CS4HS
COMPUTER SCIENCE FOR HIGH SCHOOLS
24 & 25 NOVEMBER 2022

INTRODUCTION TO ROBOTICS BY BUILDING ROBOTS AND ENGAGING WITH ROBOT CONCEPTS

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato
SCHOOL OF ENGINEERING
TE KURA PŪKAHA

BEARIE

NZRAS
NZ ROBOTICS, AUTOMATION, AND SENSING

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Project 1: Autodidactic Crane

This project is based on self-directed learning experience, tailored towards Year 7 to 12 requiring students to observe and extract information from a premade-complex model allowing for the duplication without external resources.

By providing students with the tools for self-education they are able to go forward with the confidence to find information on their own and construct and test complex mechanical systems.

This project is divided into two sessions:

1) Hardware building exercise from pre-assembled parts with preloaded program (2 to 3 hours)
2) Programming methodology control the crane (2 to 3 hours)

Hardware:

Below is a table of the electronic components utilised in the project. However, these components may not be widely available in the future and so their respective alternatives are provided.

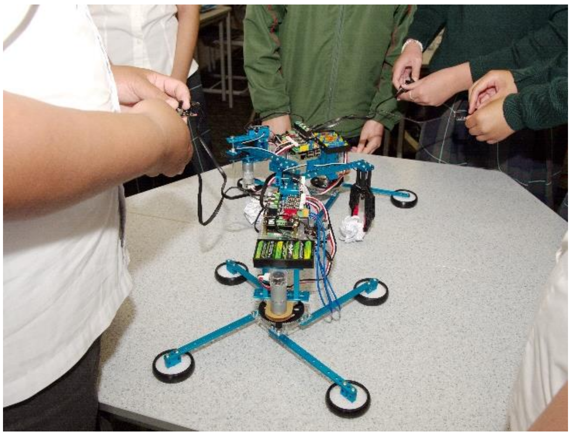
	Used in model	Available Alternatives
Controller	Makeblock MegaPi	Arduino Atmega2560
Motor Driver	Makeblock MP80495	Polulu TB6612FNG
Joystick	Makeblock RJ25 Analog Joystick	Analog Dual Axis XY Joystick
Ultrasonic	Makeblock RJ25 Ultrasonic	HCSR04 Ultrasonic Module
Seven Segment Display	Makeblock RJ25 7SD	TM1637 Display
Motors	Makeblock 25mm 1:46 DC	12V 1:46 DC Encoder Motor

Software:

This project has been coded in solely Arduino's variant of C++ through the Arduino IDE. It has been formatted in a modular fashion allowing for the capability to edit and tailor to a variety of alternative uses.

Learning Achievements:

- Introduction to basic self-teaching / self-realization of project management.
- Exploration into different sensors and actuators.
- Hardware integration and basing communication with a micro-controller.



Project 2: Collaborative Crane

Provision of a complex model requiring multiple choices of communicative pathways the students are to program and instruct the large, complex system via an assortment of programming languages.

This project can be tailored to the specific needs of a classroom by limiting the provision of specific modules increasing or reducing the difficulty as needed.

Hardware:

In addition to the hardware used in project 1, the following list of hardware has been implemented.

	Used in model
Wireless Receivers	Raspberry Pi Pico W
Localized Hub	TP-Link TL-WR902AC Access Point
Master Control Platform	Raspberry Pi 3B+

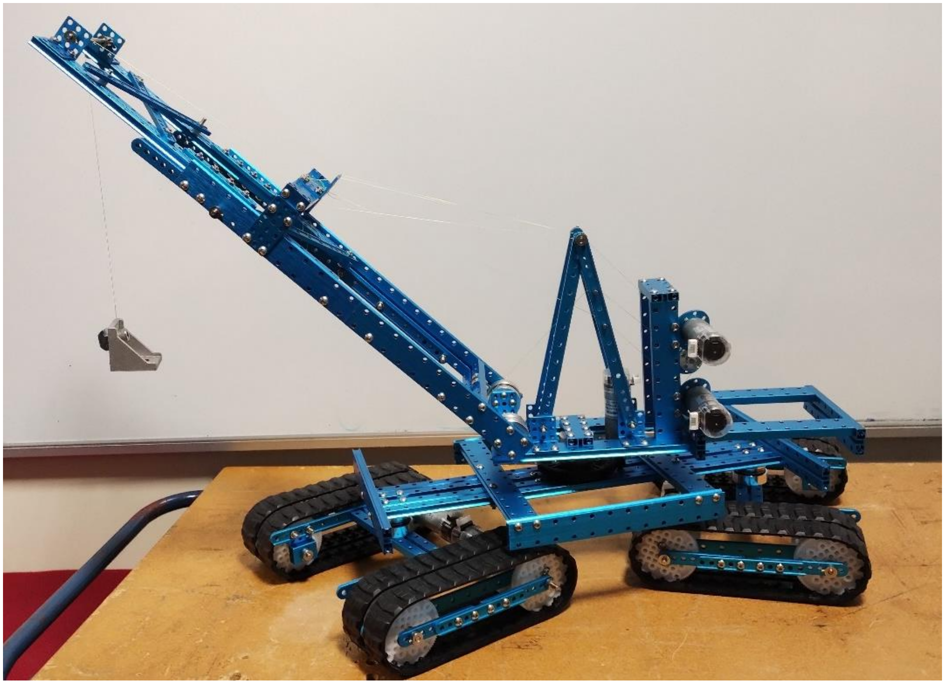
Software:

The Pico W receivers have been programmed in a subset of Python called Micro python. This allows for an expansion or more selective refinement of a students programming repertoire.

