

# The Foottroller Technology

All you need to know

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# Foottroller fundamentals

Foottroller is a control system for feet

Basic control elements used by Foottroller are:

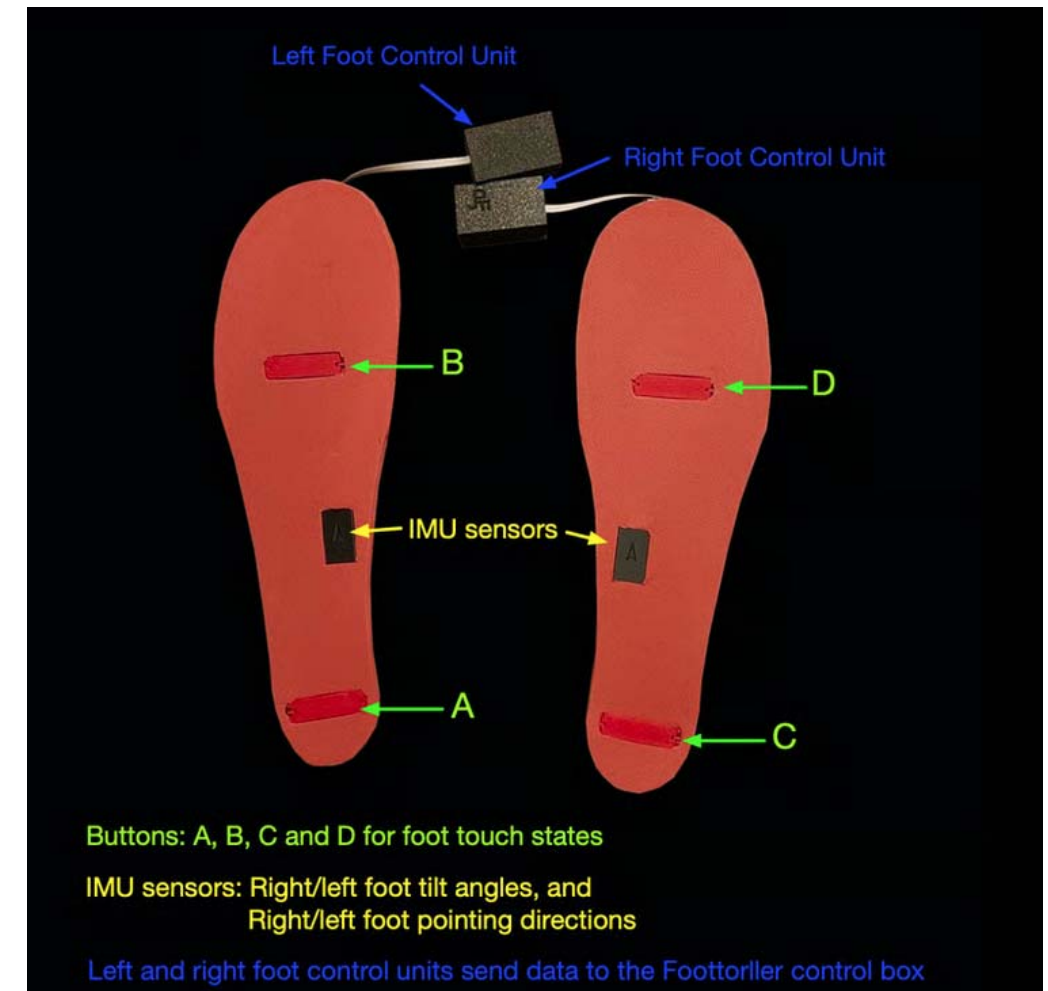
- Foot touch states – collected by four buttons A, B, C and D (digital inputs)
- Two foot tilt angles – from IMU sensors
  - Tilt\_RF and Tilt\_LF (analog inputs)
- Two foot pointing directions – for IMU sensors
  - Dir\_RF and Dir\_LF (analog inputs)

All Foottroller controls are generated using the basic control elements, e.g., by detecting a specific combination of the basic control elements, i.e., a foot gesture.

In Foottroller Dev. operation mode the basic control elements are sent to devices as button 1, 2, 3, 4, and axes Z, Rx, Ry, Rz of the gamepad, and can be accessed by programs for customized control experiences.

Axes X and Y of the gamepad are reserved for locomotion controls.

Foottroller connects to devices as a generic Bluetooth gamepad with four buttons and 6 axes.



# Foottroller Locomotion Control

Foottroller locomotion control is a control process consisting of **three states**.

$S_0$ : stationary state. No movement control in any direction is generated in  $S_0$ .

