Hot Wheels

Hacking Electronic Wheelchairs

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What this talk is about...

Why did we hack my power wheelchair?

About the target device: Sunrise Quickie powerchair

The R-net electronic control protocol

Survey of R-net modules

R-Net Profiles and Mode

R-Net protocol details and examples

Demo

About me

- Who am I?
  - What is my condition?
  - How does my condition affect me?
  - What is my motivation in hacking my chair?

Who am I?

I’m Stephen, a lover of technology. Here are some things about me.

- I like to be outdoors
- I love music and graphic designing
- I like to dance and party
- I am always learning
- MSU Denver I.T. security intern
- Security researcher
- Currently working with SpiderOak as a contractor, they're using my code in Semaphor. (libsodium-go,) and hopefully continuing on more projects with them.
- Central contributor and project leader on a few projects like libsodium-go, SuperHoneyPot, and Plzasm Twitter bot

This is my first skydive jump. It was pretty fun! @ 15,000 feet.

Zombie crawl @ Denver downtown

Hanging out with friends

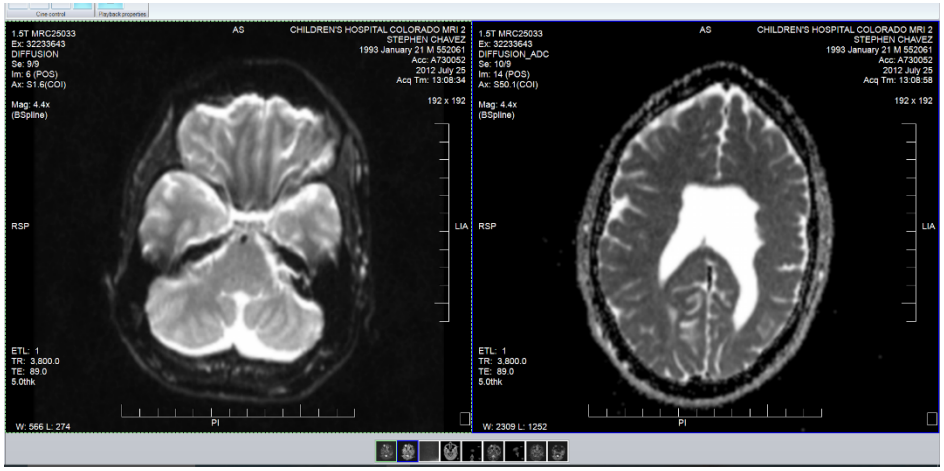
What's my condition?

Bilateral open cleft Schizencephaly is a rare brain condition. It can affect everything from physical motor skills, logic skills, speech skills, hearing, eyesight, muscle and spine cord communication.

Personal downsides:

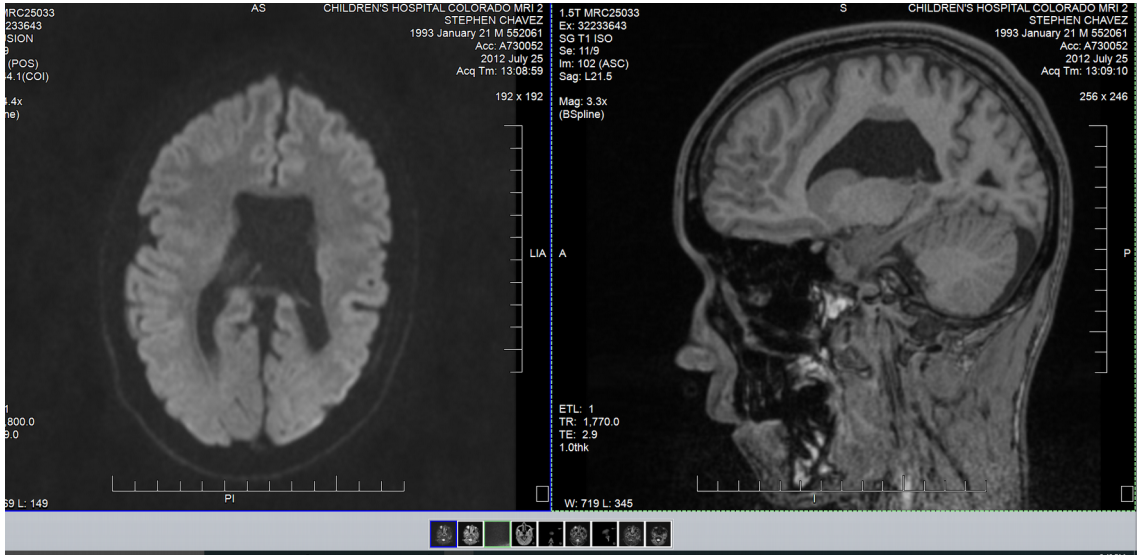
- I have to be physically active otherwise my body gets weaker
- I had to get a ton of surgeries as a kid
- I have to rely on others for personal care
- Stuck in a power wheelchair
- People make simple assumptions about me without digging any deeper.

MRI scans of my brain in 2012



Top side of my brain

Top side and side view



The white or dark areas of the scans show I'm missing pieces.

What is it like to have my condition?

Life is rough with Schizencephaly, nothing is never easy for me. This is a hard question to answer in a such short period of time. But I'll try my best to answer. It all started when I was young. I was already having issues moving my body when I was 2. Let alone be able to talk to people.

Problems of daily life:

- Social interaction is super important, but communication can be slow or tedious since I have to type everything.
- I've had to rely on support from others. Although I became mostly self-sufficient later in my life.
- Many people don't know how to approach me. Instead of asking, some use baby talk or just ignore me.

Dynavox Maestro

The super simple UI

These are the Dynavox devices I used during my elementary school years.

Downsides:

- Hard to type long paragraphs
- Good luck doing algebra on this
- Good luck finding shit you want to say
- Everything sucks on this device, not sorry to say this

The only good thing: It lets me talk for what it was worth back then

Dynawrite I used for Middle School

Traded Dynavox devices for laptops after middle school

Why I want to hack powerchairs

- I only have one arm I can use to either type or drive, not both.
- Some people find it annoying that I have to stop and type when they are in a hurry to get somewhere.
- Autonomous control could allow me to talk and drive simultaneously and be a better friend.
- I had studied embedded systems and viewed powerchairs in that light.
- If I could control the signals to the motors, I had a chance of achieving autonmous control.

Sunrise Quickie Rhythm M5

List Price: $7,795
+ $5,350 for a seat-tilt controller

Power: 24V.
Two 12V batteries, 74 Ah each.

Drivetrain:
Two 10amp motors with brakes

Modules:

Power Module:
90A max. output. 4 outputs.

Joy Stick Module:
LED bar graph display. 5 buttons