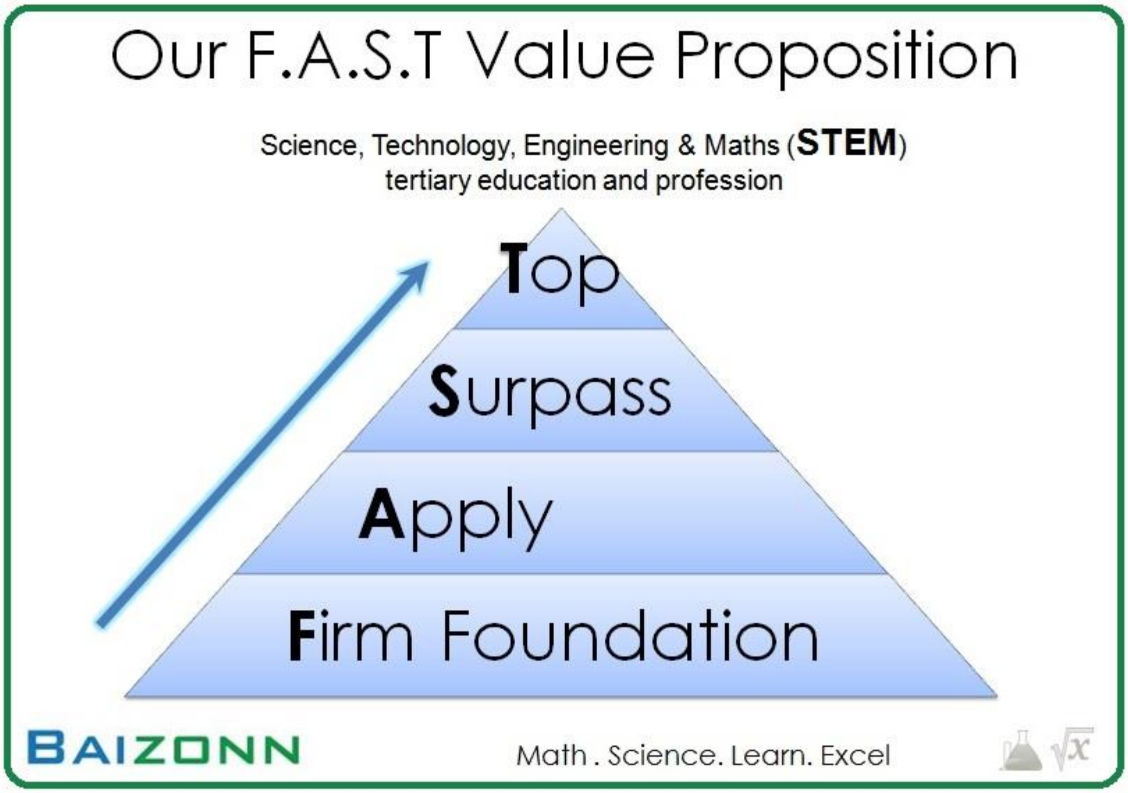
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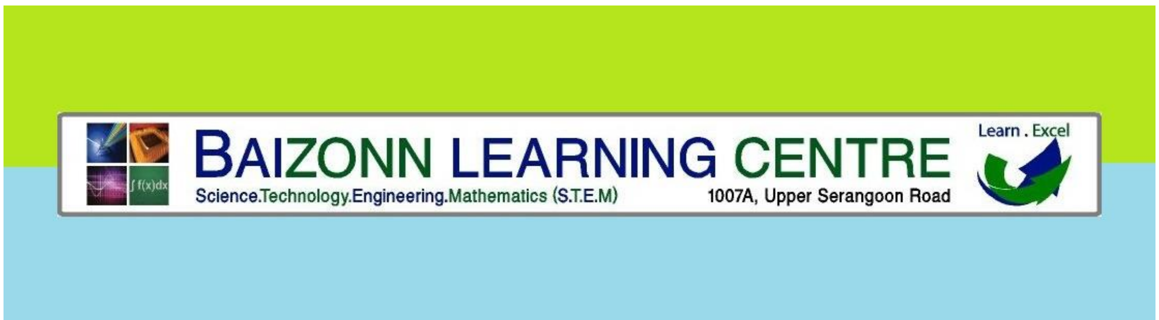
