NEW YORK UNIVERSITY

Smart Chin Brace for Secondary Dystonia
and
Smart Surveillance system for Patients with Seizures

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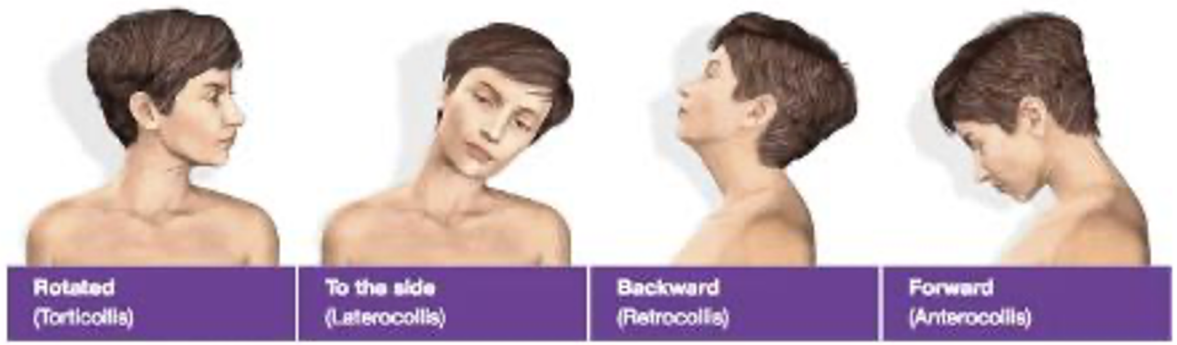
Background



Cervical dystonia is the most common form of focal dystonia. It is a neurological disorder that causes the muscles in your neck to abnormally contract. These muscle contractions cause involuntary movements and awkward positions of the head, neck, and sometimes shoulders. The major forms of Cervical Dystonia which we are focusing is

Laterocollis: Tilting of the head, neck and chin with the ear touching the shoulder about the Z-axis.

Development of Smart Chin brace

Project 1: (using Arduino)

- Accelerometers to detect the tilting of head with ears moving towards shoulders.
- Linear actuators are mounted on the brace near cheeks to provide sensory trick.
- Vibratory motors on the brace vibrate as ears touch shoulder which is the maximum limit

Project 2: (using Propeller)

- Muscle sensor aligned with the SCM muscle on each side of the neck, monitors for changes in the muscle activity
- When the muscle activity crosses a set threshold value, which might further result in dystonia, it sends signal to Arduino to actuate the motors and solenoids to prevent Dystonia

Problem Statement 1

Some people suffering from Dystonia might not respond to the sensory tricks offered by our device. Prevention can also not work in this scenario. An emergency feature is needed at times when this happens. Someone should be notified for external assistance.

