Imperial College London

Mechatronics Outreach: Machine Vision Collision Avoidance Control Demonstrator

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Overview

Device shows the benefits of electromechanical control and automation for repetitive and time critical tasks, through a collision avoidance-based arcade machine. The device is aimed at inspiring 11–14 year-olds to consider a career in Engineering. The user's control is increasingly automated, across the modes listed below.

Modes of Operation

The device operates in the following user modes:

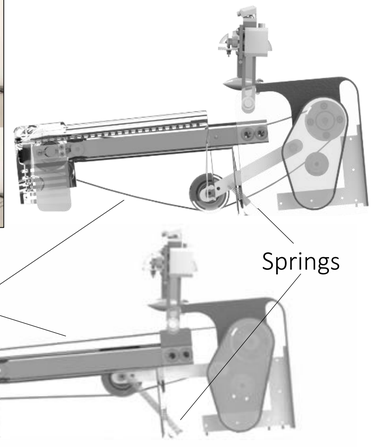
1. **Fully manual:** Manipulating the joystick moves the pin left or right continuously without computer assistance.
2. **Computer assistance:** Manipulating the joystick moves the pin to one of three discrete tracks.
3. **Computer controlled:** Fully automated machine-vision control, using the camera as input.

Machine Vision and Software Integration

A Raspberry Pi runs all code. This code controls the pin stepper motor, from inputs provided by the user and the camera. The Machine Vision system uses the OpenCV library to detect the location of each obstacle, detecting the red colour of the obstacles, against the black background of the belt.

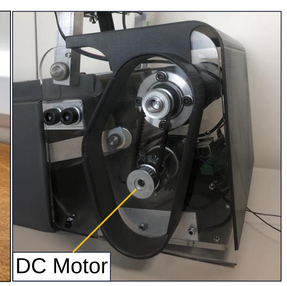
Mechanical Design

The device is required to fit in a suitcase for ease of transport, along with two other outreach devices. A longer belt allows for a greater variety of obstacle pattern, thereby improving the gameplay and spectacle. To fit in this space constraint while maintaining a longer belt length of 1390 mm, an extension mechanism was devised via a locking pin. This tensions the belt through springs connected to the idler drum and the idler weight.

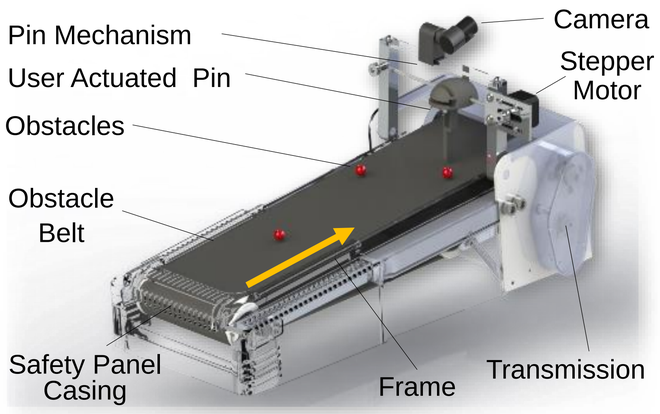


Safety Panels

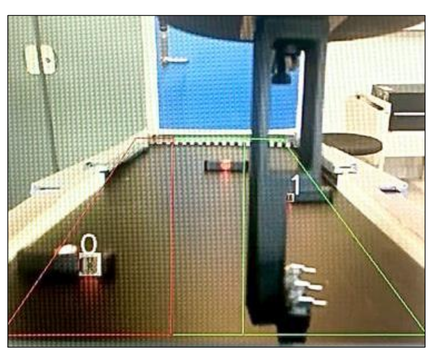
The covering panels are made from transparent ABS where possible, to display the inner workings of the device. This allows our young audience to observe the mechanical components in operation.



Device Structure



User Interface



The red track on the UI indicates the nearest obstacle.

Product Specification

- Maximum Belt Speed: Adjustable up to 1.5m/s
- Operating Dimensions: 325 x 290 x 720 mm
- Stowed Dimensions: 325 x 200 x 510 mm
- Total Mass: 6.55kg
- 6061 Aluminium shafts and structure
- Usage Environment: Indoor/Outdoor Dry
- Output: HDMI Augmented Reality with Sound
- Programming Language: Python 3
- Powered by a 12V DC Motor
- Controller: Raspberry Pi 4 8GB RAM
- 720p resolution camera
- Expenditure / Budget: £1159.30 / £1200