

## Appendix B: Open-Source and Assembly Instructions

### B.1 Materials List

Below is a comprehensive list of all components required to replicate the pickleball throwing machine. All parts were selected based on affordability, availability, and DIY-friendliness. Suggested quantities and models are included. Links to product pages should be added by the user.

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#### Electronics & Control

- **1× Raspberry Pi 4 Model B (2GB or higher)**

*Used for system control and user interface*

[Link: <https://www.raspberrypi.com/products/raspberry-pi-4-model-b/> ]

- **1× Micro SD Card (16GB or higher)**

*Used to boot and store the Raspberry Pi OS and project files*

[Link:

<https://www.bestbuy.ca/en-ca/product/sandisk-ultra-32gb-100mb-s-micro-sd-card-sdsqun-s-032g/13695879?cmp=seo-13695879>]

- **1× Touchscreen Display (HDMI + USB input)**

*Used for real-time user control and configuration*

[Link: [https://www.amazon.ca/dp/B0CRRB1GFN?ref=ppx\\_yo2ov\\_dt\\_b\\_fed\\_asin\\_title](https://www.amazon.ca/dp/B0CRRB1GFN?ref=ppx_yo2ov_dt_b_fed_asin_title)]

- **1× LM2596S-5 Step-Down Voltage Regulator (12V to 5V)**

*Powers the Raspberry Pi from the main battery source*

[Link:

<https://www.amazon.ca/LM2596S-Power-Module-DC-DC-Step-Down/dp/B0CXXP7RH?crid=2VD8XN7JVPVN0&dib=eyJ2IjojMSJ9.UFIzjvmwvLvWx-HXS-RyCIhOW3U9>

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 s%2C176&sr=8-13]

- **1× PCA9685 16-Channel PWM Servo Driver**

*Controls both continuous rotation servos*

[Link:

[https://www.aliexpress.com/item/1005006298833960.html?spm=a2g0o.productlist.main.13.57e83220yxQy21&algo\\_pvid=b0b1d400-fcc1-4718-b1f4-7cf6c5178460&algo\\_exp\\_iid=b0b1d400-fcc1-4718-b1f4-7cf6c5178460-6&pdp\\_npi=4%40dis%21CAD%214.46%212.99%21%21%2122.20%2114.88%21%402101ea8c17371818965312061e904d%2112000037529842018%21sea%21CA%210%21ABX&curPageLogUid=4X131uRG9vee&utparam-url=scene%3Asearch%7Cquery\\_from%3A\]](https://www.aliexpress.com/item/1005006298833960.html?spm=a2g0o.productlist.main.13.57e83220yxQy21&algo_pvid=b0b1d400-fcc1-4718-b1f4-7cf6c5178460&algo_exp_iid=b0b1d400-fcc1-4718-b1f4-7cf6c5178460-6&pdp_npi=4%40dis%21CAD%214.46%212.99%21%21%2122.20%2114.88%21%402101ea8c17371818965312061e904d%2112000037529842018%21sea%21CA%210%21ABX&curPageLogUid=4X131uRG9vee&utparam-url=scene%3Asearch%7Cquery_from%3A])

- **1× 12V 9Ah Sealed Lead-Acid (SLA) Battery (Mighty Max ML9-12 or equivalent)**

*Main power source for motors and electronics*

[Link:

[https://www.homedepot.ca/product/mighty-max-battery-ml9-12-12-volt-9-ah-f2-terminal-rechargeable-sla-agm-battery/1001859228?rrec=true\]](https://www.homedepot.ca/product/mighty-max-battery-ml9-12-12-volt-9-ah-f2-terminal-rechargeable-sla-agm-battery/1001859228?rrec=true)

- **2× 775 DC Motors (12V, 0.32A, ~13000 RPM)**

*Used to drive the launching wheels*

[Link:

[https://www.amazon.ca/dp/B0C1CPVVTf?ref=cm\\_sw\\_r\\_cso\\_cp\\_ud\\_dp\\_HYVPRZGB73B8CR908N55&ref\\_=cm\\_sw\\_r\\_cso\\_cp\\_ud\\_dp\\_HYVPRZGB73B8CR908N55&social\\_share=cm\\_sw\\_r\\_cso\\_cp\\_ud\\_dp\\_HYVPRZGB73B8CR908N55&starsLeft=1&skipTwisterOG=1&newOGT=1](https://www.amazon.ca/dp/B0C1CPVVTf?ref=cm_sw_r_cso_cp_ud_dp_HYVPRZGB73B8CR908N55&ref_=cm_sw_r_cso_cp_ud_dp_HYVPRZGB73B8CR908N55&social_share=cm_sw_r_cso_cp_ud_dp_HYVPRZGB73B8CR908N55&starsLeft=1&skipTwisterOG=1&newOGT=1)]