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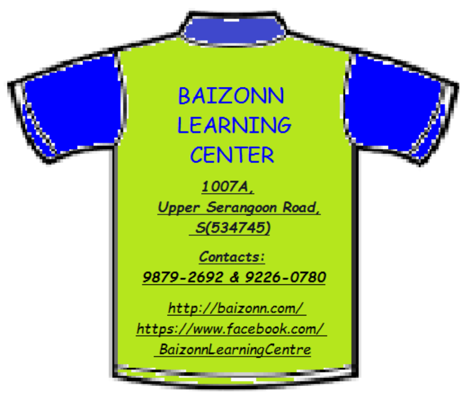
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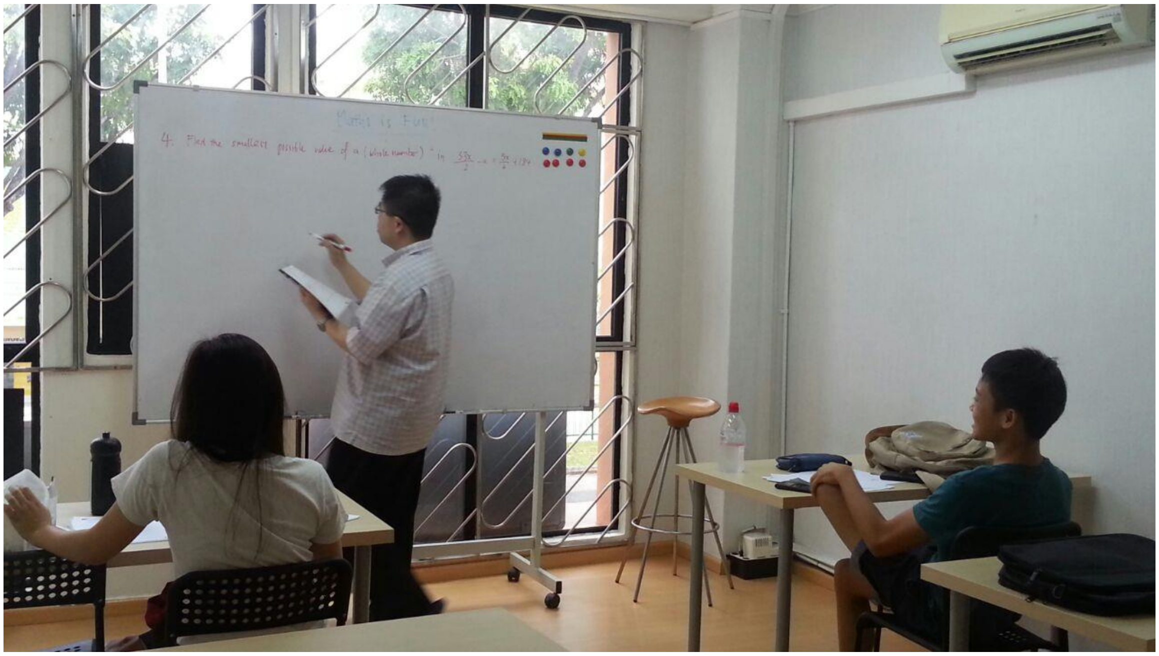
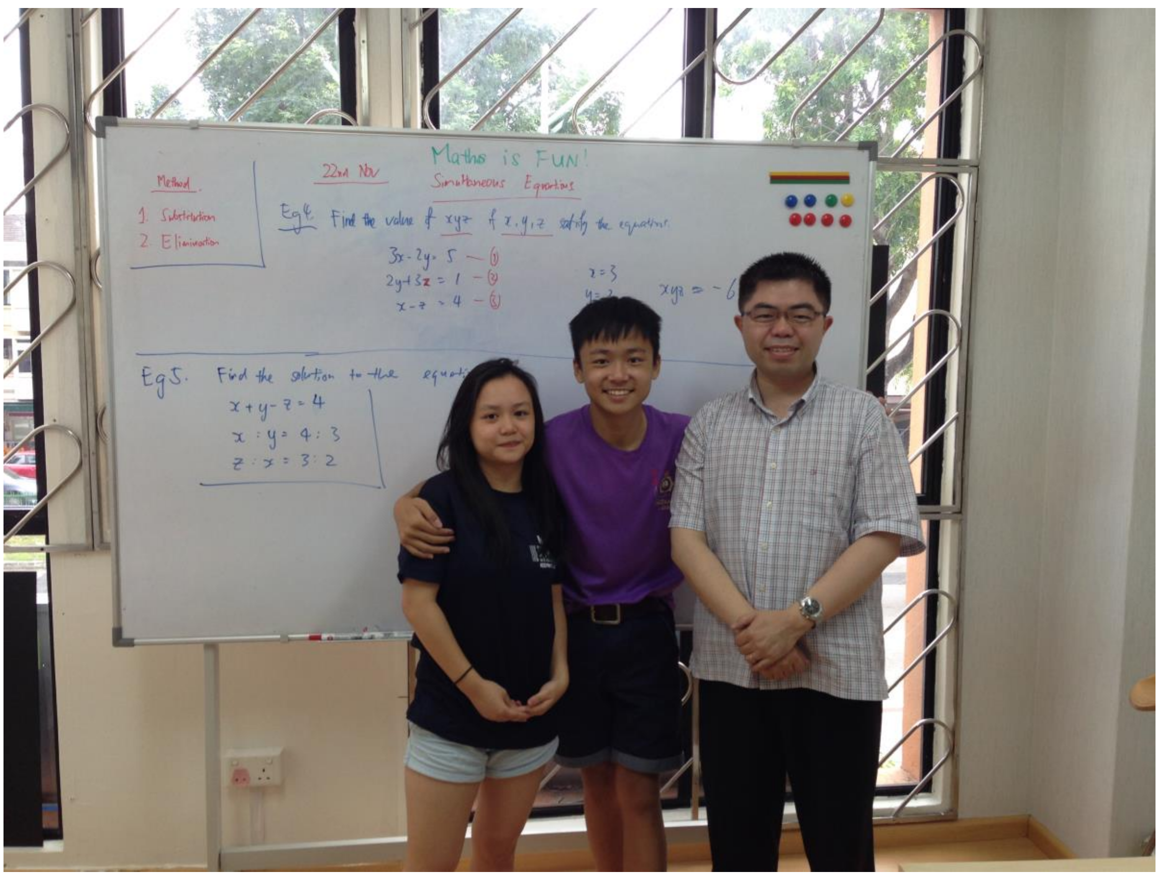
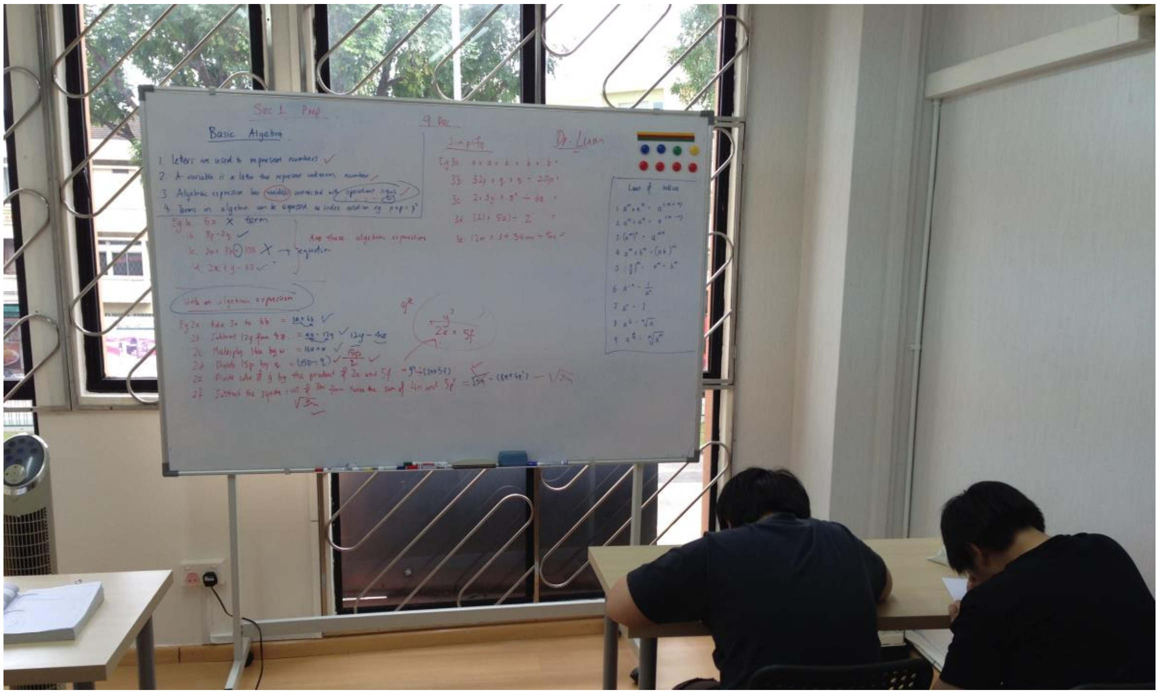



Maths is FUN!
22nd Nov
Simultaneous Equations
Method
1. Substitution
2. Elimination
Eg4. Find the value of xyz if x, y, z satisfy the equations.
3x - 2y = 5 — (1)
2y + 3z = 1 — (2)
x - z = 4 — (3)
x = 3
xyz = -6
Eg5. Find the solution to the
x + y - z = 4
x : y = 4 : 3
z : x = 3 : 2


Sec 1 Prep
Basic Algebra
9 Dec
Simplify
Dr. Leam
1. Letters are used to represent numbers
Law of Indices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A Smart Recirculating Aquaculture System with NI CompactRIO and WSN

Author(s): *Andrew Keong Ng, Yuan Kang Lim, Ryan Tay Hong-Soon, Raymond Kwang Wee Seah, Sanka Ravipriya Hettiarachchi*
Companies: *Singapore Institute of Technology, Baizonn Pte. Ltd, Providev*

NI Product(s) Used:
NI cRIO-9035 (NI-Linux 1.33GHz Dual-Core Real-Time Controller with Xilinx Kintex-7 70T FPGA)
NI 9474 (8 Channel, 24V Sourcing Digital Output Module)
NI 9795 (C Series Wireless Sensor Network (WSN) Gateway)
NI WSN-3202 (4 Ch, 16-Bit, ±10 V Analog Input Node)
NI cDAQ-9174 (CompactDAQ 4-slot USB Chassis)
SEA 9741 (3G/GPS Communication Module)
LabVIEW
LabVIEW Real-Time Module
LabVIEW FPGA Module
NI LabVIEW Wireless Sensor Network (WSN) Module

The Challenge
To develop a smart Recirculating Aquaculture System (RAS) that is easily customizable and scalable to meet the growing needs of Singapore's Aquaculture industry.

The Solution
By using the versatile NI CompactRIO platform to interface with the actuators and sensors, NI-WSN wireless nodes to expand the reach of the CompactRIO sensing nodes, and the LabVIEW software framework together with the CompactRIO Scan Interface, we developed a scalable RAS that can continuously monitor and control water quality and perform predictive alarming and reporting when conditions are harmful to fish health.

Sustainable Aquaculture with Limited Space and Resources
Achieving sustainability in the local food supply with the limited resources has always been one of Singapore's key development goals since independence. Given the limited availability, planning for food sources that use the minimum amount of land is a key challenge in meeting the growing demand for quality food. Being an island state, the aquaculture industry has always been a primary provider in facing this challenge.

The aquaculture industry otherwise known as "fish farming," has been on the rise over the past few decades to meet the soaring demand for seafood. Most fish farms are located in coastal areas and utilize fish net cages in the sea. In 2015, of Singapore's 126 fish farms, 117 were coastal farms. The livestock in these farms are constantly subjected to stresses imposed by changes in the marine environment. In the same year, a coastal plankton bloom caused the loss of nearly 500 tonnes of marine livestock [1].

