

# Artifact: μTouch: Enabling Accurate, Lightweight Self-Touch Sensing with Passive Magnets

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## Quick Links

Code repo	<a href="https://github.com/Wangmerlyn/muTouch">github.com/Wangmerlyn/muTouch</a>
MagX base	<a href="https://github.com/dychen24/magx">github.com/dychen24/magx</a>
Models	Release tag <a href="https://github.com/Wangmerlyn/muTouch/releases">backup/3_dim-models-20260121</a> on GitHub Releases (Assets)
PCB sources	pcb/ (muTouch Altium project; legacy Magway.* filenames)

## I. Scope

This guide describes the artifact supporting μTouch: Enabling Accurate, Lightweight Self-Touch Sensing with Passive Magnets [1]: hardware (μTouch PCB + magnets) and software (BLE data collection, semi-supervised classifier). It targets reviewers who want to install, run, and validate the pipeline. Component specs and how they are verified: hardware specs and outputs in `pcb/README.md` (used in Section V); firmware/data-collection specs and expected signals in `Codes/read_raw_ble/README.md` (used in Sections V–VI); project overview and folder purposes (including `artifact/`) in `README.md`.

## II. Notation

Paths are relative to the repo root unless stated; runtime scripts assume `Codes/` as the working directory.

## III. Bill of Materials & Requirements

### A. Hardware (minimal)

- μTouch PCB (Altium project in `pcb/`; assembled board; filenames use legacy Magway.\*). PCB design by Xiaomeng Chen.
- 1–2 passive N52 grade magnets (6–8 mm recommended).
- Host laptop: Ubuntu 20.04+ or macOS 12+, 4-core CPU, ≥8 GB RAM, BLE 4.0+ adapter.
- Optional: BLE USB dongle (if desktop lacks BLE).

### B. Software

- Python 3.10; Conda virtual env named `muTouch` recommended.
- Git with submodules; CMake/Make only if you rebuild the C++ solver.

- Dependencies installed via `pip install -r Codes/requirements.txt`.
- LaTeX/PDF tools only needed to rebuild this document.

## IV. Obtaining the Artifact

- 1) Clone the repository (now public):

```
git clone --recurse-submodules \
git@github.com:Wangmerlyn/muTouch.git
# HTTPS fallback:
# git clone --recurse-submodules \
# https://github.com/Wangmerlyn/muTouch.git
```

If you hit SSH “permission denied”, use the HTTPS command above or ensure your SSH key is added to GitHub.

- 2) Activate env:

```
conda create -n muTouch python=3.10
conda activate muTouch
```

You should see the shell prompt prefixed with (`muTouch`) after activation; this isolates dependencies for repeatability.

- 3) Install deps:

```
pip install -r Codes/requirements.txt
```

Expect a clean install without errors; rerun from the repo root if paths are not found.

- 4) Models: snapshot tag `backup/3_dim-models-20260121`. Download binaries from GitHub Releases (Assets).
- 5) Set working directory for runtime scripts to `Codes/`:

```
cd Codes
```

## V. Setup & Configuration

- 1) Flash firmware:

`Codes/Arduino/bleReadMultiple/bleReadMultiple.ino` in Arduino IDE;  
select Feather nRF52; upload.

- 2) Find BLE address: `python read_raw_ble/find_device.py` (copy device MAC/UUID).

- 3) Hardcode BLE address: edit the address = “...” line near the bottom of `read_raw_ble/read_sensor.py`, `read_raw_ble/read_sensor_real.py`, and (if used) `read_raw_ble/read_sensor_real_classifier.py`.
- 4) Calibration capture (run inside Codes/):

```
python read_raw_ble/read_sensor.py
```

Do a brief figure-8 motion away from metal surfaces; CSVs are saved under datasets/.

- 5) Offsets/scales: place the latest files named `offset-*.npy` and `scale-*.npy` in `calibration_files/`. The scripts automatically load the newest files with those prefixes.
- 6) Models: ensure `read_raw_ble/models/` holds the downloaded checkpoint set if you need pretrained classifiers.

## VI. Running the Artifact

### A. Data capture

Captures raw magnetometer streams over BLE with the latest calibration, writing timestamped CSVs under datasets/.

```
python read_raw_ble/read_sensor_real.py
```

### B. Real-time classification

Runs the live classifier; expect gesture labels printed to console and logged in datasets/.

```
python read_raw_ble/read_sensor_real_classifier.py
```

Ensure the script uses the latest `offset-*`, `scale-*`, and model files (picked automatically if they sit in `calibration_files/` and `read_raw_ble/models/`).

### C. Expected outcomes

- Face-touching: ≈93% accuracy (8 gestures) with 3 s fine-tuning/user.
- Scratch detection: ≈95% accuracy (9 gestures) with 3 s fine-tuning/user.
- Real-time loop maintains >30 Hz inference on a laptop CPU.

## VII. Reproducibility Checklist

- Hardware reproducible: PCB sources + BOM (muTouch; files named Magway.\* for compatibility) included.
- Software reproducible: All scripts + TS2Vec submodule; pinned deps in Codes/requirements.txt.
- Data: Calibration and small demo runs can be generated locally; full datasets are participant-specific and not included.
- Pretrained models: Provided via GitHub tag `backup/3_dim-models-20260121`.

## VIII. Troubleshooting

- BLE not found: retry `find_device.py`; check power and pairing blocks; use BLE dongle.
- Drifting predictions: recalibrate sensors; ensure distance from large metal; re-run offset/scale.
- Import errors: confirm submodule init (git submodule update --init --recursive) and Python path from repo root.

## IX. For Complete Instructions

Due to page limits, this PDF is a concise checklist. For full, continuously updated steps and tips, please refer to the repository README.md and the Markdown guide (best viewed via GitHub preview): artifact/README.md. Use those as the authoritative references for reproduction and further code tweaks.

## X. Notes on Prior Work

The project builds on MagX (MobiCom’21) codebase for magnetic sensing [2]. This artifact extends it to self-touch sensing and includes updated PCB by Xiaomeng Chen.

## References

- [1] S. Wang, K. Li, J. Huang, J. Wang, C. Zhang, A. Sample, and D. Chen, “ptouch: Enabling accurate, lightweight self-touch sensing with passive magnets,” in Proceedings of the IEEE International Conference on Pervasive Computing and Communications (PerCom), Pisa, Italy, Mar. 2026, to appear.
- [2] D. Chen, M. Wang, C. He, Q. Luo, Y. Iravantchi, A. Sample, K. G. Shin, and X. Wang, “Magx: Wearable, untethered hands tracking with passive magnets,” in Proceedings of the 27th Annual International Conference on Mobile Computing and Networking (MobiCom ’21), 2021, pp. 269–282.