

DEVELOPING A COLLABORATIVE ROBOT STANDED BY PEOPLE

Kazumasa Nishihara

Sho Akiyama

Otemon Challenger Jun Teramoto

Problem

In major earthquakes, building collapses cause most fatalities, with ~77% of victims surviving the first 15 minutes. However, both humans and tracked robots face clear limits on severe debris, delaying rescue. To overcome this, our research focuses on an insect-inspired multi-legged robot capable of navigating any terrain to reach isolated areas and save lives.



multi-legged robot

We built a robot that can climb over steps, inspired by the shape of insects. We used LEGO Mindstorms EV3.

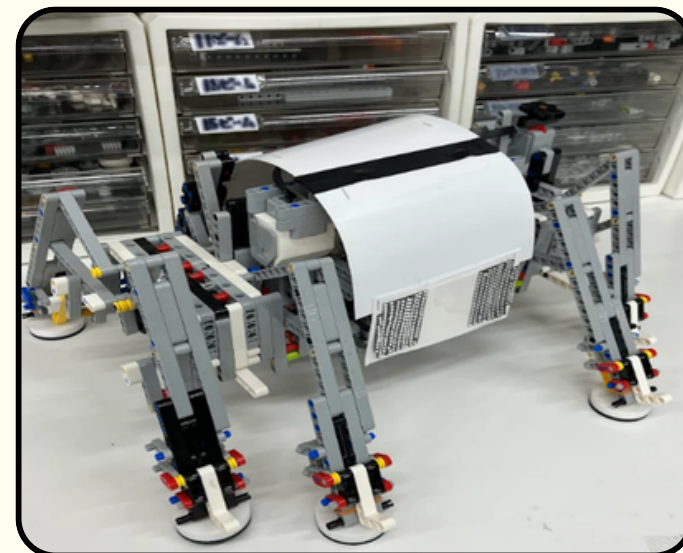
Features

- It can clear a 5-centimeter step.
- Impact Absorption Function for Falls in Rough Terrain

Under Development

- Keeps the center section level at all times

It can do things that a wheeled robot can't.



➡ **but its body is too big to fit inside the house.**

Multi-legged robots cannot move in the same environment as humans.

That's why we turned our attention to collaborative robots that can play an active role in human society.

Concept for our robot

Wheel Robot

What We Can Do

- High Speed
- Easy Control

What I Can't Do

- Cannot Climb Stairs



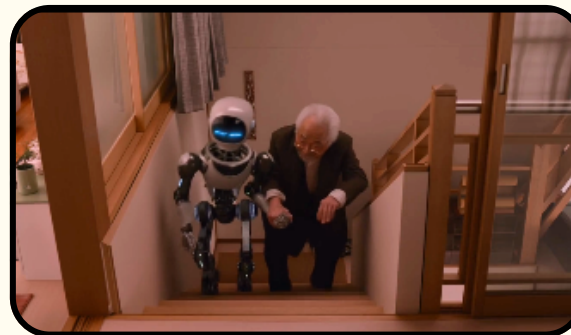
Bipedal Robot

What We Can Do

- Stair Mobility
- Adapts to Human Environments
- Performs Tasks for Humans

Something terrible

- Difficult to Control



※Created by Kazumasa using Canva AI

In nursing care, wheeled robots like ROBEAR can transport individuals, but their need for large spaces limits their use in narrow homes. To overcome this, we developed a bipedal collaborative robot that adapts to standard home environments to closely assist people. We believe that wheels and multi legged robots have limitations in truly supporting people.



※https://www.riken.jp/press/2015/20150223_2/index.html

Experiment

In April, I received a model of a bipedal robot from Professor Hirai at Osaka Public University.

- A robot model for university students to learn robot control
- No control textbook available
- 8 motors in the torso
- Controlled by M5Stack

Using VSCode

```
static void updateyrobalance() {  
    if (!standMode || !imu6886_connected) {  
        return;  
    }  
    float pitch = imu6886_ahrs.getPitch();  
    float roll = imu6886_ahrs.getRoll();  
    const float pitchError = balanceTargetPitch - pitch;  
    const float rollError = balanceTargetRoll - roll;  
    const float pitchCorrection = constrain(pitchError * BALANCE_GAIN_PITCH, -BA  
    const float rollCorrection = constrain(rollError * BALANCE_GAIN_ROLL, -BA  
    leftKneeAngle = constrain(40.0f + pitchCorrection, 0.0f, 180.0f);  
    rightKneeAngle = constrain(145.0f + pitchCorrection, 0.0f, 180.0f);  
    leftHipOpenAngle = constrain(130.0f + rollCorrection, 0.0f, 180.0f);  
    rightHipOpenAngle = constrain(70.0f - rollCorrection, 0.0f, 180.0f);  
}
```



Software ~Inverse Kinematics~

- Successfully Controlled Height and Depth Using 2D Inverse Kinematics
- Print Knee for the ankle motor connect it to the robot's control system



Starting from a basic model in April with no documentation, our robot has evolved from simple motor driving to stable standing through a four-bar linkage ankle mechanism and center-of-gravity control.

We are currently developing a quiet walking program.



Hardware ~Ankle~

- Create a program to keep the calves which support the legs constantly parallel
- Used a four segment link mechanism to recreate the calf and create dorsiflexion of the ankle

sources

Beyond creating mere convenience, our goal is to build a robot that reduces anxiety and brings comfort, directly aligning with SDG Goal 3: Good Health and Well-being. Specifically, our project addresses this goal through two key contributions:

①**Physical Support:** Assist those needing physical support.

②**Daily Life Support:** Assisting people in their everyday living environments.

This research represents our first step toward that future. Although the path ahead is long and challenging, we will continuously explore the possibilities of collaborative robots that stay close to people and benefit society.

<https://techshare.co.jp/product/unitree/unitree-h1/>