The Control platform is running a basic Linux OS presenting a rudimentary web portal.

Learning Achievements:

- Collaborative project management.
- Introduction to a complex multi-control platform.
- Utilisation of multiple programming languages including Python, Javascript, HTML and C++.



Project 3: Dynamic, Auto-Balancing Beam

Demonstration and initial introduction into the implementation and effect of a simple PID controlled system. By demonstration and immediate visual relatability of the project students are able to form a fundamental understanding of basic control theory.

Hardware:

In addition to the hardware used in project 1, the following list of hardware has been implemented.

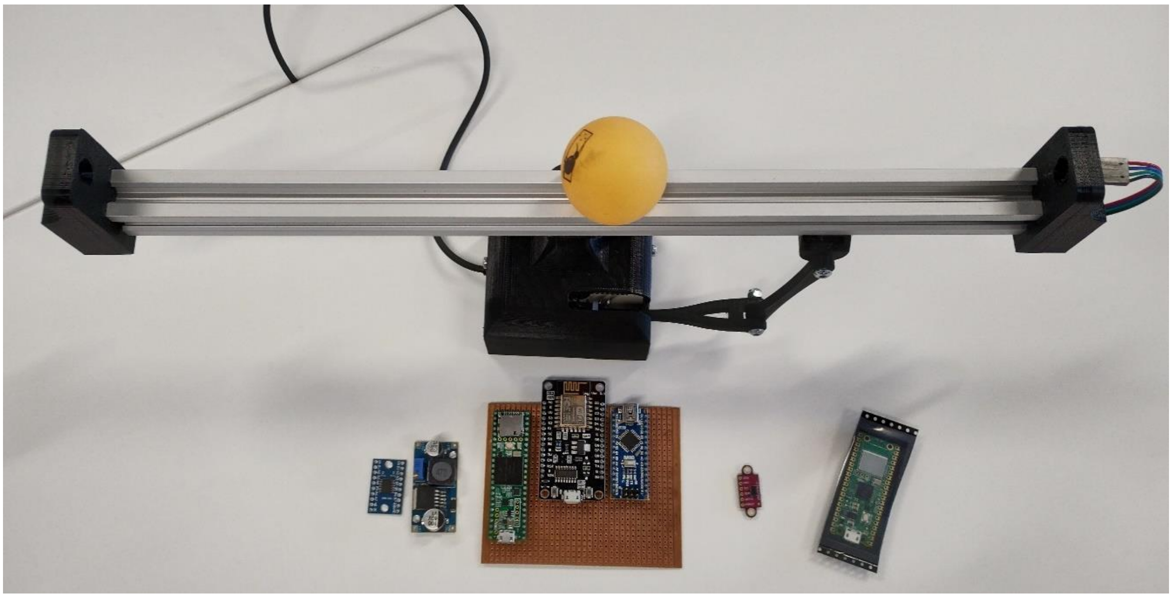
	Used in model
3D Printed Structure	Esun PLA+
Micro-controller	Raspberry Pi Pico W
Logic Level Converter	TXS0108E Breakout board
Servo	Tower Pro MG995
Distance Measure	I2C 940nm Laser Time of Flight Module

Software:

This project has been programmed solely in Micro python in a modular format to allow for a tailored learning experience.

Learning Achievements:

- Fundamental understanding of closed loop, basic control theory
- Observation of UV time of flight measuring sensors
- Testing and application of multi-logic level systems
- Introduction to a PID controller and encourage exploration as to how this effect the system.
- Stepping stone to encourage more complex control projects.



Project 4: Piano model

By utilizing I2S, UART, internal interrupts and single line LED control communication protocols, a product made using, now, readily available techniques and materials a large number of simple electronic principles are demonstrated with the intention of creating sound from basic teachings.

This project is used as a stepping stone for increased complexity and to give a sense of achievement at each successful milestone.

Hardware:

In addition to the hardware used in project 1, the following list of hardware has been implemented.

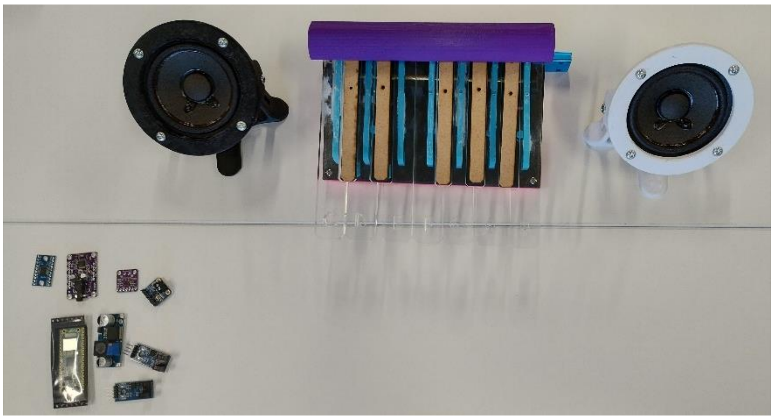
	Used in model
3D Structure	Esun PLA+, Laser-cut MDF and Acrylic
Micro-controller	Raspberry Pi Pico W
Logic Level Converter	TXS0108E Breakout board
Amplifier / ADC	MAX98357 I2S D-Amplifier
Speakers	8 Ohm Onkyo Speakers
Limit Switches	Optical limit switch modules

Software:

This project has been programmed solely in Micro python in a modular format to allow for a tailored learning experience. This has been further enhanced with the application of multi-threading and I2S communication.

Learning Achievements:

- Development of an audio driver as well as complex multi-switch input system.
- Fundamental understanding of multi-threaded processes and how they can be correctly implemented.



Teachers, please give us feedback of your project ideas and thoughts to:

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