AFRETEC NETWORK IDT RESEACH FUNDING PERIODIC NARRATIVE REPORT

Report Submitted By
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INSTRUCTIONS

Partner: Please refer to the original Inclusive Digital Transformation Africa Research Proposal when answering these questions, as relevant. Upon completion, please email this report to CMU-Africa at **afretec@andrew.cmu.edu**.

GENERAL INFORMATION

Organization Name:

Reporting Period: 2025 ☐January- June ☑July- December

1. REPORTING PERIOD SUMMARY

1.1 Activity Achievements

Outline your key achievements that occurred during this reporting period. What factors do you think contributed to these achievements? Please consider and include achievements that touch on inclusion.

Achievements:

Continual maintenance of the project website www.cssr4africa.org and wiki, including periodically updated News, Deliverables, and Publications pages. No new research publication was published, but the ''Culturally Sensitive Social Robotics for Africa'' submission from the proceedings of the 2nd International Workshop on Cultural Robotics: Diversified Sustainable Practices, IEEE/ACM HRI 2025 was updated with the final revised version that will appear in Springer LNAI.

All CSSR4Africa software for all individual system sub-modules for which CMU-Africa is responsible in the work plan, or for which CMU-Africa had assumed responsibility in lieu of delivery by Wits, was submitted and uploaded to CSSR4Africa's official GitHub repository after successfully passing quality assurance processes.

CSSR4Africa's CMU-Africa team and Wits team, on 21 August 2025, jointly presented and performed an interactive demonstration of culture-embedded robotics with Pepper humanoid robot at the 3rd Workshop on Robotics and Automation in Africa that was part of Deep Learning Indaba 2025 that was held at the University of Rwanda in Kigali. Pictures of this presentation are found here.

Revision of 3 deliverables:

D3.3	Software Installation Manual
D3.5	System Integration and Quality Assurance
D5.5.4	Robot Navigation

Successful demonstration of the Lab Tour use case scenario with a conversational system integrated. The Pepper humanoid robot was able to interact in English with a user at the end of each exhibit in the AI and Robotics Lab at CMU-Africa while giving a lab tour, showing an understanding of natural human language.

The CSSR4Africa project has been forked to be implemented in ROS 2 for use in giving tours of the Digital Experience Centre of the Upanzi Network at CMU-Africa.

The following changes that were identified in the first phase of the evaluation of the functional operation of the CSSR4Africa system, and which are due to be implemented in the final year of the CSSR4Africa project as described in the Use Case Evaluation deliverable document, have been successfully implemented:

1. Have two variants of the lab tour use case: (a) the robot operates autonomously, without requiring someone to introduce it, and (b) someone introduces Pepper and initiates the tour demo. The former requires the Pepper robot to locate a visitor, wait until mutual gaze is established, and then ask the visitor if she or he would like a tour. The second omits this part, launches directly into the tour, and doesn't require the visitor to follow the robot.
2. Improve navigation and locomotion, to make it look more purposeful, e.g., using the divide-and-conquer algorithm.
3. Improve the automatic speech recognition, both in terms of reducing the time taken and the reliability.
4. Enhance interactive conversational capabilities to enable Pepper to respond to visitor inquiries about its identity, robotics lab research, teaching activities, and general questions, thereby facilitating more dynamic and engaging human-robot dialogue beyond scripted tour content.
5. Add or extend a service to use a key-value pair `deicticHand LEFT | RIGHT | EITHER`.
6. Implement speech during navigation transitions between exhibits using connecting words or phrases to make the tour flow naturally and enhance human-robot interaction smooth.
7. Enhance end tour conversation to be more humanly and interactive, providing additional meaningful dialogue beyond the standard goodbye to address visitor expectations for continued interaction.
8. Increase navigation movement speed while maintaining goal-reaching precision to meet visitor preferences for faster robot movement during tours.
9. Implement audience-focused gaze behavior where Pepper looks at visitors while explaining exhibits, similar to human tour guide behavior, rotating towards exhibits only when pointing and then returning attention to the audience.
10. Adjust English speech delivery to be slower and more human-like with natural breaks between complete sentences to improve comprehension for visitors without science or robotics background.

