Camera Tracking on Moving Objects using Raspberry Pi

Camera Tracking

- Pan-Tilt-Mount (steuerbar)
- Nvidia Jetson Nano

- Automatic Target Tracking
- Autonomous Follow

https://developer.nvidia.com/embedded/jetson-nano-developer-kit

https://www.axibo.com/

https://edelkrone.com/products/headplus-v2

https://github.com/isaac879/Pan-Tilt-Mount
https://www.youtube.com/watch?v=1FfB7cLkUyQ

Baseline

- Follow https://github.com/isaac879/Pan-Tilt-Mount
  - Daniel Richter has most parts and willing to share with us
  - Pan-Tilt-Mount is controlled via Xbox controller
- Use a Raspberry Pi to calculate the movements of an Arduino-controlled camera slider
- Implement a simple tracking algorithm
- Limit to one axis

→ Improve appropriately (e.g. more axes, more advanced tracking algorithms)

3-Axis Slider Parts	Quantity
Nema 17 42 x 42 x 40mm Stepper Motor	1
Nema 17 42 x 42 x 23mm Stepper Motor	2
TMC2208 Stepper Motor Driver	3
Arduino Nano	1
JDY-31 Bluetooth Module (Alternatively HC-05, HC-06 or JDY-30)	1
A3144 Hall Effect Sensor	3
6.4mm diameter x 1.7mm Neodymium Magnets	2
3.2mm diameter x 1.7mm Neodymium Magnets	4
2N3904 NPN Transistor	1
330Ω Resistor	1
470Ω Resistor	1
15kΩ Resistor	1
22kΩ Resistor	1
33kΩ Resistor	2
100µF Electrolytic Capacitor	3
2 Pin Plug-In Screw Terminal Block Connector 5.08mm Pitch (for power)	1
6 Pin Female Header Connector 2.54mm (for Bluetooth module)	1
15 Pin Female Header Connector 2.54mm (for Arduino Nano)	2
15 Pin Male Header Connector 2.54mm (for Arduino Nano)	2
8 Pin Female Header Connector 2.54mm (for Stepper drivers)	6
8 Pin Male Header Connector 2.54mm (for Stepper drivers)	6
XH2.54 4 Pin Terminal Socket Header (for Stepper motors)	3
XH2.54 4 Pin Terminal Socket Plug (for Stepper motors)	3
XH2.54 3 Pin Terminal Socket Header (for Hall Effect)	3
XH2.54 3 Pin Terminal Socket Plug (for Hall Effect)	3
XH2.54 2 Pin Terminal Socket Header (for camera shutter trigger)	1
XH2.54 2 Pin Terminal Socket Plug (for camera shutter trigger)	1
2.5mm 3 pole Jack Male (for camera trigger)	1
11.1V 3S LiPo Battery or 12V DC Power Source and connector to screw terminal	1
Pan Tilt Mount PCB	1
Solder Wire	

Hardware “Wishlist” (More of an overview of what we use)

- Reminder: Most of these parts are already taken care of by Daniel Richter

This slide and the following 2 slides contain screenshots of https://github.com/isaac879/Pan-Tilt-Mount/blob/TMC2208-Drivers/3-Axis%20Slider%20Parts%20List.pdf

Cyanoacrylate or Hot Glue (for magnets and Hall Effect sensor)	
Wire (for Stepper motors, Hall sensors, Bluetooth module)	
M3 Hexagonal Nyloc Nut	16
M3 Square Nut	10
M3 Button Head Hex Bolt 40mm	4
M3 Button Head Hex Bolt 20mm	3
M3 Button Head Hex Bolt 16mm	10
M3 Button Head Hex Bolt 12mm	14
M3 Button Head Hex Bolt 8mm	5
M3 Button Head Hex Bolt 6mm	5
M3 Button Head Hex Bolt 3.5mm	1
Camera Mounting Bolt	1
M3 T-Nut for Aluminium Extrusion Profile	4

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Screw 2mm Outer Thread Diameter, 6mm Long	3
2GT Timing Belt	1
2GT Timing Pulley 36 Teeth	1
V-Slot 2040 Aluminium Extrusion	1
F623ZZ Flange Bushing Ball Bearings 3 x 10 x 4mm	6
V-Slot Pulley Wheels with Bearings (24 x 16 x 10.2mm)	4

Hardware “Wishlist” (More of an overview of what we use)

3D-Printable Parts

127 x 146.05 x 12.7mm INA CSXU050-2RS Bearing Or 3D printable bearing parts 1-3 and 28 x 6mm balls (BB pellets)	1
21 Tooth Herringbone Gear	1
64 Tooth Herringbone Gear	1
17 Tooth Herringbone Gear	1
144 Tooth Herringbone Gear Base Mount	1
Tilt U-Mount	1
Idle Side Bearing Mount	1
Gear Side Bearing Mount	1
Idle Side Support	1
Gear Side Support	1
Pan Mount	1
Pan Mount Bearing Clamp	1
Base Mount Bearing Clip Ring	1
2040 hall clamp	1
2040 slider carriage top	1
2040 slider carriage bottom	1
2040 belt clamp side 1	1
2040 belt clamp side 2	1
2040 support leg (Optional)	
Belt clamp lever	2
3mm to 5mm wheel bearing spacer centred	4
5mm to 8mm shaft spacer (for timing pulley if it has a 8mm bore)	1

Where to set focus?

Add new axes:
- Automatic zoom?

Add object detection
- Detect faces?
- Use ML-models (need GPU?)

Improve tracking speed
- Follow ping pong ball?

“although some shaking does occur when rapidly changing directions”
→ Smoothness of motor movements

Our Idea - Relation to EOS

- Hypothesis: All camera tracking solutions with Raspberry Pi are slow
  - because of often complex algorithms in combination with **limited resources**

  → improve effectiveness?

- **Real-time** behaviour
  - Analysis of camera feed and activation of motors should ideally be possible in real time for tracking a moving object
  - Probably not feasible in reality, but: Fast processing times needed

What do we want to do?

1. We want to implement the github solution for the camera slider which includes 3D-printing necessary parts.
2. We want to be able to make the Raspberry Pi steer the Arduino camera so that we can track a slow-moving object

Open Questions

- Streaming of camera data via cable possible?
  - FPS?
  - Else might need additional camera for rasPi
- Where to print filaments? Ask at HCI chair, else private/order online
- Will we have enough time to 3D-print all parts?
- If we focus on tracking, what kinds of trackable objects will we use? How do we ensure their speed/trackability?