Conversely, the coastal fish farms also have a huge impact on the neighboring water bodies and habitats. The dense crowding of fish and accompanying release of large amounts of waste products (feces, uneaten food, and dead fish) contaminate the surrounding waters. Furthermore, pesticides and veterinary drugs that are used to treat the pests and diseases that cause harm to the fish are also released together with this waste. Such chemicals potentially affect the entire aquatic ecosystem.

To address the above issue, fish farmers and researchers are exploring the technique of Recirculating Aquaculture Systems (RAS), where fish and shellfish are farmed intensively in a closed environment. The water containing the livestock is continuously circulated through a series of mechanical and biological filters that remove and absorb excretion. Therefore, it requires minimal water exchange and results in great space and water savings. Singapore, with the limitation in agricultural land and the threat from annual plankton blooms, is ideally poised for intensive RAS integrated with hydroponics (growing of plants in nutrient rich waters) to address local demand for safe and sustainable fish and vegetables.

Due to RAS's intensive nature, water quality must be monitored at regular intervals to prevent catastrophic losses, such as when ammonia levels are too high or dissolved oxygen plunges. RAS have been in existence, in one form or another, since the mid 1950's. However, only in the past few years has their potential to grow fish on a commercial-scale been realized. New water quality measurement techniques and computer-based data acquisition and control systems have been incorporated to revolutionize the ability to grow fish in closed aquatic environments.

This project aims to develop a smart system that not only monitors water quality in real-time but also sends alerts to the fish farmers and automates intelligent responses to changes in water quality to prevent livestock loss, thereby increasing productivity and reducing labor costs.

The idea of developing an intelligent scalable RAS was conceptualized and proposed by Prof. Andrew Ng and his team from Singapore Institute of Technology. The mission was to create a scalable RAS prototype that can easily expand to meet the large scale commercial requirements and utilize the latest technology in data acquisition and control. The system would demonstrate RAS integrated with hydroponics to showcase a complete prototype system that can be adopted and deployed.

This project funded by the Singapore Institute of Technology, successfully collaborated with three technical parties: Baizonn, Providev, and National Instruments. Baizonn is a NI Academic Channel Partner with experience in sensors, mechanical design and prototyping. Baizonn collaborated closely with Providev, a NI Alliance Partner with over a decade of LabVIEW and CompactRIO development experience. The combined effort of the NI Partners sharing their domain expertise and technical knowledge in hardware and software, together with the support and guidance of the NI Singapore sales and application engineering team, ensured the successful completion of this project.

Meeting Stringent System Requirements with the Right Tools
Choosing a flexible hardware platform and versatile design tools was crucial in meeting the following key requirements set forward for the RAS project:

1. Minimize cost of initial setup and being able to scale-up the system easily after deployment
2. Possible to relocate sensors with minimum manpower or system reconfiguration requirements
3. Provide cellular connectivity for 24/7 alarming and alerting of adverse conditions
4. Provide continuous real-time monitoring of the following measurements for each tank:
   - Air temperature
   - Water temperature
   - Water level
   - pH
   - Dissolved oxygen
   - Electrical conductivity
   - Ammonium
   - Nitrite

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5. Choose a rugged platform for long-term data logging for offline analysis
6. Develop and deploy the project within a tight schedule
7. Design to have a small form factor, given the limited instrumentation cabinet space near the water tanks

Based on the discussions held during the requirements analysis, it was determined that the overall system would comprise of the following main components (Figure 1). The justification of selecting each hardware platform is described in the sections below.

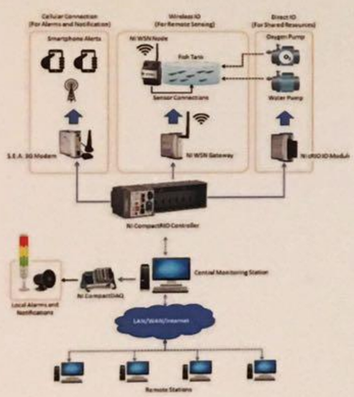

Figure 1: RAS prototype deployment system overview

IO for Shared Resources: These are resources that would be shared among all the fish tanks in an industrial deployed system (i.e. water pumps, oxygen pumps, filtration systems, etc.). These resources are mostly fixed assets and would be pre-defined for each RAS installation.