Factors of Success:

Having a team with critical mass in terms of number and background, with the following working on the project in the current period: four research associates (Birhanu Shimelis Girma, Muhirwa Richard, Tsegazeab Taye Tefferi, Clifford Onyonka), one part-time researcher (Ibrahim Jimoh), and two research associates tied to the Upanzi Network at CMU-Africa fork of the CSSR4Africa project (Muhammed Danso, Yohannes Haile).

Having a detailed work plan, which all team members are thoroughly familiar with.

Having detailed deliverable documents of all CSSR4Africa components, including the system architecture, which all team members are thoroughly familiar with.

Conducting weekly project team meetings at the start of the working week on Mondays.

Sharing weekly task progress updates within the team at the end of each working week on Fridays, keeping overall system progress transparent across the whole team.

Holding frequent periodic demonstrations, which ended up being conducted on weekly basis towards the end of the current period.

Hands on project management, with the team members taking on the responsibility of project manager for periods of two months at a time, each project manager being chosen on a simple majority vote by the rest of the team members from among the team members that are yet to serve as project manager.

1.2 Activity Learnings

What key lessons did you learn during this reporting period (e.g. through the process of design and implementation of Activities). Include learnings that touch on inclusion. Outline 3 key lessons that emerged during this reporting period. *Add rows as needed.*

Lesson 1: Frequent demonstrations of the system are beneficial. They provide quick feedback for tasks that are being worked on by the team, ensuring quicker updates and evaluations for each task. They also motivate the team members to work towards completing their tasks

Lesson 2: Demonstrations of the system to non-robotics visitors is essential to gain valuable insights on how to improve the system. The team has conducted several demonstrations to select non-faculty staff members and CMU-Africa visitors, including visiting students from a refugee camp in Rwanda, visiting students from several high schools in Rwanda, and visiting pre-teenage children. The feedback collected from these demonstrations has been valuable in providing a broader picture of how best to develop the system to cater for diverse varieties of visitor groups.

Lesson 3: Collaboration is key in achieving success. Some of the systems that have been developed over the current period, especially the conversational system of the CSSR4Africa project, have involved close collaboration among the team members due to the close interaction of several sub-modules that was needed to implement the system. The team has also collaborated with other research teams in CMU-Africa, notably Wakanda AI with whom the team has collaborated on automatic speech recognition.

Lesson 4: Experimentation and exploration is vital in system development. Some of the sub-modules of CSSR4Africa, especially those that require use of deep learning models such as speech event and text to speech, have required several iterations of experimentation with various deep learning models and system design techniques in order to identify the best models for use and the best system design techniques to ensure that these models run efficiently during inference.

Lesson 5: Weekly team meetings and task progress updates is essential. Where some tasks have lagged behind, the team has been able to identify this and step in with a remedy to ensure continual progress of the project.

1.3 Progress & Impact

Use the tables below to report numerical targets, results, and relevant explanations or comments. If any internal or external factors may influence progress, please explain. All quantitative indicators should be disaggregated by gender, and where possible and relevant, by age groups, disability status, rural/urban, degree program, etc.

1.3.1: Progress Reporting (Outputs): Progress reporting shows the outputs of the Activity. In the table below, please provide updates on your progress of funded Activities. Examples of progress indicators include the gender representation of students/ learners/ faculty receiving support, number of Afretec and non-network universities partnered with, or share of participants who successfully completed training or education out of the total target. *Add rows as needed.*