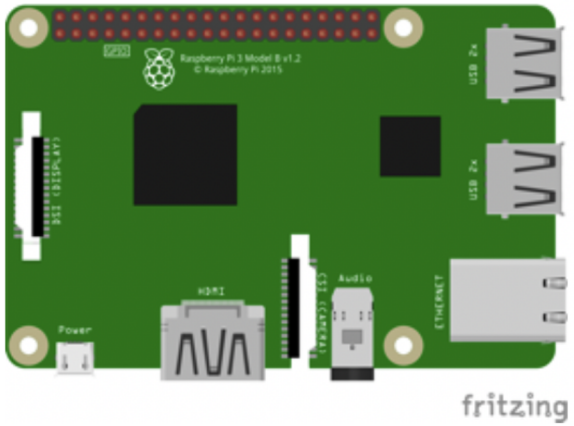
Solution

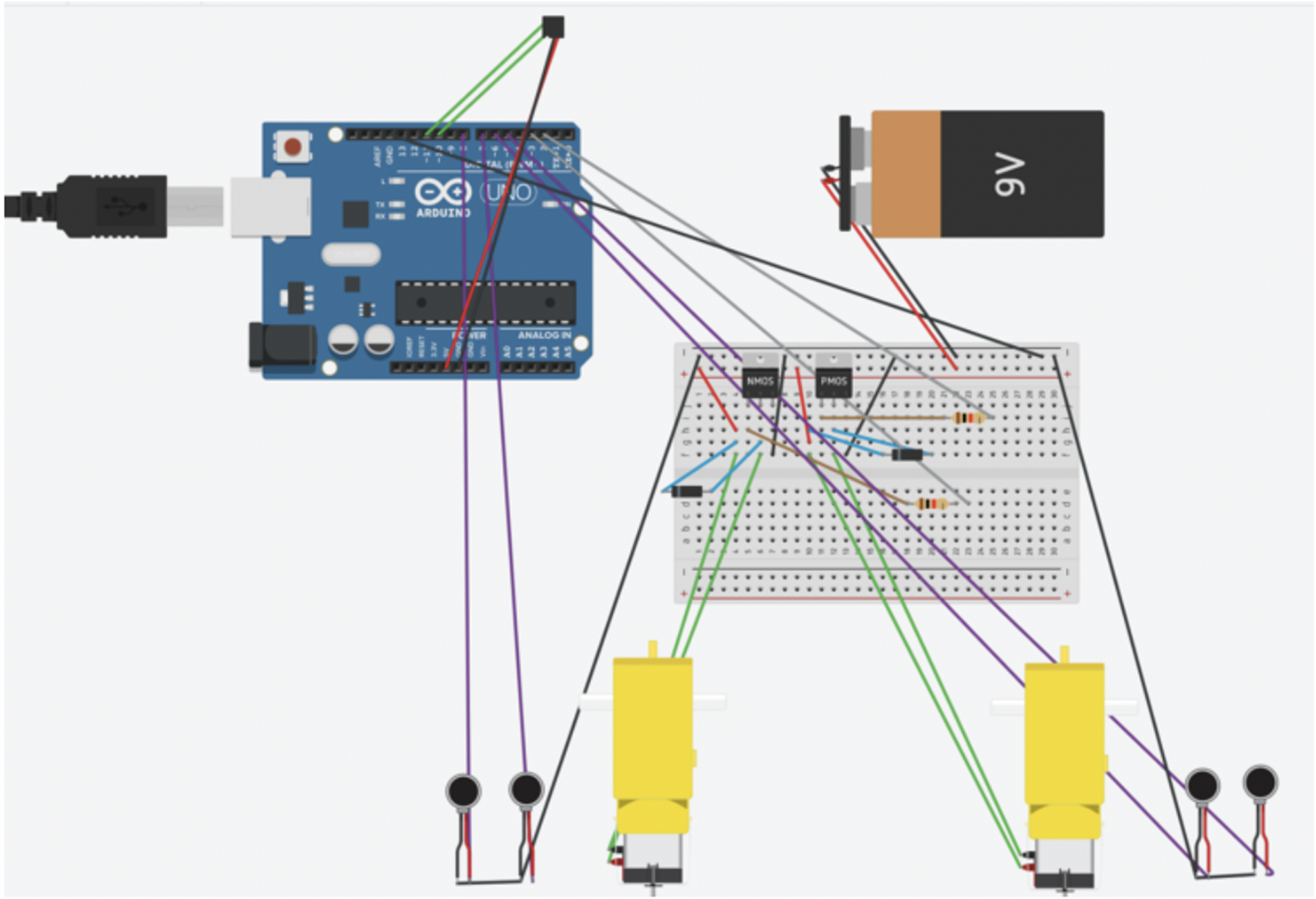
If the patient wearing the Chin Brace, has his/her head tilted for more than 10 seconds on either side, Patient's Emergency Contacts will get a message alert on their phones saying: “ Emergency”.

Working

- Arduino actuates the solenoids mounted on the chin brace according to the readings of accelerometer.
- Serial communication is established between Arduino Micro and Raspberry Pi 3
- Head tilts - Arduino actuates solenoid if after 10 secs the reading on accelerometer is same - Raspberry Pi sends an emergency message.

Circuit Diagram (Dystonia)

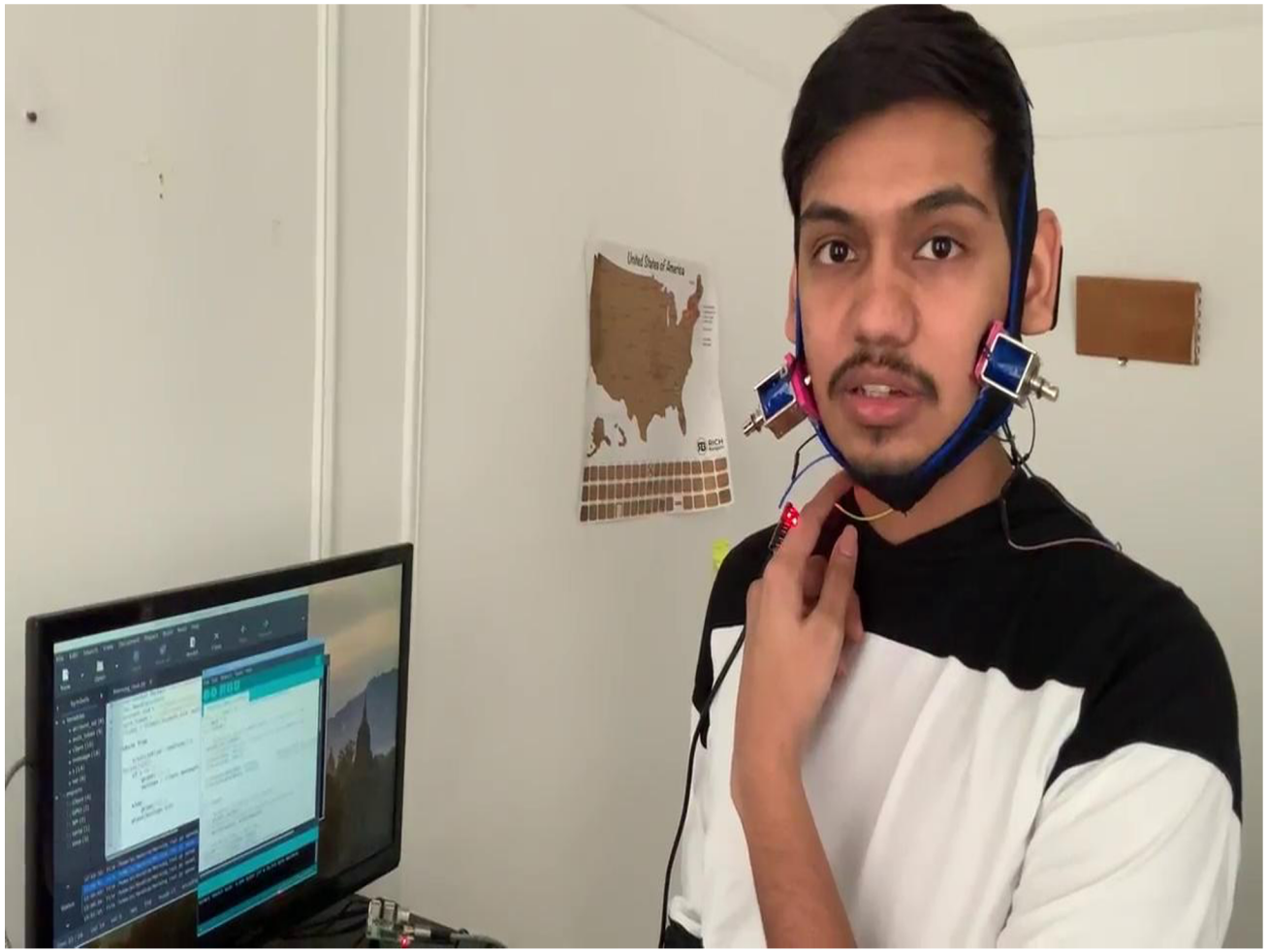




Bill of Material (Dystonia)

ITEM	QUANTITY	AMOUNT($)
Arduino Micro	1	50
Raspberry Pi	1	70
12v Push Pull solenoid	2	12.5
Chin Brace	1	15
Vibrating motor	6	12
Cables	Lots	2.25
Battery Pack	1	5
Battery	8	0.42
Transistor	2	5
Memsic 2125	1	10
TOTAL		205

Demonstration (Dystonia)



Background

1. Paroxysmal dystonia (historically known as tonic spasms or tonic seizures) is a type of fluctuating dystonia characterized by repetitive and patterned twisting movements and abnormal postures lasting seconds to hours.

1. Epilepsy is a central nervous system (neurological) disorder in which brain activity becomes abnormal, causing seizures or periods of unusual behavior, sensations, and sometimes loss of awareness.