It was decided that the NI CompactRIO hardware platform would be ideal for providing the main intelligence in the system. The ruggedized design of the controllers and compliance with the Lloyd's Register (LR) Type Approval for marine and offshore applications ensured that the controller would be able to sustain the deployment conditions in and around fresh and marine water bodies. The wide range of C Series modules available for CompactRIO would allow us to meet the different variations of the control and measurement signals required. Since the C Series modules contain built-in signal conditioning, the layout and connections of the sensors would be simple and neat.

IO for Water Condition Monitoring: The water monitoring for the fish tanks was the most critical requirement of this project. The non-standard design and layout of the fish tanks would render any wired sensor connections impractical and difficult to maintain. It was decided that a suitable wireless sensing approach was to be used for water condition monitoring.

The NI Wireless Sensor Network Modules (NI-WSN) proved to be a suitable option for water condition monitoring since the edge nodes could be setup and deployed by simple configuration from the main station. The Zigbee wireless standard used by the NI-WSN modules provided the flexibility of customizing the wireless network based on the different tank layouts in the field. The different WSN node selection available for standard analog and digital IO, including the programmable NI 3231, RS-485 wireless node, made future expansion a feasible option by allowing integration with many sensing and actuation devices, even accessing industrial communication buses wirelessly.

A NI 9795 C-Series Wireless Sensor Network (WSN) Gateway module provided the link from the edge WSN nodes to the central CompactRIO controller. In each remote fish tank, a "Sensor Pod" contained the sensors for measuring the water quality parameters (Figure 2). The sensors are connected to the "Wireless Data Acquisition Box" (WDAQ) containing their power sources and two NI WSN 3202 analog input edge nodes. When the system expands to support multiple tanks, these WDAQ boxes were to be duplicated and connected to form a single wireless network with the CompactRIO controller as the gateway. The CompactRIO would then be connected through a Local Area Network (LAN) to the main control station PC (Figure 3).

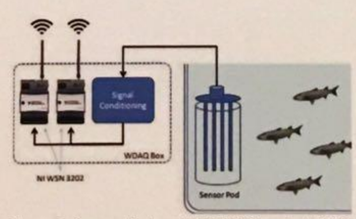

Figure 2: Sensor Pod and NI WSN Setup in WDAQ Box

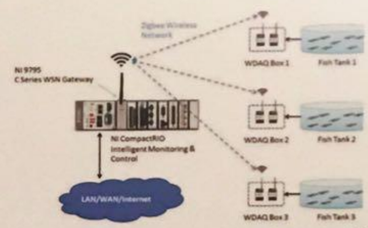

Figure 3: Multiple System Expansion using NI WSN and CompactRIO

Alarming and Notifications: Changes in the water conditions can affect the fish health at alarming speeds. Fast action to mitigate any changes to the nominal conditions is critical in RAS systems as the density of the livestock is very high. It was required to display visual alarm conditions both locally at the control room and also utilize cellular networks to inform the users and systems administrators about any sensor readings that exceed nominal values. For local alarming a CompactDAQ system connected by USB to the main control PC was used. For remote alarming through cellular networks, we had to consider that some fish farm locations would only have 3G or GSM connectivity; therefore, it was decided to use SMS as the notification method.

Due to the open hardware architecture of the NI CompactRIO platform, finding suitable 3rd party C Series modules to fit any custom application requirement is simple. Through discussion with the NI Sales Team, we were able to find the SEA 9741 3G/GPS module developed by a NI Alliance Partner to fulfill the SMS notification requirement. The ease of configuring the hardware of the module and the easy-to-use software API reduced days of code development. We were able to send SMS notifications within less than an hour of setting up the hardware.

The following images displays the final test-bed setup, the WDAQ box containing the NI WSN edge nodes, the CompactRIO central controller and the Central Monitoring Station with the NI CompactDAQ alarming setup.