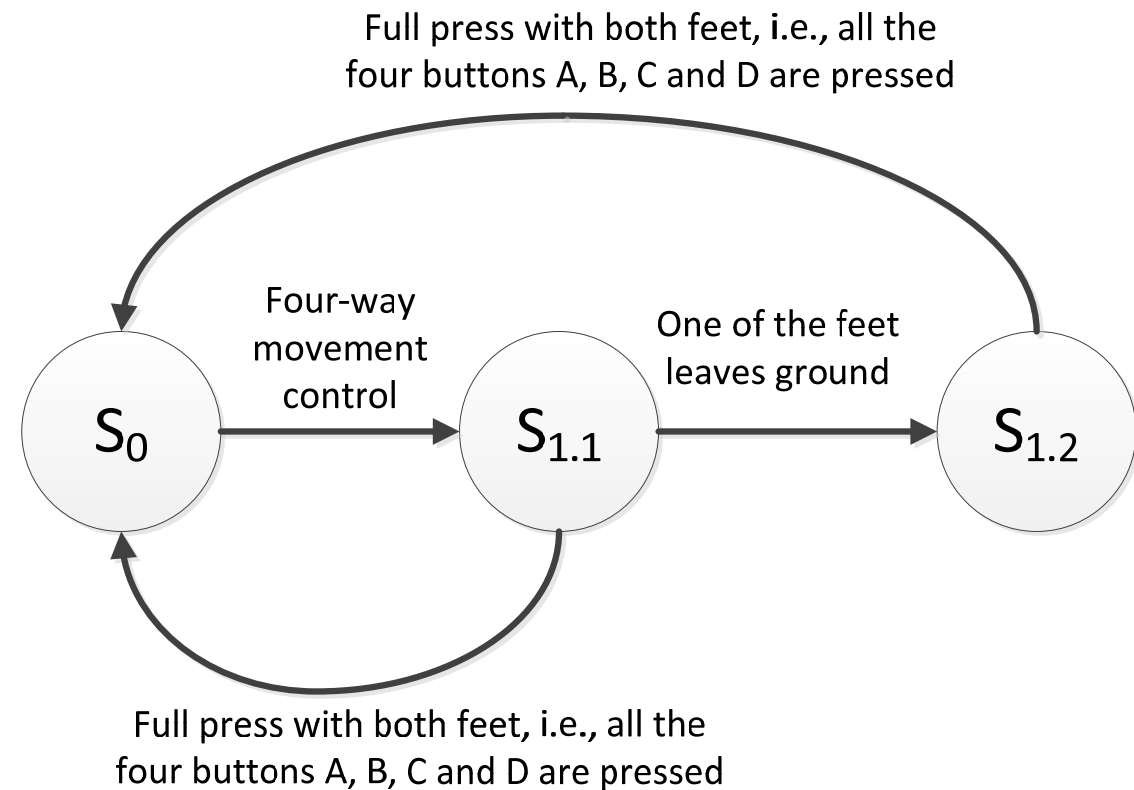
$S_{1.1}$ : Moving state 1. Movement control in a direction (forward, backward, left or right) is being generated with the four-movement control method, while both feet keep pressing the ground.

- In  $S_{1.1}$ , while the user's both feet keep pressing the ground, the user can change the foot tilt angle to adjust the movement speed

$S_{1.2}$ : Moving state 2. The user has taken a step and started to walk/run in place.

- In  $S_{1.2}$ , the user can walk/run in place. The movement speed is controlled by the durations of two types of steps, i.e., (a) the user's left foot pressing the ground and right foot in the air, and (b) the user's right foot pressing the ground and left foot in the air.

The transitions between the states are shown in the Figure on the right.



# Footroller Locomotion Control

## Locomotion control state transitions

$S_0 \rightarrow S_{1.1}$ : Four-way movement control

- Function: start movement control in one of the four directions.
- The foot gestures (as combinations of the basic control elements):
  - Move Forward: {ABD} & Tilt\_RF
  - Move Backward: {ABC} & Tilt\_RF
  - Move right: {BCD} & Tilt\_LF
  - Move left: {ACD} & Tilt\_LF

$S_{1.1} \rightarrow S_{1.2}$

- Function: switch from four-way movement control to walk/run in place.
- The foot gesture: (After setting a desired initial movement speed with the foot tilt angle in  $S_{1.1}$ ) lift the tilted foot off the ground and start to walk/run in place.

$S_{1.1} \rightarrow S_0$ , and  $S_{1.2} \rightarrow S_0$

- Function: stop the movement
- The foot gesture: Fully press the ground with both feet, with all the four buttons pressed, i.e., {ABCD}.

Note that there is no transition from  $S_{1.2}$  to  $S_{1.1}$ .

# Foottroller Locomotion Control (Advanced)

## Adding new controls that are compatible with the Foottroller locomotion control process

- New controls can be designed and added to work with the Foottroller locomotion control process, e.g., turn controls by feet.
  - Step 1: determine in which locomotion control state the new control works.
  - Step 2: design a foot gesture for the control function without triggering the state transition out of the locomotion control state.
  - Example:
    - Turn control in the stationary state  $S_0$ :
      - Left turn: {AD} & (Tilt\_RF - Tilt\_LF)
      - Right turn: {BC} & (Tilt\_RF - Tilt\_LF)Both foot gestures will not trigger a locomotion control state transition from  $S_0$
    - Turn control in  $S_{1,2}$ :
      - Left turn: {ABC} & tilt\_RF
      - Right turn: {ABD} & tilt\_RFBoth foot gestures will not trigger a locomotion control state transition from  $S_{1,2}$