- **2× Continuous Rotation Servo Motors (DS04-NFC or equivalent)**

*Used for the feeding and launch angle adjustment mechanisms*

[Link:

[https://www.aliexpress.com/item/1005008290985117.html?spm=a2g0o.productlist.main.3.5923HdSpHdSp3b&algo\\_pvid=0e7bc3db-2277-491c-8c55-27793aeeb744&algo\\_exp\\_id=0e7bc3db-2277-491c-8c55-27793aeeb744-1&pdp\\_npi=4%40dis%21CAD%217.99%217.99%21%21%215.42%215.42%21%402101d9ee17371786323311474e7289%2112000044500754039%21sea%21CA%210%21ABX&curPageLogUid=Bqh9kpQDENj1&utparam-url=scene%3Asearch%7Cquery\\_from%3A](https://www.aliexpress.com/item/1005008290985117.html?spm=a2g0o.productlist.main.3.5923HdSpHdSp3b&algo_pvid=0e7bc3db-2277-491c-8c55-27793aeeb744&algo_exp_id=0e7bc3db-2277-491c-8c55-27793aeeb744-1&pdp_npi=4%40dis%21CAD%217.99%217.99%21%21%215.42%215.42%21%402101d9ee17371786323311474e7289%2112000044500754039%21sea%21CA%210%21ABX&curPageLogUid=Bqh9kpQDENj1&utparam-url=scene%3Asearch%7Cquery_from%3A)]

- **2× Single-Channel H-Bridge Motor Driver Boards (LM2936 or equivalent)**

*Drives each DC motor independently*

[Link:

[https://www.amazon.ca/Channel-Controller-Semiconductor-Automotive-Electronics/dp/B07BKPV5Z7?crd=EKXHR5SV6N8Q&dib=eyJ2IjojMSJ9.a-FZLeci9YwgrJpoFtTQ-qEzYQ2aLGCJ9\\_U2yvxNa8SoCDoAjcaI-zIbqlwWgrH5y8OTU8AvsKLvVW\\_GsdB3bgsfxk32H2Dr0X9zgyRtxFBv\\_7gz1ujp0g9Oxrc6powGN8PKD1Foxmx64GSi5RPc15kkLk1nC2rB0-15ZKBRWZrggOzfyXsf44sjlTW8lW\\_ruAJzsHBNGyTfGhoCWlGiRGJsbRRjnonnd\\_I\\_gst6TK-PtAlmoOAyVeUgy72iNZ8jGLESIwvJhgZofWLVTq-59tQ.NiJSd1uO-fCInA9ndMZXKSzmSezdCYtIfWHHJfYA8nI&dib\\_tag=se&keywords=Cytron&qid=1737089191&srefix=cytron%2Caps%2C133&sr=8-9](https://www.amazon.ca/Channel-Controller-Semiconductor-Automotive-Electronics/dp/B07BKPV5Z7?crd=EKXHR5SV6N8Q&dib=eyJ2IjojMSJ9.a-FZLeci9YwgrJpoFtTQ-qEzYQ2aLGCJ9_U2yvxNa8SoCDoAjcaI-zIbqlwWgrH5y8OTU8AvsKLvVW_GsdB3bgsfxk32H2Dr0X9zgyRtxFBv_7gz1ujp0g9Oxrc6powGN8PKD1Foxmx64GSi5RPc15kkLk1nC2rB0-15ZKBRWZrggOzfyXsf44sjlTW8lW_ruAJzsHBNGyTfGhoCWlGiRGJsbRRjnonnd_I_gst6TK-PtAlmoOAyVeUgy72iNZ8jGLESIwvJhgZofWLVTq-59tQ.NiJSd1uO-fCInA9ndMZXKSzmSezdCYtIfWHHJfYA8nI&dib_tag=se&keywords=Cytron&qid=1737089191&srefix=cytron%2Caps%2C133&sr=8-9)]

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## Connectors & Wiring

- **1× Pi Prototype Board or Breadboard Kit**

*Optional, for initial testing or soldered connections*

[Link: <https://52pi.com/products/52pi-prototype-hat-breadboard-for-raspberry-pi>]

- **1× IEC Power Connector and Socket**

*Used for battery charging or external supply integration*

[Link:

<https://leeselectronic.com/en/product/21069-rocker-switch-w-iec-socket-fuse-holder-screw.html>]

- **Assorted Wires (Dupont jumper wires, 12-gauge power wire)**

*Used for general wiring and power distribution*

[Link:

[https://www.aliexpress.com/item/1005002599108827.html?spm=a2g0o.productlist.main.29.6cd4442fOfJs2L&algo\\_pvid=7416e11f-492b-4508-8fe5-995f7d9ca056&algo\\_exp\\_id=7416e11f-492b-4508-8fe5-995f7d9ca056-14&pdp\\_npi=4%40dis%21CAD%212.25%211.51%21%21%211.53%211.03%21%402101c72a17371787415886971e5288%2112000021331960075%21sea%21CA%210%21ABX&curPageLogUid=5epYVaPxuz0v&utm-url=scene%3Asearch%7Cquery\\_from%3A](https://www.aliexpress.com/item/1005002599108827.html?spm=a2g0o.productlist.main.29.6cd4442fOfJs2L&algo_pvid=7416e11f-492b-4508-8fe5-995f7d9ca056&algo_exp_id=7416e11f-492b-4508-8fe5-995f7d9ca056-14&pdp_npi=4%40dis%21CAD%212.25%211.51%21%21%211.53%211.03%21%402101c72a17371787415886971e5288%2112000021331960075%21sea%21CA%210%21ABX&curPageLogUid=5epYVaPxuz0v&utm-url=scene%3Asearch%7Cquery_from%3A)]

- **Wago Connectors / Spade Connectors / Crimp Connectors**

*Used for secure and modular electrical connections*

[Link:

<https://www.wago.com/us/wire-splicing-connectors/compact-splicing-connector/p/221-415>

[https://www.amazon.ca/Feggizuli-Connectors-Connector-Terminals-Electrical/dp/B0B4H54KPS?crd=3H2A3XX5N5M1E&dib=eyJ2IjojMSJ9.ivHa5yATJoa4CEkwPXB5FALWKgTgCfQnRaujhDWNDQc5qn-HM5Fr9hgvr7bkageySZu38Iziue\\_d0nq9DLgHuHB19T-Be8gywIw2eS5sJ1Q8a72hOOmC2kzdgzjcArJ0SYih3\\_Y2Lw5BNCO\\_sKfBXHAQIXH](https://www.amazon.ca/Feggizuli-Connectors-Connector-Terminals-Electrical/dp/B0B4H54KPS?crd=3H2A3XX5N5M1E&dib=eyJ2IjojMSJ9.ivHa5yATJoa4CEkwPXB5FALWKgTgCfQnRaujhDWNDQc5qn-HM5Fr9hgvr7bkageySZu38Iziue_d0nq9DLgHuHB19T-Be8gywIw2eS5sJ1Q8a72hOOmC2kzdgzjcArJ0SYih3_Y2Lw5BNCO_sKfBXHAQIXH)

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## Mechanical Components

- **Ball Bearings**

*Used in rotating or tensioned mechanisms (e.g., launcher wheel support)*

[Link:

[https://www.amazon.ca/uxcell-4-inchx3-8-inchx1-Shielded-Bearings/dp/B0828JXX4N?crid=7ZFCNQXDD2BK&dib=eyJ2IjojMSJ9.u9-VjEG6CGLu3w76i3X1E937T3JiKajmgdCoX9Nx354c1HQNrqY-S9EkHEYFnGa9zi\\_an0Llk\\_tzX23aeIJnTTzsnQBpYO\\_2FZqleKf\\_yLXPfUVd-g3GPdpPDz\\_j7V1SXY\\_GKXM7OKjqMS5l\\_Gt-O5nw9mRiyeJNmDBsJA0odIiIrxA23jwhvvUkC6XhbRQbEkHLWW4aVSqbcJ-1Y5R0fIdq7NMTvEclMCSJSDTkXp-NO7ihhKi7ocJxLhDykAkWBju8sXgKtQieVuz6eOibPwWEZuAdzsJlqHSZOhs8nxDZWpW3O\\_nTudCbqRS32JfDAZ3VgffWXDLzzN9frLyilUbHw7j3oU07YROJ6zkaQrvMHsMKraH73GqhuZsKnmoGvA1HQ0HNL\\_d-VbIYoonpJrk5fKrcpjC6f-PYqBdqU2l26MgidUoKc\\_FDIrM0csy.SX76jApIdP0uKtFNR7KGz4l17OHpeIGds-Eaol1bF00&dib\\_tag=se&keywords=r168+bearings&qid=1738465099&sprefix=r168+bearings%2Caps%2C156&sr=8-5\]](https://www.amazon.ca/uxcell-4-inchx3-8-inchx1-Shielded-Bearings/dp/B0828JXX4N?crid=7ZFCNQXDD2BK&dib=eyJ2IjojMSJ9.u9-VjEG6CGLu3w76i3X1E937T3JiKajmgdCoX9Nx354c1HQNrqY-S9EkHEYFnGa9zi_an0Llk_tzX23aeIJnTTzsnQBpYO_2FZqleKf_yLXPfUVd-g3GPdpPDz_j7V1SXY_GKXM7OKjqMS5l_Gt-O5nw9mRiyeJNmDBsJA0odIiIrxA23jwhvvUkC6XhbRQbEkHLWW4aVSqbcJ-1Y5R0fIdq7NMTvEclMCSJSDTkXp-NO7ihhKi7ocJxLhDykAkWBju8sXgKtQieVuz6eOibPwWEZuAdzsJlqHSZOhs8nxDZWpW3O_nTudCbqRS32JfDAZ3VgffWXDLzzN9frLyilUbHw7j3oU07YROJ6zkaQrvMHsMKraH73GqhuZsKnmoGvA1HQ0HNL_d-VbIYoonpJrk5fKrcpjC6f-PYqBdqU2l26MgidUoKc_FDIrM0csy.SX76jApIdP0uKtFNR7KGz4l17OHpeIGds-Eaol1bF00&dib_tag=se&keywords=r168+bearings&qid=1738465099&sprefix=r168+bearings%2Caps%2C156&sr=8-5)

- **M4 Hardware (Nuts, Bolts, Washers, Axle Bolts)**

*Used for mounting and assembly of 3D printed and mechanical components*

[Link:

[https://www.amazon.ca/uxcell-4-inchx3-8-inchx1-Shielded-Bearings/dp/B0828JXX4N?crid=7ZFCNQXDD2BK&dib=eyJ2IjoiMSJ9.u9-VjEG6CGLu3w76i3X1E937T3JiKajmgdCoX9Nx354c1HQNrqY-S9EkHEYFnGa9zi\\_an0LIk\\_tzX23aeIJnTTzsnQBpYO\\_2FZqleKf\\_yLXPFUVd-g3GPdpPDz\\_j7V1SXY\\_GKXM7OKjqMS5l\\_Gt-O5nw9mRiyeJNmDBsJA0odliIrXa23jwhvvUkC6XhbRQbEkHLWW4aVSqbcJ-1Y5R0fIdq7NMTvEcIMCSJSDTkXp-NO7ihhKi7ocJxLhDykAkWBJu8sXgKtQieVuz6eOibPwWEZuAdzsjlqHSZOhs8nxDZWPw3O\\_nTudCbqRS32JfDAZ3VgffWXDLzzN9frLy1UbHw7j3oU07YROJ6zkaQrvMHsMKraH73GqhuZsKnmoGvA1HQ0HNL\\_d-VbIYoonpJrk5fKrcpjC6f-PYqBdqU2l26MgjidUoKc\\_FDIrM0csy.SX76jApIdP0uKtFNR7KGz4l17OHpeIGds-Eaol1bF00&dib\\_tag=se&keywords=r168+bearings&qid=1738465099&srefix=r168+bearings%2Caps%2C156&sr=8-5\]](https://www.amazon.ca/uxcell-4-inchx3-8-inchx1-Shielded-Bearings/dp/B0828JXX4N?crid=7ZFCNQXDD2BK&dib=eyJ2IjoiMSJ9.u9-VjEG6CGLu3w76i3X1E937T3JiKajmgdCoX9Nx354c1HQNrqY-S9EkHEYFnGa9zi_an0LIk_tzX23aeIJnTTzsnQBpYO_2FZqleKf_yLXPFUVd-g3GPdpPDz_j7V1SXY_GKXM7OKjqMS5l_Gt-O5nw9mRiyeJNmDBsJA0odliIrXa23jwhvvUkC6XhbRQbEkHLWW4aVSqbcJ-1Y5R0fIdq7NMTvEcIMCSJSDTkXp-NO7ihhKi7ocJxLhDykAkWBJu8sXgKtQieVuz6eOibPwWEZuAdzsjlqHSZOhs8nxDZWPw3O_nTudCbqRS32JfDAZ3VgffWXDLzzN9frLy1UbHw7j3oU07YROJ6zkaQrvMHsMKraH73GqhuZsKnmoGvA1HQ0HNL_d-VbIYoonpJrk5fKrcpjC6f-PYqBdqU2l26MgjidUoKc_FDIrM0csy.SX76jApIdP0uKtFNR7KGz4l17OHpeIGds-Eaol1bF00&dib_tag=se&keywords=r168+bearings&qid=1738465099&srefix=r168+bearings%2Caps%2C156&sr=8-5)