Figure 4: Recirculating Aquaculture System (RAS) Test-bed (a) Front View (b) Side View

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Figure 5: Sensor Pod and WDAQ Box with NI WSN

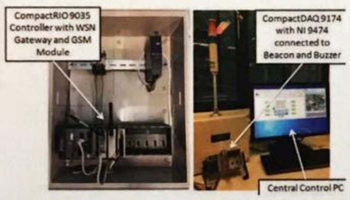

Figure 6: CompactRIO Controller Box and Main Control PC

Rapid Software Development using LabVIEW and the CompactRIO Scan Interface

Due to the low sampling rates required by the application, it was decided to use the CompactRIO Scan Interface to accelerate our development process. The CompactRIO Scan Interface provided all the basic functionality and low-level FPGA code for the selected modules through an easy to use IO Node interface. The LabVIEW Wireless Sensor Network Module provided access to the remote WSN modules with a simple configuration procedure and access to the values through shared variables. To get the basic IO and wireless sensor connections ready for testing, our developers only had to configure the remote WSN nodes in NI-Measurement and Automation Explorer (NI-MAX), insert the modules to the CompactRIO target in the LabVIEW project and drag-and-drop the IO nodes and shared variables to the LabVIEW block diagram. With the use of the Scan Interface and shared variables, we could monitor the sensor connections and readings with minimum coding effort.

Once the initial system requirements were set and IO connections verified, our next step was to determine the system architecture for our application. The LabVIEW in-product sample projects was invaluable during this stage since it gave us a scalable, well documented starting point that perfectly fit our overall system requirements. We utilized the "LabVIEW Real-Time Control on CompactRIO (RIO Scan Interface)" sample project that shipped with LabVIEW. This sample project included extensive documentation that clearly indicated how the code worked and also useful comments for adding and modifying functionality.

The sample project wizard in LabVIEW finishes up by creating a fully functional project inclusive of the Scan Engine Interface for CompactRIO, a real-time application, host PC communications, and a sample user interface for monitoring and control. All codes were organized neatly in a scalable folder structure. As developers, we truly appreciated the efficiency of the built-in system level integration support in LabVIEW and knew the choice of development framework truly set us ahead of the project schedule. With the project template as a starting point, the development team went ahead to customize and modify the architecture to suit the fine details of the application. At the end of the project, we were able to create a system architecture that could be easily scaled to support multiple fish tanks and any future customizations needed for the project. The user interfaces created for the Main Control PC application is shown in Figure 7, 8 and 9.

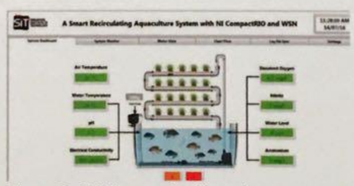

Figure 7: GUI System Dashboard

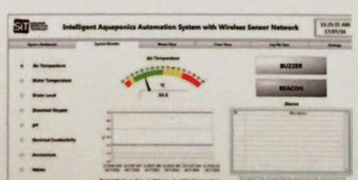

Figure 8: GUI System Monitor

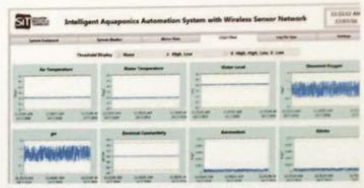

Figure 9: GUI Chart View

Possibilities for Tablet PC Integration

During the project deployment, the possibility of monitoring the water conditions through tablet PCs was discussed. It was understood that by using the Data Dashboard for LabVIEW, we would be able to realize this possibility with minimum or no cross-platform development effort. Since the Data Dashboard for LabVIEW supports the same shared variable interface used in communicating with the central control PC, any tablet connected to the same network would easily have access to the measurement values. Furthermore the dashboards created on iOS are also fully compatible with Android tablets without any modifications.

Conclusion

Enhancing traditional industries such as farming and aquaculture with the latest technology is crucial in meeting present day social needs. Often in such situations, the stringent requirements for monitoring and control that were formally done by humans must be carefully met by the new hardware platforms and software frameworks. The choice of using National Instruments hardware and software ensured us that we are well-equipped with the tools needed to meet such requirements with maximum efficiency and effectiveness.