Replicación de movimientos con robot 3D y visión por computadora-3D skeleton and computer vision motion replication

OBRAJERO YAÑEZ ALMA LIDIA,
GUTIERREZ RODRIGUEZ KARLA BERENICE,
BELMAN CASIQUE MELISSA

In this project, a 3D design of a humanoid robotic skeleton with integrated servo motors is used to mimic human movements. Although the replication is not completely accurate and there is a delay in the robot's response, the system is still able to mimic movements. The robot detects key points on the human body, such as wrists, elbows and shoulders, through a computer vision system. Communication between the vision system and the robot's actuators is via Wi-Fi, which facilitates the transmission of data for the execution of movements, albeit with a slight delay in synchronization. In addition, an ESP32 module and an LCD display have been integrated to improve the interaction and control of the system.

- Understand and apply MediaPipe functionalities to detect and locate human joints, in order to facilitate the replication of movements in the robot.
- Program and integrate servomotors for the robot to replicate human movements with as accurate control as possible, considering a slight delay in execution.
- Implement an existing algorithm to interpret a person's motion data and generate the necessary signals for the servomotors, allowing near real-time synchronization.

Methodology
- Define the objectives of the project
- Gathering materials
- Image processing in Python
- Communication between Arduino and Python
- Testing and tuning

Contribution

- Education and Training:This project can serve as an educational tool in the field of robotics and engineering, allowing students and professionals to learn about design, programming and control of robotic systems.
- Design Innovation: The creation of a humanoid robotic skeleton with an optimized 3D design and integrated servo motors represents a breakthrough in the ability to replicate human movements. This may inspire future designs that are more sophisticated and efficient.
- Technology: Integrates the image analysis power of Python's image analysis power with Arduino's control and sensing capabilities of the Arduino, creating hybrid solutions that can automate industrial, agricultural or domestic processes.

Keywords (In English)

- Image processing
- Sending and receiving data
- Algorithm implementation

En este proyecto se diseña en 3D un esqueleto robótico humanoide con servomotores integrados para imitar los movimientos humanos.
servomotores integrados para imitar los movimientos humanos. Aunque la réplica no es
y hay un retraso en la respuesta del robot, el sistema es capaz de imitar movimientos.
es capaz de imitar los movimientos. El robot detecta puntos clave del cuerpo
humanos, como muñecas, codos y hombros, mediante un sistema de visión por ordenador.
La comunicación entre el sistema de visión y los actuadores del robot se realiza mediante
Wi-Fi, lo que facilita la transmisión de datos para la ejecución de los movimientos,
aunque con un ligero retraso en la sincronización.
Además, se han integrado un módulo ESP32 y una pantalla LCD para mejorar la interacción y el control del sistema.
del sistema

- Comprender y aplicar las funcionalidades de MediaPipe para detectar y ubicar las articulaciones humanas, con el fin de facilitar la replicación de movimientos en el robot.
- Programar e integrar servomotores para que el robot replique los movimientos humanos con un control lo más preciso posible, considerando un ligero retraso en la ejecución.
- Implementar un algoritmo existente para interpretar los datos de movimiento de una persona y generar las señales necesarias para los servomotores, permitiendo una sincronización en tiempo casi real.

Methodologia
- Definir los objetivos del proyecto
- Recolectar los materiales
- Procesamiento de imágenes en Python
- Comunicación entre Arduino y Python
- Pruebas y ajustes

Keywords

- Procesamiento de imágenes
- Envío y recepción de datos
- Implementación de algoritmos

Contribucion

1. Educación y Formación: Este proyecto puede servir como una herramienta educativa en el ámbito de la robótica y la ingeniería, permitiendo a estudiantes y profesionales aprender sobre diseño, programación y control de sistemas robóticos.
2. Innovación en Diseño: La creación de un esqueleto humanoide robótico con un diseño 3D optimizado y servomotores integrados representa un avance en la capacidad de replicar movimientos humanos. Esto puede inspirar futuros diseños más sofisticados y eficientes.
3. Tecnología: Integra la potencia de análisis de imágenes de Python con las capacidades de control y sensorización de Arduino, creando soluciones híbridas que pueden automatizar procesos industriales, agrícolas o domésticos.

Citation:GUTIIERREZ RODRIGUEZ KARLA BERENICE, MELISSA BELMAN CASIQUE,ALMA LIDIA OBRAJERO YAÑEZ

* Correspondence to Author (322030093@upjr.edu.mx)
† Researcher contributing as first author.