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### 3D Printing Materials

- **ASA Filament**

*Used for UV-resistant structural parts (e.g., housing, brackets, gear mounts)*

[Link:

[https://www.amazon.ca/OVERTURE-Filament-Printing-Functional-Dimensional/dp/B0CPXJ5RT5?crid=E2JDJPLKBR0C&dib=eyJ2IjoiMSJ9.xJulXuIEbM2F02c1LJAvKlfa6V1\\_4VZNK\\_UzzFqrW\\_-34ItwYM9gf9mm6o6yIYICawFFwRaR0W1cnYmVRaiAbv7wmh7q1xcrEmr6fnA4pwSFVDQkOL2eOFqFlaceMjqdb\\_VPUV944GH1zu2jvgDpDHhVGJknYhMUHoh42gcPcDPtNrK8LWNEGwSeBvwujehLXBeuuolZaAaOHktBm6yJQtjcNTSoic8xHXADM2VMjD\\_qMwBSrLBBi7zRUsgRB-Tz6GOYY41B9lzSnhXQRBD3hfNbm04QpjYdYghtJ9GUcDclWFzBKRjnOenCm96hHoBPCW8JczFjgbiZQzmIzm3-wgDIRonozKl2Jz4l\\_1L1LeDvdSP9dXaxpA5lgmM5mpZWMabjfJh5DLj\\_j8nRhidufNIL1fjajimSIIMT5cLNcJs--xILtluNxDWstNrf0uH5T.2du9scbxx5CsAZkDjtP-O\\_YdQ9Zhw9\\_OqF902w9sM5c&dib\\_tag=se&keywords=asa+filament&qid=1742841067&srefix=ASA+%2Caps%2C149&sr=8-5\]](https://www.amazon.ca/OVERTURE-Filament-Printing-Functional-Dimensional/dp/B0CPXJ5RT5?crid=E2JDJPLKBR0C&dib=eyJ2IjoiMSJ9.xJulXuIEbM2F02c1LJAvKlfa6V1_4VZNK_UzzFqrW_-34ItwYM9gf9mm6o6yIYICawFFwRaR0W1cnYmVRaiAbv7wmh7q1xcrEmr6fnA4pwSFVDQkOL2eOFqFlaceMjqdb_VPUV944GH1zu2jvgDpDHhVGJknYhMUHoh42gcPcDPtNrK8LWNEGwSeBvwujehLXBeuuolZaAaOHktBm6yJQtjcNTSoic8xHXADM2VMjD_qMwBSrLBBi7zRUsgRB-Tz6GOYY41B9lzSnhXQRBD3hfNbm04QpjYdYghtJ9GUcDclWFzBKRjnOenCm96hHoBPCW8JczFjgbiZQzmIzm3-wgDIRonozKl2Jz4l_1L1LeDvdSP9dXaxpA5lgmM5mpZWMabjfJh5DLj_j8nRhidufNIL1fjajimSIIMT5cLNcJs--xILtluNxDWstNrf0uH5T.2du9scbxx5CsAZkDjtP-O_YdQ9Zhw9_OqF902w9sM5c&dib_tag=se&keywords=asa+filament&qid=1742841067&srefix=ASA+%2Caps%2C149&sr=8-5)

- **TPU Filament**

*Used for the launcher wheels for improved grip and durability*

[Link:

[https://www.amazon.ca/Overture-Filament-Flexible-Consumables-Dimensional/dp/B0841CKM6F?crid=2Q87KOXO3J4XL&dib=eyJ2IjojMSJ9.ke-JVX3HIVjUlaaE2bNAk7T0boxmK2iNYP8JNsIndQ2wD94oYNpLedH\\_ISL7Ij14GXlizqGA2scVnSPfLKVziWnds5fkHvf0JEu7HP7U2q5govOFFEiop0jMCJF7f5X0Vb3NjRivQOP9Z6Z5bPU2YcbK7JQZmHZmbNwMq\\_mOobjK48ZvcvwtWD6ROXQ-zXxAtpW0fYZYjGwAcfO5hKnFCKZBSOi2-kDT7fdJsfFm0CiepwvwyTkA7qpKPfOFI6m9vUVBJcTGlsLISVCLdDRup9SCTIpI8932ixUVRU-bW\\_Q.qmH6Ia461wtSs05FTvUrReXaVvYWkNlcH1Hd2mCed98&dib\\_tag=se&keywords=tpu+filament&qid=1742841080&sprefix=tpu+filament%2Caps%2C177&sr=8-5\]](https://www.amazon.ca/Overture-Filament-Flexible-Consumables-Dimensional/dp/B0841CKM6F?crid=2Q87KOXO3J4XL&dib=eyJ2IjojMSJ9.ke-JVX3HIVjUlaaE2bNAk7T0boxmK2iNYP8JNsIndQ2wD94oYNpLedH_ISL7Ij14GXlizqGA2scVnSPfLKVziWnds5fkHvf0JEu7HP7U2q5govOFFEiop0jMCJF7f5X0Vb3NjRivQOP9Z6Z5bPU2YcbK7JQZmHZmbNwMq_mOobjK48ZvcvwtWD6ROXQ-zXxAtpW0fYZYjGwAcfO5hKnFCKZBSOi2-kDT7fdJsfFm0CiepwvwyTkA7qpKPfOFI6m9vUVBJcTGlsLISVCLdDRup9SCTIpI8932ixUVRU-bW_Q.qmH6Ia461wtSs05FTvUrReXaVvYWkNlcH1Hd2mCed98&dib_tag=se&keywords=tpu+filament&qid=1742841080&sprefix=tpu+filament%2Caps%2C177&sr=8-5)

## Frame Materials

- **2× 8-ft Wooden Boards**

*Used for the base and support structure*

[Link:

[https://www.homedepot.com/p/2-in-x-3-in-x-8-ft-2-Select-Grade-Dimensional-Lumber-845000/100038668\]](https://www.homedepot.com/p/2-in-x-3-in-x-8-ft-2-Select-Grade-Dimensional-Lumber-845000/100038668)

- **Wood Screws (1” and 3”)**

*General assembly of frame and component mounting*

[Link:

[https://www.homedepot.ca/product/kreg-tool-company--8-1-1-4-inch-square-maxi-loc-head-coarse-zinc-plated-steel-pocket-hole-screw-100-pack-/1000711142\]](https://www.homedepot.ca/product/kreg-tool-company--8-1-1-4-inch-square-maxi-loc-head-coarse-zinc-plated-steel-pocket-hole-screw-100-pack-/1000711142)

- **Hinges, Bucket, and Additional Support Brackets (as required)**

*Used for ball loading and launch positioning mechanisms*

[Link:

<https://www.homedepot.ca/product/the-home-depot-19l-orange-home-depot-logo-plastic-paint-bucket/1000143871>

<https://www.homedepot.ca/product/richelieu--2-pack-non-mortise-bifold-inset-hinge-for-framed-cabinet-matte-black/1001066169>]



## B.2 Electrical Connections

This section provides an overview of the electrical wiring required to operate the pickleball throwing machine. The system is powered by a **12V sealed lead-acid battery**, stepped down via a voltage regulator to supply safe and consistent power to the **Raspberry Pi 4B**, **motors**, and **servo controller**.

A complete circuit schematic is provided below for reference, along with supporting images of the prototype wiring.

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### B.2.1 System Overview

- **Power Source:**

A 12V 9Ah SLA battery powers the entire system. The Raspberry Pi is powered via a LM2596 step-down converter that outputs 5V.

- **Motor Drivers:**

Two DC motors are controlled using single-channel H-bridge drivers (LM2936). Each motor is wired to a separate GPIO pair on the Raspberry Pi for directional control.

- **Servo Controller:**

A PCA9685 PWM driver board is connected via I2C to control two continuous rotation servo motors (for feeding and launch angle adjustment).

- **Display Power:**

The touchscreen display connects via micro HDMI and USB, and is powered via the Raspberry Pi. (In earlier iterations, powering the display directly caused instability, which was resolved by powering the Pi through the LM2596 converter.)

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## B.2.2 Circuit Schematic

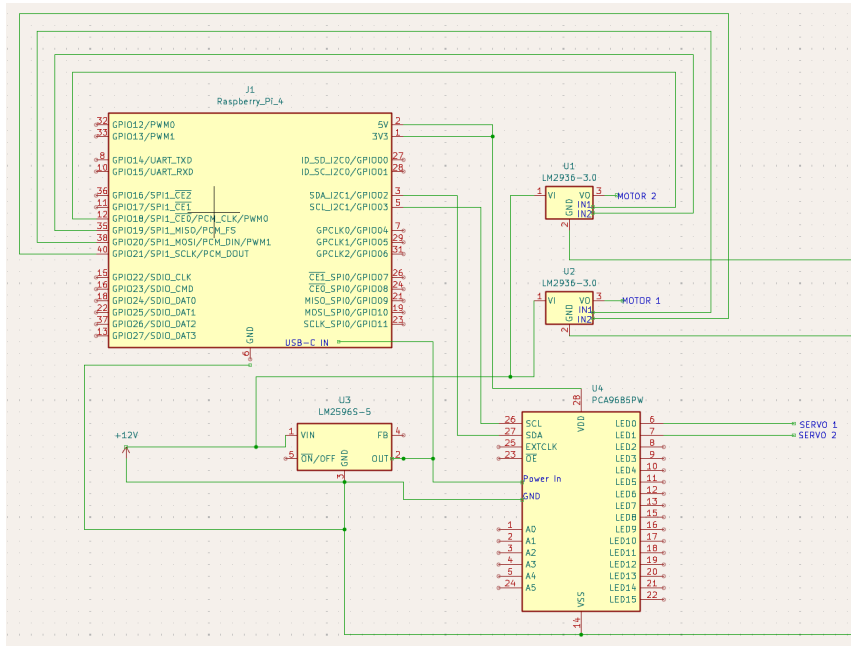
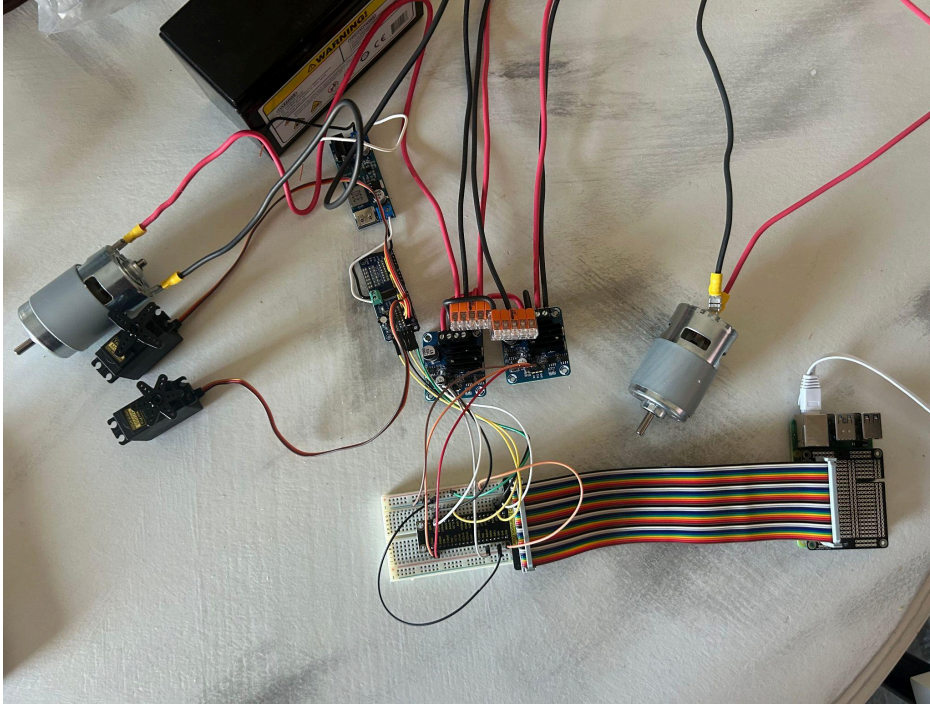


Figure B.1 – Full Circuit Schematic for Pickleball Throwing Machine

## B.2.3 Wiring Images



*Figure B.2 – Assembled Wiring Example*



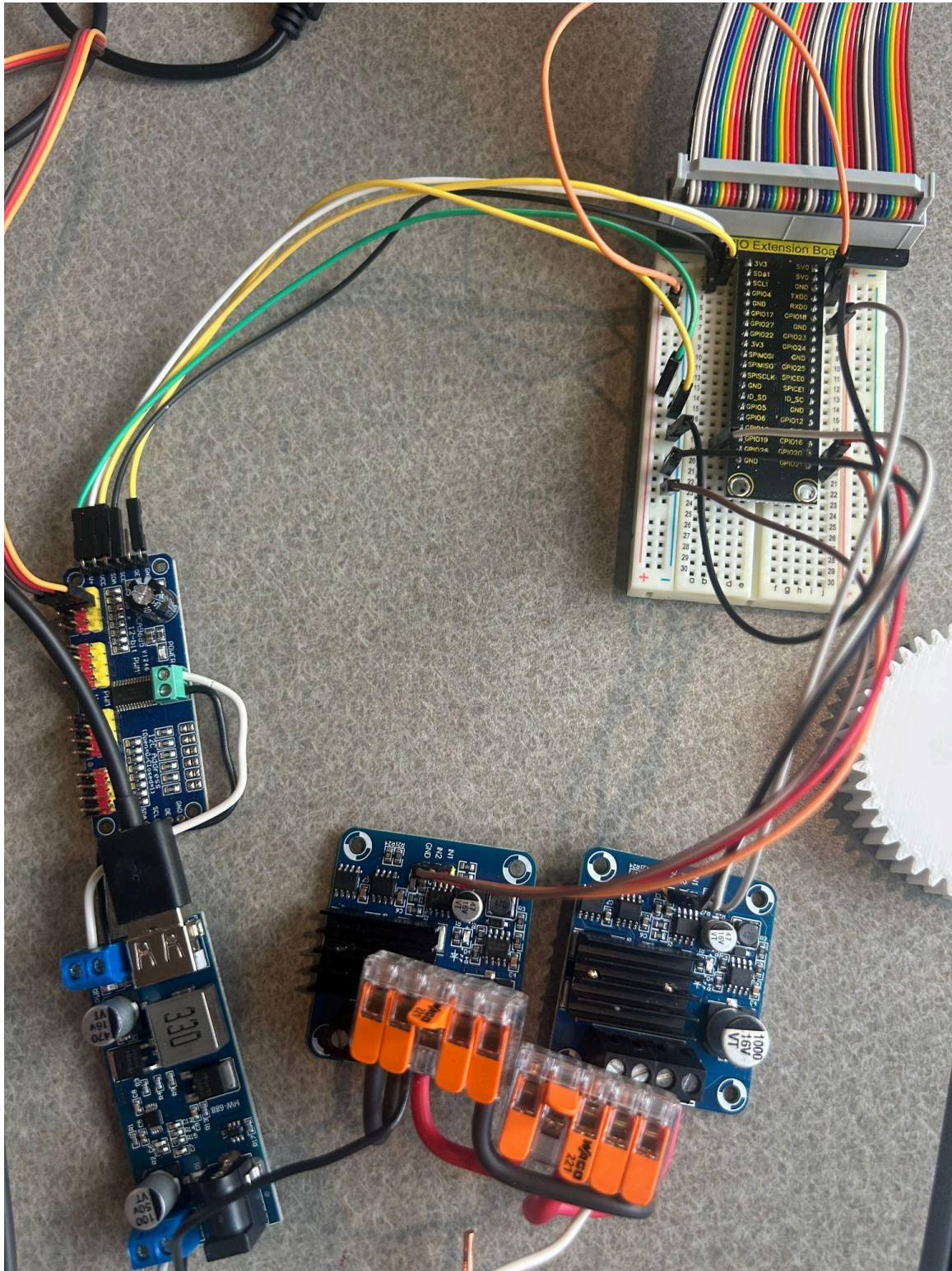


Figure B.3 – Close-up of Motor Driver Wiring and Power Distribution

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### B.2.4 GPIO and I2C Pin Mapping (Raspberry Pi)

Function	Raspberry Pi Pin	Connection
Servo I2C – SDA	GPIO 2 (Pin 3)	PCA9685 SDA
Servo I2C – SCL	GPIO 3 (Pin 5)	PCA9685 SCL
Motor 1 IN1 / IN2	GPIO 18 / GPIO 19	LM2936 (Motor 1)
Motor 2 IN1 / IN2	GPIO 20 / GPIO 21	LM2936 (Motor 2)
Power Output	5V / GND	Servo Driver, Display, Pi
USB-C Power Input	–	From LM2596 5V Output

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### B.2.5 Notes and Tips

- **Power Sequencing:** Always connect the battery last, after confirming all wiring.
- **Wire Gauge:** Use at least **12 AWG** for battery-to-motor and regulator connections.
- **Test Step-by-Step:** First confirm power to Pi and screen, then test motors/servos individually using sample scripts.
- **Optional:** Use inline fuses or Wago-style connectors to improve electrical safety and modularity.