Imperial College London

GAMIFYING THE MRI EXPERIENCE

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Introduction

Research gap: a non-invasive method to reduce anxiety and movement of paediatric patients during MRI scans.

MRI scans are life-saving interventions in paediatric medicine, however, due to their loud, claustrophobic environment, they can be terrifying experiences. Anxiety induced movement can lead to poor quality scan images thus a repeat scan may be necessary or the use of sedation.

Aims

- Increase the **success rate of paediatric MRI scans**
- Devise a **non-invasive method to reduce paediatric patient movement**
- **Decrease** proportion of MRI scans with **detrimental movement artefacts**

Solution

1) Patient plays a gaze-controlled game.

- Two games were developed **to distract and focus the patient's attention**
- Coded control of the game with a Tobii **Eye Tracker**
- **Fog** is introduced on the screen in **response to movement** to prompt the patient to remain still
- To remove the fog, the patient must remain still

Trials	*Movements in FSR*	*Fog animations displayed*	*Percentage of efficient responses (%)*	*Delay between movement and fog (seconds)*
Trial 1 (1-2s presses)	10	6	**60**	**0.83**
Trial 2 (5s presses)	6	5	**83**	**2.0**

Table 1. Game Results

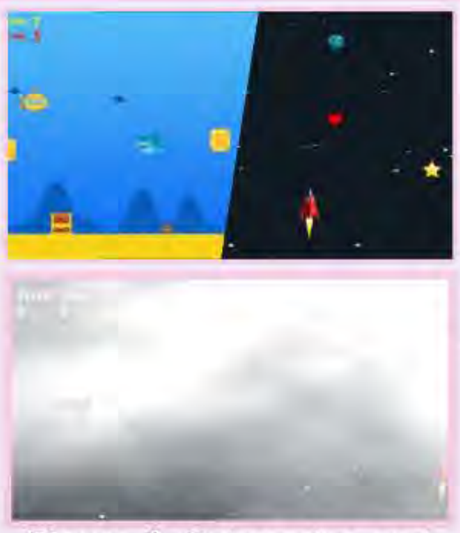

Figure 1. Submarine and Spaceship Games with and without fog

2) Movement transmitted through the Movement Detection Board (MDB).

A sectioned board transmits movements from the patient lying upon it to the fitted **Force Sensitive Resistors (FSR)** array.

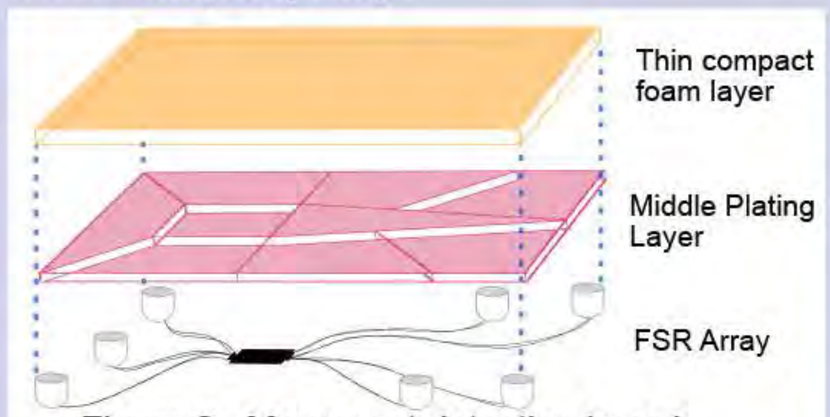

Figure 2. Movement detection board

The 9 sections of the board effectively distribute the weight so that **every movement will be detected** by at least one FSR.