Progress Reporting	**Indicators** (quantitative or qualitative)	**Target**	**Results to date** (include gender & other disaggregation as relevant)	**Comments on progress (any insights, opportunities to adapt, etc.)**
Software	Submission to project GitHub repository	12 ROS nodes 1 Pepper interface tests ROS node 1 cultural knowledge dashboard	12 ROS nodes 1 Pepper interface tests ROS node 1 cultural knowledge dashboard	All software that was part of the CSSR4Africa work plan has been submitted and integrated into the official CSSR4Africa GitHub repository. The conversational system software has been demonstrated and shown to functionally work, however it is yet to pass quality assurance processes, and therefore is not submitted for integration into the CSSR4Africa GitHub repository. A full interactive demonstration, together with the conversational system, has been achieved.
Diversity	Balance of female/male research associates	Equal balance	All the research associates at CMU-Africa are male	Previous female research associates at CMU-Africa transitioned out of the project, leaving only male researchers. Number of females at CMU-Africa taking robotics courses is low. A number of demonstrations were conducted to showcase CSSR4Africa to diverse groups of visitors, including students from a refugee camp in Rwanda, several groups of high school students in Rwanda (most of whom were from girls high schools), and several groups of pre-teenage children.
Collaboration	Meetings and task progress updates	Weekly	Approx. 95% of weekly meetings were held Approx. 95% of weekly task progress updates were shared	Development of the conversational system of CSSR4Africa project saw close collaboration among the team members, including a series of pair and mob programming sessions. Collaboration was also achieved with researchers outside of the AI and Robotics Lab at CMU-Africa, most notably the Wakanda AI team who are working on language technologies for African languages.

Please describe any above-mentioned qualitative indicators that show progress. Examples of qualitative progress indicators are development of a training curriculum, signing of an agreement, etc.

1.3.2: Impact Reporting (Outcomes): Impact monitoring shows the changes or outcomes that occur partly or fully due to the Afretec collaboration and program investment. In the table below, please provide updates on outcomes and/or emerging outcomes. Examples of outcomes include: level of student preparedness for and interest in pursuing graduate education in ICT, assessment of faculty engagement in professional development that enhances their teaching, or evidence of increased collaboration with universities or industry locally and regionally. *Add rows as needed.*

Outcomes should relate specifically to the Afretec Network Principles [***Network-Based***, ***Leveraged***, ***Collaborative***, ***Diverse & Inclusive***, ***Transformative*** *and* ***Evidence-Based***] (see Principles section of Afretec Action Plan). Include in Comments to which Principle the outcome is related.

Main changes or outcomes (indicate the level the activity is focusing on– learner, student, faculty, institution, industry, country or region)	**Indicators** (quantitative or qualitative)	**Target**	**Results to date/contribution to impact** (include gender & other disaggregation as relevant)	**Comments on impact (any insights, opportunities to transform)**
Professionalism	Research associate productivity	8 RAs/interns trained	7 RAs/interns trained	Comprehensive training material and a period of induction are essential. This material has been made available to other groups and research projects.
Technical knowledge and skills	Ability to acquire new technical skills and overcome unforeseen technical problems	Independent learning	Clear evidence of independent learning, varying from good to outstanding, depending on the research associate	It is essential to assign individual responsibilities to encourage the acquisition of new knowledge and skills, and to make it transparently obvious when these skills have been acquired, and the degree to which they have been learnt.
Diversity	Ability to work with people from different cultural and professional backgrounds	100% cohesion in the team	Most RAs work well together	Diversity adds value as it exposes RAs to different standards and expectations regarding both professionalism and technical competence.
Leadership	Ability to co-ordinate multiple tasks and manage projects	Rotational project manager role	3 Ras have served as project managers	The project manager position is rotated among the RAs after a period of two months to ensure that every RA acquires tangible leadership skills.

Describe any emerging effects or changes that are not captured quantitatively. Include both positive or negative changes that were either intended or unintended.

1.3.3. Ripples of Impact: Your intervention may have ripple effects beyond the level identified above. For example, a program targeting young women or men to pursue education or entrepreneurship opportunities may have an impact on their households or communities. A program targeting university-industry relationships may have an impact on recent graduate job placement. Multi-university knowledge creation projects may impact the visibility of African research collaborations to global funding organizations.

We hope to capture the full range of potential ripples of impact and broader changes of Afretec programs, so we may potentially follow up with impact assessments. Please note if any programs that targeted one level (e.g. learner, student, faculty, institution, industry, country or region) are showing ripple effects on other levels:

Several girls high schools and pre-teenage children have visited the AI and Robotics Lab at CMU-Africa, where they have been shown a demonstration of the CSSR4Africa project. While it is too early to determine the impact of these demonstrations, we project that these demonstrations will inspire the next generation to pick STEM-related careers, and create a general interest in robotics.

The Upanzi Network at CMU-Africa has forked the CSSR4Africa repository, and is porting it to ROS 2 for use in giving a tour of the Digital Experience Centre at CMU-Africa. The results of CSSR4Africa will therefore continue to be felt even after the conclusion of the research, creating robotics interest in incoming CMU-Africa students who will continue to see the results of the project at the Digital Experience Centre.

1.3.4: Additional data collection: Please describe any additional quantitative and qualitative data collection efforts utilized (e.g. key interviews and focus group discussions, pre and post program knowledge assessments, attitudes and practices (faculty or collaboration partner surveys, etc.). This may help identify opportunities to deepen how we capture the impact of this partnership. These efforts could include data collection described in your proposals or any other relevant data collection.

No data was collected in the current period. However, in April 2024, a wide-ranging survey in both English and Kinyarwanda was conducted to acquire cultural knowledge about how to interact respectfully with people in Rwanda.

2. PARTNERSHIP UPDATES

2.1 Partnership Changes

Have there been any key changes (changes with significant impact on partnership or activity success) to any of the following items? ☑Yes ☐No

Items: context, outputs/deliverables; key activities; inputs/resources; monitoring, evaluation, research and learning plan; communications approach; team structure (including staffing), etc.

If yes, please describe: The CMU-Africa team has updated its staffing, which has seen a change in the way the team works to fulfill its mandate. The previous CMU-Africa PI, Prof. David Vernon, retired at the end of the previous reporting period, with Prof. Assane Gueye taking over as the new CMU-Africa PI. Two of the CMU-Africa RAs also switched to work on porting the CSSR4Africa project to ROS 2 for the Upanzi Digital Experience Centre (DEC), and one RA worked on part-time basis. While the two RAs working on the Upanzi DEC port of the project still provided support to the CSSR4Africa project, these changes saw the CMU-Africa team reduced to only four full-time RAs.

2.2 Collaboration Update

Please provide an update of your engagement and collaboration with partnership stakeholders (e.g. academic institutions, private sector organizations, government organizations, community groups, civil society organizations, etc.) during this reporting period.

There has been collaboration with the Wakanda AI team of researchers at CMU-Africa. The collaboration has seen a sharing of Kinyarwanda speech recognition models for use in the CSSR4Africa project, as well as software contributions by CSSR4Africa researchers to one of the Python packages developed by the Wakanda AI team.

There has also been collaboration with the Upanzi Network at CMU-Africa, with two of their research associates working in close collaboration with the CSSR4Afrca CMU-Africa team, and the Upanzi Network lab manager and project manager also helping in managing the CSSR4Africa project.

3. COMMUNICATIONS UPDATE

3.1 Communications Activities Update

Please describe the marketing and communications outreach that occurred during this reporting period as well as any relevant media links.

CSSR4Africa's CMU-Africa team and Wits team, on 21 August 2025, jointly presented and performed an interactive demonstration of culture-embedded robotics with Pepper humanoid robot at the 3rd Workshop on Robotics and Automation in Africa that was part of Deep Learning Indaba 2025 that was held at the University of Rwanda in Kigali. Pictures of this presentation are found here.

4. RISK UPDATE

4.1 Risk Update

Please provide an update to the risks, either new, as previously identified in the Proposal or previous Periodic Reporting Template. Consider partnership and activity-level (e.g. capability, capacity), and organizational-level (e.g. affecting management, governance, personnel essential to the functioning of the organization). *Add rows as needed.*

Risk	Likelihood	Risk Impact	Risk Mitigation Plan
Inadequate funding for research associates	Low	High	One of the researchers on the CMU-Africa team is working on a part-time basis, having taken a teaching assistant position for the 'Robotics: Principles and Practice' course.
Unable to achieve synchronization of ROS nodes via parallel execution of ROS nodes	Moderate	High	A partial effective workaround has been employed, as a more robust approach which has already been identified is being implemented.
Unable to resolve an ongoing control problem requiring termination of the inbuilt autonomous life mode on the Pepper robot	Moderate	Low	We have found a partially effective workaround to this problem.
African cultural knowledge are not effective in use cases	Low	High	D6.2 documents the required changes to be implemented in Year 3 in Tasks 1.4, 2.4, 3.5, 4.4, and 5.6.
Implementation of the system architecture for use cases is insufficient	Low	High	D6.2 documents the required changes to be implemented in Year 3 in Tasks 1.4, 2.4, 3.5, 4.4, and 5.6.
Robot sensing and analysis does not perform adequately	Low	High	D6.2 documents the required changes to be implemented in Year 3 in Tasks 1.4, 2.4, 3.5, 4.4, and 5.6.