1. Common to both cases – Sudden Uncontrollable Seizures

Problem Statement 2

- It is estimated that up to 50,000 deaths occur annually in the U.S. from status epilepticus (prolonged seizures).
- There is a need to have eyes on patients that experience these seizures constantly to prevent unintended suicides or injury to the patient which can be tiresome for a person.

Solution

A camera that monitors a patient with seizures either at night time or a bedridden patient anytime for sudden uncontrollable movement and then trigger an alarm as well as send a text message to specified recipients on the current condition.

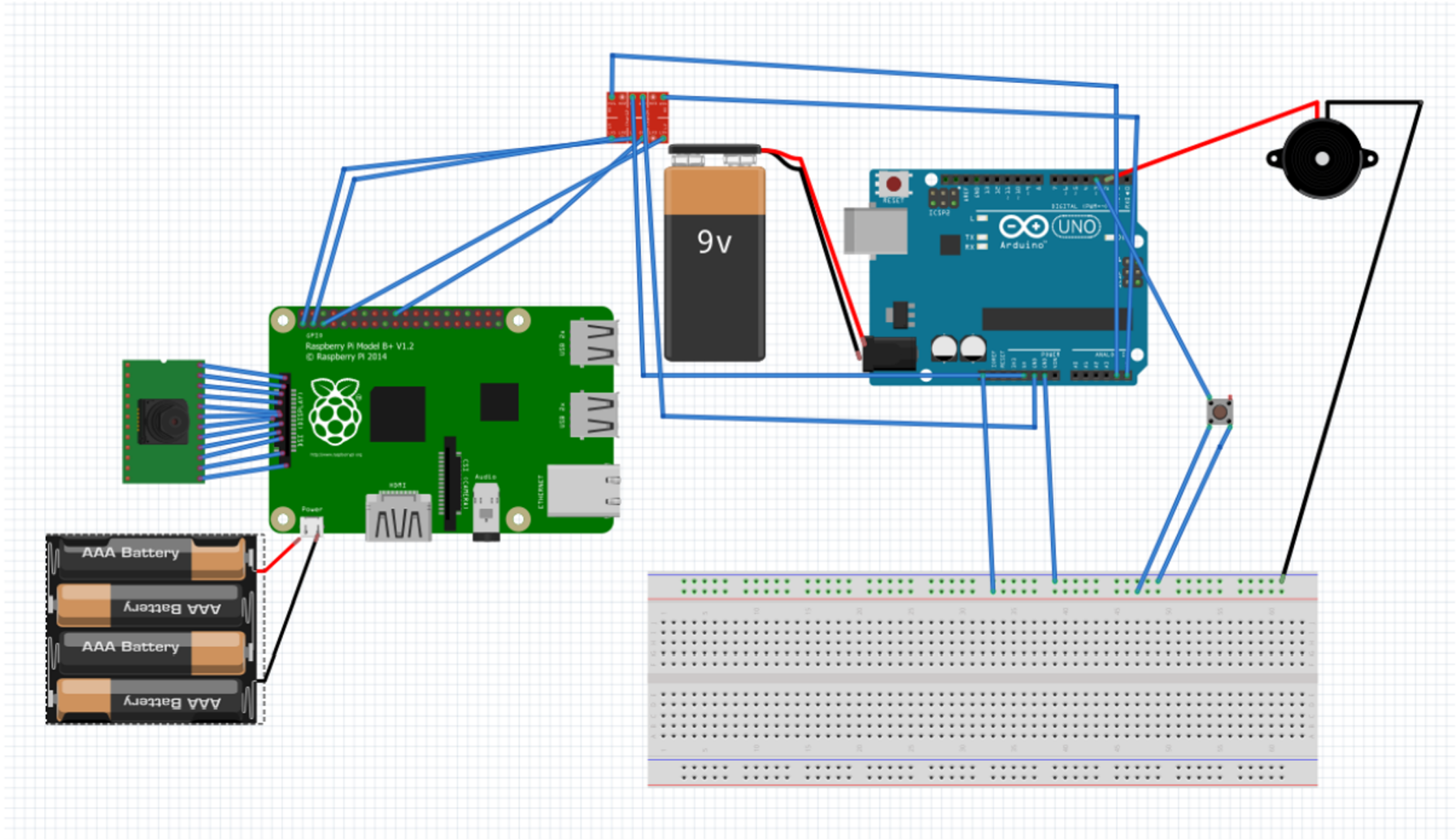
Working

The primary sensor for the surveillance system was the Raspberry Pi Camera. It is mounted on the Raspberry pi B+. It continuously takes images of the environment in its view, saves it temporarily in bitmap format and then compares it with the past image it took to see if a change occurred quickly. If the change exceeds the set threshold, it saves that image as a JPEG format in the directory specified in the code as well as start a 5 second video recording to show what was happening.