Introduction

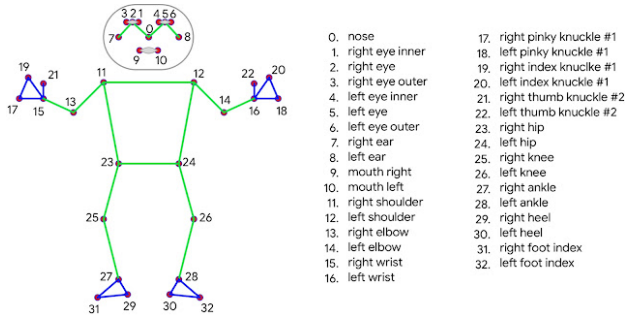
Robotics today has advanced significantly in recent decades, enabling the creation of systems that mimic human anatomy and movements. In this context, the development of a humanoid robotic skeleton that can emulate human movements is presented as a technical and scientific challenge with great relevance.
The present project focuses on the design and implementation of a 3D robotic humanoid skeleton, equipped with servomotors that allow the imitation of human movements. Although the replication of these movements is not completely accurate and faces a slight delay in response, the system demonstrates a remarkable ability to emulate the dynamics of the human body. To achieve this imitation, a computer vision system has been integrated to allow the robot to detect key points of the body, such as wrists, elbows and shoulders, thus facilitating the synchronization of movements.

Development of headings and subheadings of the article with subsequent numbers

1.Introduction
2. Implementation and use the mediapipe
3.Skeleton
4.Robot lina
5.Equation calculate angle
6.Results
7.Conclusions
8.References

Implementation and using the mediapipe

MediaPipe Pose is a high-fidelity body pose tracking solution that renders 33 3D reference points and a full-body background segmentation mask from RGB frames.



Graphic 1 Mediapipe

Skeleton

Robot lina
The lina robot is able to detect a person and follow him/her for a period of time, it is also able to move its limbs as the person in front of it does or it is detecting.

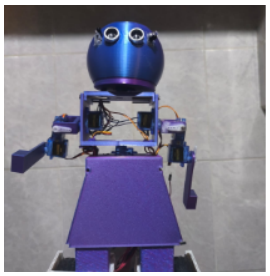


Figure 1 Robot Lina

Robotic skeleton
The robotic skeleton has the function of detecting the face of the person in front of it thanks to the Maixduino camera as well as replicating the movements of the person in front of it.

Should not be images-everything must be editable.

ISSN:

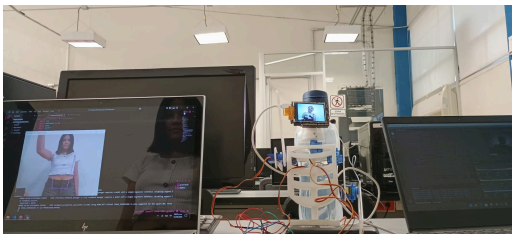
For equation calculate angle:

$$\cos\theta = \frac{\vec{a}\cdot\vec{b}}{|\vec{a}||\vec{b}|}$$

(1)

Results

Different algorithms were obtained using python and its free to observe the movement of the shield robot



Annexes

- Wiring Diagrams: Illustration diagrams for the connection of the servomotors and the ESP32 module.
- Vision System: Camera, used by means of the computer.
- 3D Model: Use of solid Works for the printing of the parts.
-

Conclusions

The project combines computer vision, image processing and robotics to reproduce movements in near real time with a pre-designed robot Using Python and Arduino, a camera captures motion and transmits it to the robot via -use of the bluetooth and wifi . This method allows for
effective and accurate communication, demonstrating integrating technologies to create dynamic interactions between the environment and the robot.

References

Saenz, J. A. A. (2024, 22 julio). Visión por Computadora (Computer Vi-
sion). Inteligencia Artificial Ppt. https://inteligenciaartificialppt.
com/vision-por-computadora-computer-vision/

Varun, J. (2022, 11 julio). Computer vision using mediapipe and openCV -
joel varun - Medium. Medium. https://medium.com/@joeajiteshvarun/
computer-vision-using-mediapipe-and-opencv-4b44b902b918

Technical Specifications

Each article must submit your dates into a Word document (.docx):

Journal title
Article title
Abstract
Keywords
Article sections, for example:

1. Introduction
2. Description of the method
3. Analysis from the regression demand curve
4. Results
5. Thanks
6. Conclusions
7. References

Alma Lidia Obrajero Yañez
Melissa Belman Casique
Karla Berenice Gutierrez Rodriguez
3220330093@upjr.edu.mx

Intellectual Property Requirements for editing:

ISSN: