Inclusion Drives Sustainable Development: The Case of Social Robotics for Africa

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Introduction

Artificial Intelligence (AI) and robotics are widely recognized to be crucial for realizing the UN Sustainable Development Goals (SDGs) [1]. However, sustainable innovation requires inclusion and collaboration among all stakeholders. Furthermore, effective inclusion is culture-dependent. Inclusive innovation in AI and robotics must therefore be sensitive to people's culture, what they believe and value. The Culturally Sensitive Social Robotics (CSSR4Africa) for Africa project aims to achieve this goal.

Inclusive Social Robotics Requires Cultural Sensitivity

Social robots, especially humanoid robots are expected to interact in a human-centered manner and on humans terms, not the robots' . Effective human-human interaction requires inclusion which depends on social infrastructure shaped by cultural norms, conventions and beliefs. Inclusive social robots must use verbal, nonverbal, and spatial cues to communicate, reflect respect and understand and adapt to their human interaction partner's socio-cultural norms. Hence, social robots require cultural competence to be inclusive. A culturally competent robot has five elements: (i) **cultural knowledge representation**, (ii) **culturally sensitive planning and action execution**, and (iii) **culturally aware multi-modal human-robot interaction** (iv) **culturally aware human emotion recognition** and (v) **culture identity assessment, habits, and preferences** [3]. The CSSR4Africa research project focuses exclusively on culture-sensitivity which includes the first two elements of cultural competence — cultural knowledge representation and culturally sensitive planning and action execution — and an aspect of the culturally aware multimodal human-robot interaction.

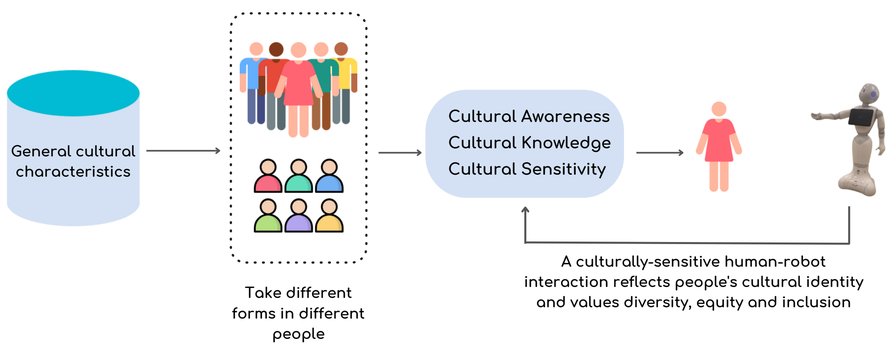


Fig. 1. Key elements of a culturally-sensitive robot. [3]

Culturally Sensitive Social Robotics For Africa

CSSR4Africa is a three year project with three main objectives: (i) identify the verbal and non-verbal social and cultural norms of human interaction that are prevalent in Rwanda and South Africa through an ethnographic study, (ii) encapsulate the behavioral patterns into predictable and reconfigurable software primitives, and (iii) demonstrate the culturally sensitive robot behaviors in two use case scenarios: one for giving a tour of a university laboratory, and one for assisting and giving directions to visitors at the reception of a university.

	Socio-Cultural Norm or Trait
1	To show respect, one should bow slightly and lower gaze when greeting someone older.
2	One should use an open palm of the hand to point to people and objects.
3	One should not use the left hand to hand something to someone.
4	One should not use the left hand to point to anything.
5	To show respect, one should shake hands with the right hand.

Table 1. A sample of African cultural knowledge. [2]

Selected References

[1] Vincent Mai, Bram Vanderborght, Tamás Haidegger, Alaa Khamis, Niraj Bhargava, Dominik BO Boesl, Katleen Gabriels, An Jacobs, AJung Moon, Robin Murphy, et al. 2022. The Role of Robotics in Achieving the United Nations Sustainable Development Goals—The Experts' Meeting at the 2021 IEEE/RSJ IROS Workshop [Industry Activities]. IEEE Robotics & Automation Magazine 29, 1, Article 1 (2022), 92 pages.

[2] D. Vernon. 2023 Culturally Competent Social Robotics for Africa: A Case for Diversity, Equity, and Inclusion in HRI. 2nd Workshop on Equity and Diversity in Design, Application, Methods, and Community at the Human-Robot Interaction conference (DEI HRI 2023).

[3] B. Bruno, N. Y. Chong, H. Kamide, S. Kanoria, J. Lee, Y. Lim, A. K.Pandey, C. Papadopoulos, I. Papadopoulos, F. Pecora, A. Saffioti, and A. Sgorbissa. 2017. Paving the way for culturally competent robots: A position paper. In 26th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN). Lisbon, Portugal, 553–560.

[4] P. Zantou and D. Vernon, "Culturally-Sensitive Human-Robot Interaction: A Case Study with the Pepper Humanoid Robot", Proc. IEEE Africon, Nairobi, Kenya, September, 2023.

Please visit the CSSR4Africa website for more information and updates about the project **cssr4africa.org**

System Architecture

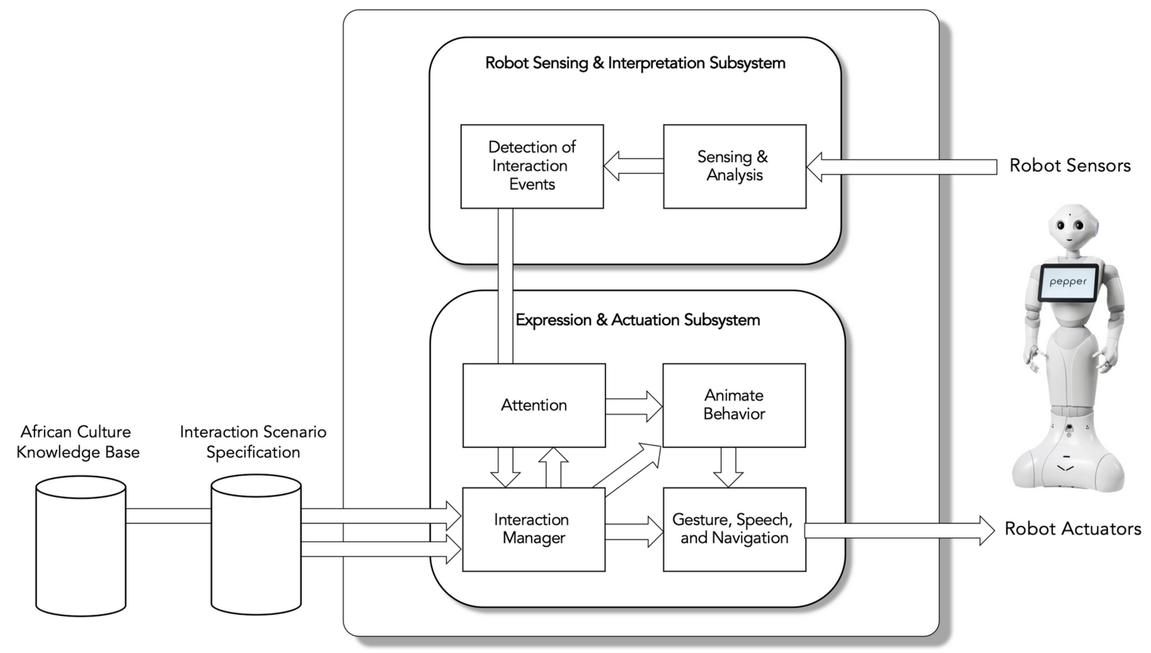


Fig. 2. System architecture.

The system architecture has two main subsystems and two external knowledge bases. The two subsystems are the **Robot Sensing & Interpretation** subsystem and the **Robot Behaviors** subsystem. The two knowledge bases are: **African Culture Knowledge** Base and **Interaction Scenario Specification**.

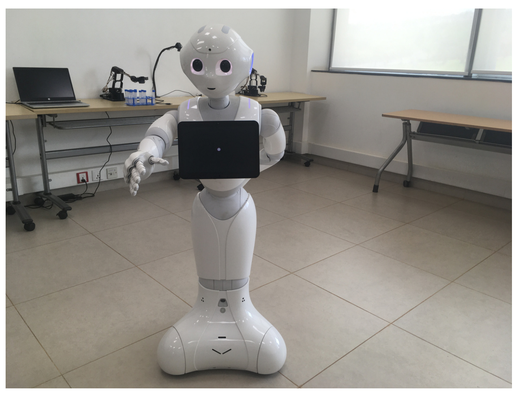
Description: A guest visits the CMU-Africa campus. She stopped by the CMU-Africa robotics lab. The social robot Pepper gives a tour of the lab. Initial lab setting: The humanoid robot Pepper is in the lab. The only other occupant of the lab is a lecturer.		
Scenario	**Robot skills**	**Culture-sensitivity**
The guest enters the robotics lab **Guest**: Hello! My name is Hilary. Can you please tell me what you do here? **Professor Busogi** welcomes the guest and introduces what students study and work on in the lab. He kindly asks the guest to come up to the robot as he introduces the Human-Robot Interaction (HRI) research project that is going on in the lab	Moving (head, arms, torso, hip)	[Culture-generic]: Pepper knows that you should initiate a greeting and welcome a guest. [Culture-specific]: Pepper knows that in Africa you should initiate a polite greeting by bowing your head and chest.

Table 2. A sample of a laboratory tour interaction scenario. [4]

Preliminary Demonstration: Culturally-Sensitive University Robot Behaviors for a University Laboratory Tour

The system architecture and the constituent components that are required for a culturally-sensitive social robot will be implemented for a culturally-sensitive laboratory tour with the Pepper humanoid robot. Fig. 3 provides examples of the culturally-sensitive gestures and behaviors to be incorporated in this tour.

(a) Welcome gesture



(b) Greeting gesture with right hand extension and a slight bow

(c) Pointing at something with open palm: eye contact

(d) Pointing at something with open palm: joint attention

Fig. 3. The Pepper humanoid robot exhibiting culturally-sensitive gestures.

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