- The image taken is timestamped for record and investigatory purposes.
- Apart from taking pictures and videos, the program integrates Twilio REST APIs that allows a specified text message to be sent to specified recipients.

- The Raspberry pi communicates with the Arduino Uno using I2C Communication Protocol. The Raspberry Pi acts as the master while the Arduino Uno is the slave. A logic level converter is used to interface the Raspberry with the Arduino because Raspberry pi 3 B+ operates with maximum of 3.3v while the Arduino uno operates with maximum of 5v.
- Once the Pi camera detects changes in observed environment, the raspberry pi sends a high signal via the SDA line and start and stop bit to the logic level converter, the Arduino then receives the corresponding signal from the high voltage side of the logic level converter and turns on the buzzer. The buzzer turns off when the button is pressed.

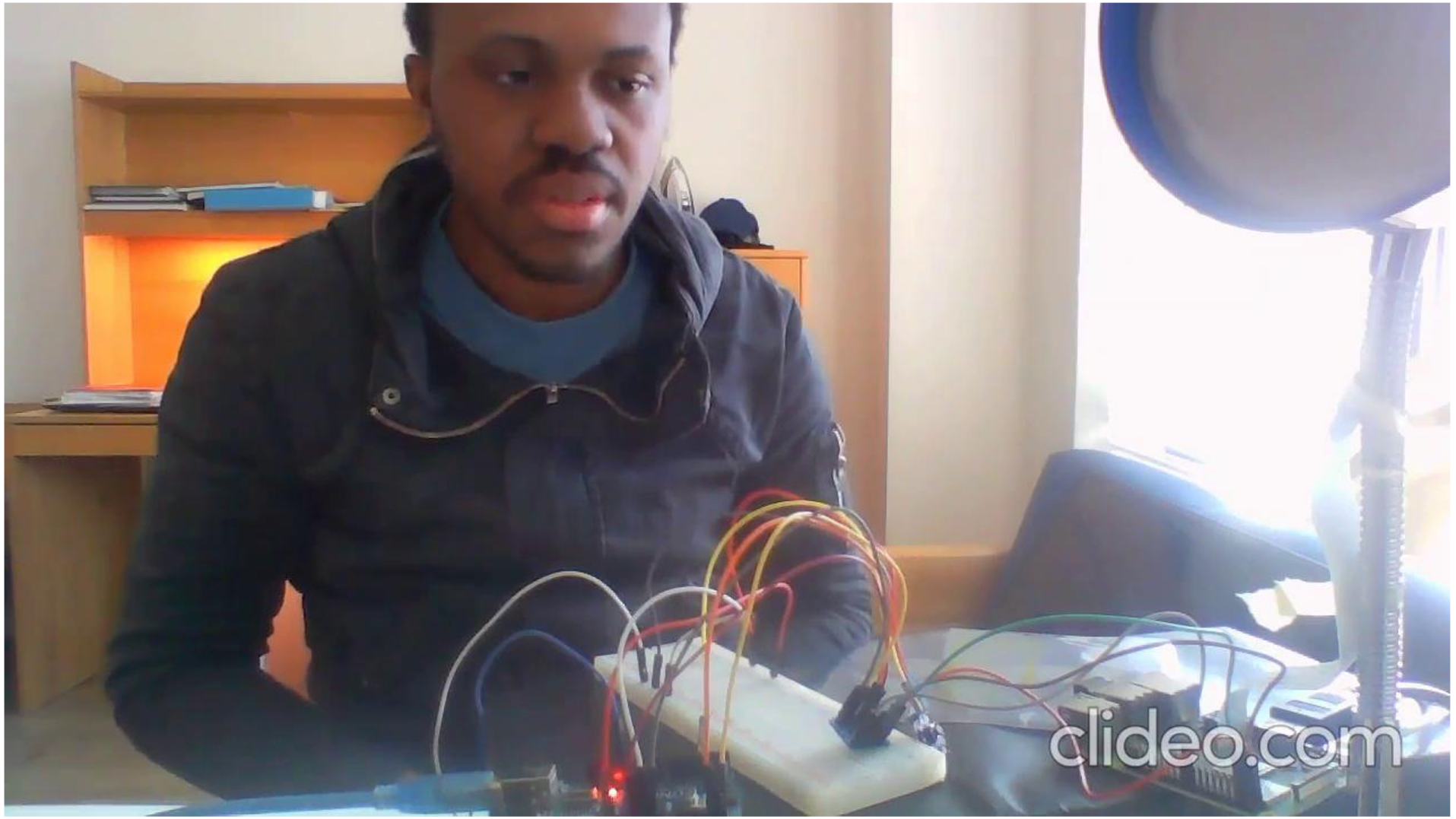
Circuit Diagram (Epilepsy)

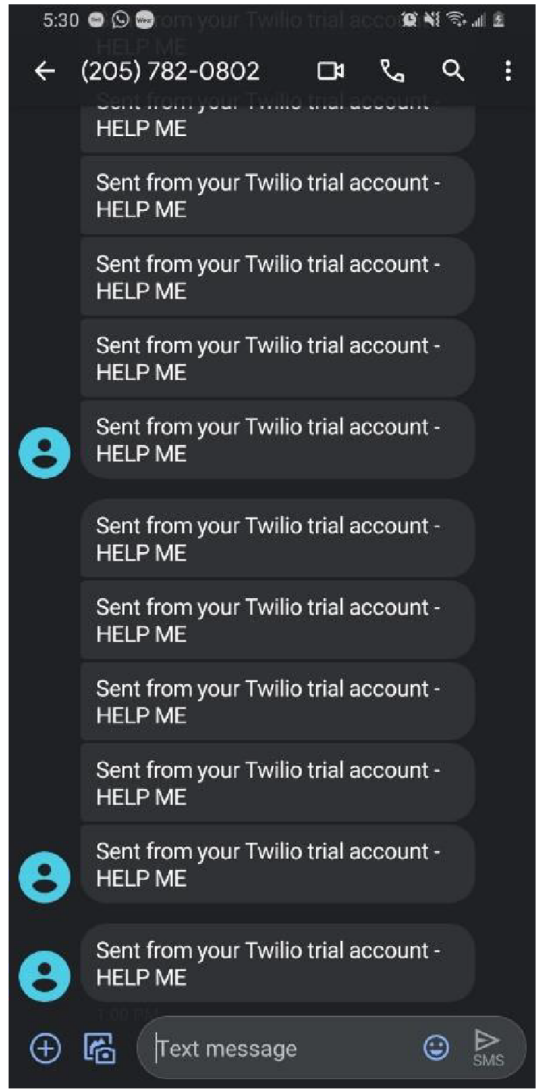


Bill of Material

S/N	ITEM	QUANTITY	TOTAL AMOUNT($)
1	Arduino Uno	1	50
2	Raspberry Pi 3 B+	1	39.38
3	Raspberry Pi Camera Module V2.1	1	29.90
4	5v Active Buzzer	1	1.82
5	Pushbutton	1	1.69
6	BSS138 Bidirectional Logic Level Converter	1	3.95
7	Cables	Lots	2.25
8	SD Card	1	11.62
9	Battery	1	1.90
	Total		142.51

Demonstration (Dystonia)





Future Developments

1. We can use Fast Fourier transform to differentiate between voluntary and involuntary muscle activity by taking the least mean square and extracting the mean wave.

2. Accommodation of more types of cervical dystonia such as Torticollis, Anterocollis and Retrocollis.

3. Some false alarms can be given and as such, an upgrade to this project is to use OpenCV to increase the effectiveness of the seizures and dystonic movements and reduce detecting of other non-dystonic or seizure attacks.

4. Another upgrade will be to send short videos of the monitored personnel via social media like WhatsApp to the specified recipients so they can have a better idea of the situation and respond appropriately.

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THANK YOU FOR YOUR TIME