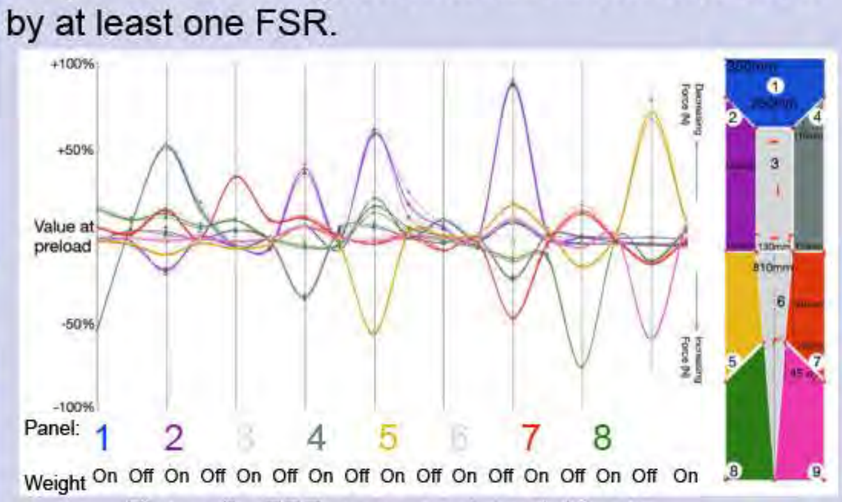

Figure 3. FSR response to weights on

Figure 4. Movement detection gaming system diagram (MDGS)

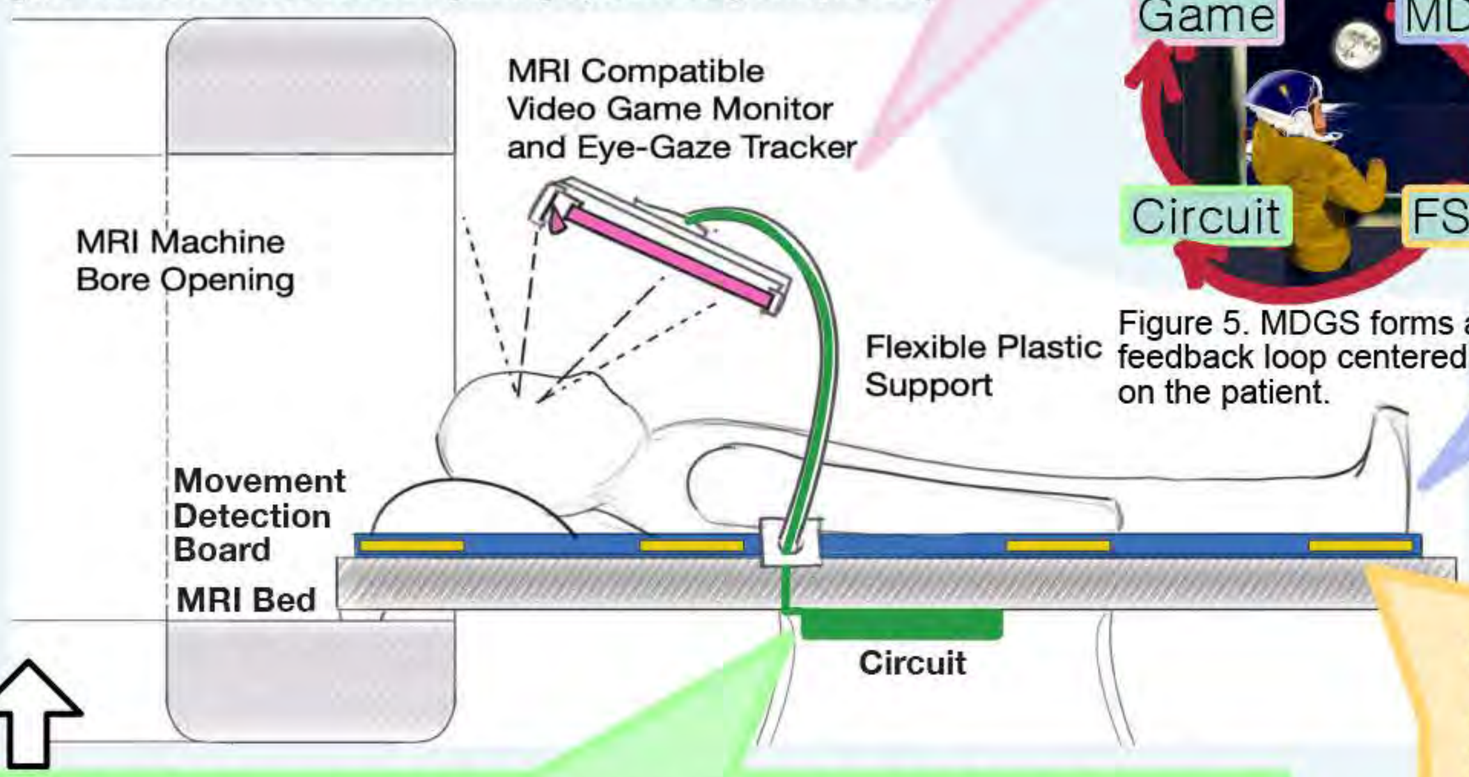

Figure 5. MDGS forms a feedback loop centered on the patient.

3) Movement detected by the FSRs.

An FSR acts as a variable resistor dependent on force applied, **force varies if a patient moves.**

- A change in force results in change in circuit voltage.
- FSRs do **not require skin preparation** of the patient
- FSRs **resistance creep** (modelled in Figure 6) which has been accounted for in the Arduino code

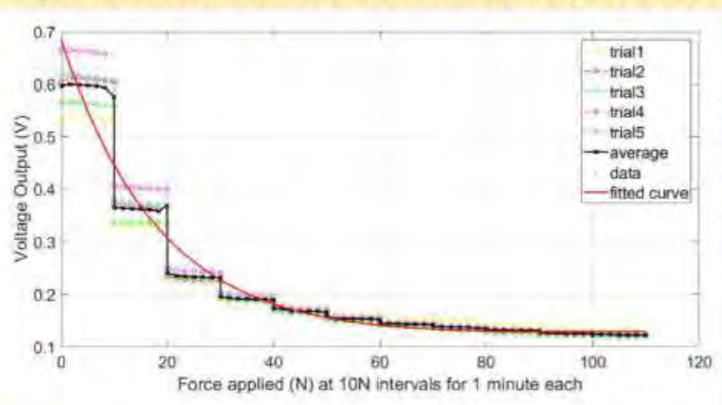

Figure 6. Voltage Output of FSRs vs Force Applied

4) Circuit communicates movement back to patient via game.

Voltage change correlates to movement which results in the Arduino Nano outputting a boolean response to the game.

- **Potential dividers** (FSR and one 5.5k resistor) to output a voltage change proportional to force change
- Arduino outputs a 1 to the game when a movement is detected, **triggering fog**

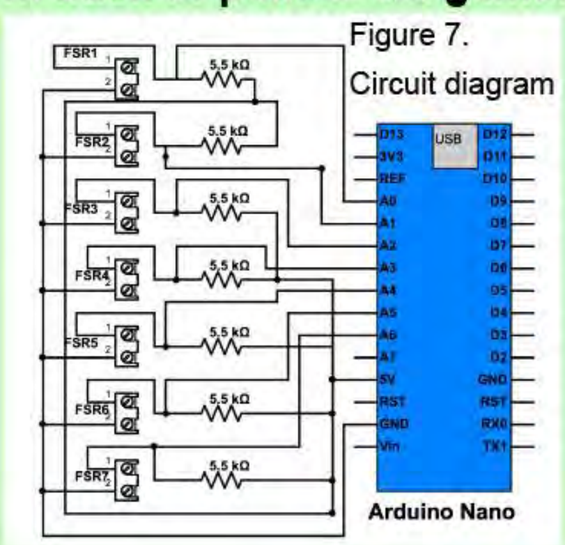

Figure 7. Circuit diagram

Clinical Trials

- **Aim:** Collect movement data and written feedback to show effect of our overall system on participants' movement and anxiety
- With the aid of Dr Warren Macdonald and Dr Alavi, we were **granted approval** from the London-Surrey Borders Research Ethics Committee
- Produced **technical protocol documents**, **consent and assent forms** for participants and guardians along with **information sheets**

Conclusion

Aims	Achievement
Non-invasive system to reduce movement	**Achieved**
Interactive games controlled by eye gaze	**Achieved**
Motion detection system reliably detects motion	**Achieved**
Distribution of forces from the board onto the FSRs	**Achieved**
Efficient communication between parts	**Partly Achieved**
Test with all components	**Achieved**

Future

- **Decrease lag** of game response
- Improve **precision** of movement detection system
- Collect data from **clinical trials** to further prove our concept
- Produce an **MRI compatible** version of our prototype