RADiation ROBOTS: handling nuclear waste

Objectives

Students will understand the difference between legacy nuclear waste and new build nuclear waste.

They will also see the role that robots play in the clean up of nuclear waste

Fast facts

Subject: Chemistry

Age range: 5+ years old

Ambassador preparation time: 30 minutes

Demonstration time required: 5 minutes

Location: Science Fair

Overview

Nuclear activities in the past have generated 'legacy waste'. This is very hazardous radioactive waste that we now need to handle and safely dispose of.

We need to separate this waste, but it is too hazardous for human to approach or handle- so we use robots and remote handling.

Equipment

- multicoloured ping pong balls
- 2 x medium baskets
- grabber arms
- mixed wooden shapes

Links to purchase the equipment are given at the end of the guide (Equipment Purchase Links section).

Background

Radioactive waste is a controversial topic. But there is a big difference between historic legacy waste and new build waste.

Legacy waste can be defined as the radioactive waste produced during the infancy of the UK's nuclear industry, unfortunately at this time waste storage and treatment was not well managed or planned. The government is now making a greater effort to ensure this legacy waste is managed and disposed of in a manner that protects both people and the environment.

The cost of legacy waste clean up in the UK is very high. But should it condemn new build and the future of the UK's nuclear industry? The next generation of nuclear power station proposed to be built in the UK (including Hinkley point C) will be built by the private sector, with waste and decommissioning plans in place from the beginning. A funded decommissioning programme must be submitted before construction can start.

Clean up and disposal of legacy waste as quickly as possible is a priority for the government, but it has presented many unforeseen challenges that have had to be overcome by scientists and engineers.

Clean up of legacy nuclear waste has been one of the key drivers for robotics technology. Automated robots have been designed to: conduct inspections of radioactive areas with fitted cameras, enter area too hazardous for humans, retrieve radioactive samples, carry out radiation surveys, demolish buildings and monitor for contamination.

These Robots are very effective but also very expensive. The nuclear industry welcomes innovation and new ideas! One of these ideas was to utilise Master Stave Manipulators (MSMs), these sound very complicated but it's the exact same technology as a puppet arm. It's a machine that mimics your movements but at a distance, for example behind a lead wall where radioactive materials are stored. These have been used since the start of nuclear technology development and have been applied to modern solutions.

Can you think of any advantages of using a MSM over a robot?

Some answers to this question are: cost, it is much cheaper to build; maintain, mechanical components are less likely to break than electrical components; operation is easier, no computer programming is easier making it quicker to use and more versatile and training, you can train a larger range of operators more quickly.

In this activity we are going to use a robot to separate and isolate different wastes.

Method

Set up the equipment as below:

Figure 1- demonstration set-up

The demonstration is quite simple. The student will use the arm to remove the wooden shapes from the basket of 'mixed radioactive waste' and isolate it, into the empty basket. This is to demonstrate separating different types of radioactive waste before they go onto to be treated and eventually disposed of. Here the grabber is representing a Master Stave Manipulators (MSMs).

If the students are in groups, use a stopwatch to see you can remove the wooden blocks the quickest!

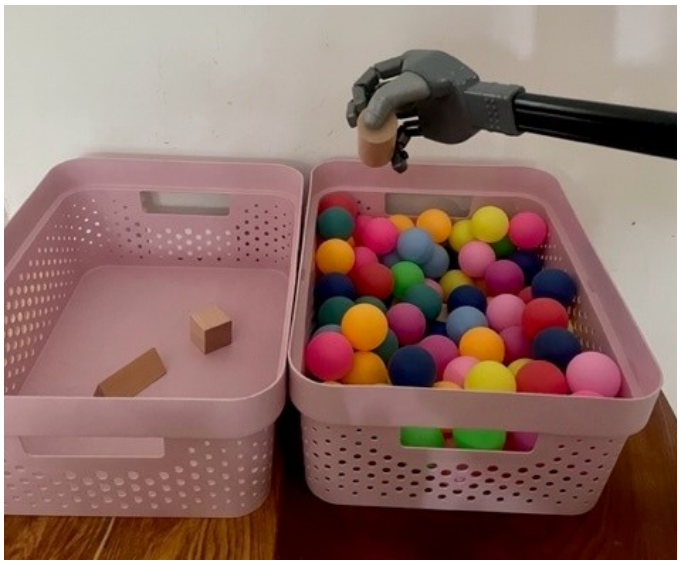

Figure 2- demonstration in action

At the end of the demonstration use the notes above to discuss the advantages of using MSMs instead of robot arms in the nuclear industry.

Equipment Purchase Links

- https://www.amazon.co.uk/CURVER-245961-Storage-Tray-Medium/dp/B07ZPD3CWQ?pd_rd_w=x4DYC&content-id=amzn1.sym.ae973372-04ab-4f43-8bdd-219dc0aabb13&pf_rd_p=ae973372-04ab-4f43-8bdd-219dc0aabb13&pf_rd_r=Z7S1NM7P9XVD4RQCV8QV&pd_rd_wg=SFkXp&pd_rd_r=9d7c7fc6-69a2-4777-a7fd-3363925f9264&pd_rd_i=B07ZPD3CWQ&ref_=pd_bap_d_grid_rp_0_14_t&th=1
- https://www.amazon.co.uk/gp/product/B076WMH17S/ref=ppx_yo_dt_b_asin_image_o06_s00?ie=UTF8&th=1
- https://www.amazon.co.uk/gp/product/B0847MY7MM/ref=ppx_yo_dt_b_asin_image_o06_s01?ie=UTF8&psc=1
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