Robot behaviors do not perform adequately	Low	High	D6.2 documents the required changes to be implemented in Year 3 in Tasks 1.4, 2.4, 3.5, 4.4, and 5.6.
Use case evaluation does not achieve sufficiently high user ratings in the evaluation	Moderate	Moderate	D6.2 documents the required changes to be implemented in Year 3 in Tasks 1.4, 2.4, 3.5, 4.4, and 5.6.

5. NEXT REPORTING PERIOD

5.1 Plans for Next Reporting Period

Based on the Afretec Action Plan and progress updates thus far, please outline your key activities for the next reporting period.

Completion of unfinished tasks identified in D6.2 Use Case Evaluation, as summarized below:

Task 4.4: Ensure that visitor does not have to facilitate interaction by standing is a particular position.

Task 5.6: Minimize pauses or dead zones between different phases of the tour in the behaviorController node, i.e., between each behavior tree action nodes.

Task 5.6: Implement more comprehensive failure handling in the behaviorController node.

Task 5.6: Query the culture knowledge base in the behaviorController node for the deicticHand keyvalue pair and pass the value to the gestureExecution node.

Task 5.6: Query the culture knowledge base in the behaviorController node for the eyeContactDuration and nodExtentRespect key-value pairs and pass the value to the overtAttention node.

Task 5.6: Implement the receptionist use case.

Task 5.6: Adapt seek mode in the overtAttendion node to adhere to cultural norms by dropping the head slightly intermittently to avoid looking at a visitor continuously for long periods. The duration of the mutual gaze before dropping the head and the extent of the drop should be determined by the behaviorController by quering the culture knowledge base using the eyeContactDuration and nodExtentRespect key-value pairs.

Task 5.6 Add a key-value pair (deicticHand LEFT | RIGHT | EITHER) to the culture knowledge base.

Task 5.6 Ensure English names (Carnegie Mellon, Robotics, Roomba, etc.) are pronounced in English while speaking Kinyarwanda, without translation to Kinyarwanda pronunciation or accent.

Tasks 4.4, 5.6 All nodes Implement a means of resetting the node through a service call.

Integration of the conversational system into the official CSSR4Africa GitHub repository after passing the quality assurance process.

Finally, Task 6.3 will address the user's perception from a social perspective of the manner in which the mission is executed, i.e., an evaluation using RoSAS.

6. ADDITIONAL INFORMATION

6.1 Additional Information

Please describe any additional information that the Director of the Afretec Network should be aware of.

This is a CMU-Africa periodic narrative report. It does not refer to the progress made by The University of the Witwatersrand over the current period (save for the 21 August 2025 collaboration for the robotics demonstration at the 3rd Workshop on Robotics and Automation in Africa that was part of Deep Learning Indaba 2025).

CMU-Africa had four full-time research associates over the current reporting period, who will continue to work on the project in the next reporting period. CMU-Africa also had one part-time researcher over the past reporting period and two research associates tied to the Upanzi Network at CMU-Africa fork of the project (for the Digital Experience Centre at CMU-Africa) who also worked on CSSR4Africa over the current reporting period.

Prof Assane Gueye took over as the Principal Investigator (PI) of the CMU-Africa team at the start of the current reporting period, with Prof David Vernon who was the PI in previous reporting periods having retired at the start of the current reporting period. Prof Assane Gueye is also the PI of the Upanzi Network at CMU-Africa fork of the project that will be used at the Digital Experience Centre at CMU-Africa.

NOTE: THE FOLLOWING SECTION IS FOR INTERNAL USE AT CMU-AFRICA ONLY.

Associate Director of Impact to complete this section following submission of the Periodic Narrative Report by the Afretec Partner.

7. REVIEW

7.1 Associate Director of Impact Comments

Please describe any key issues and/or follow-up items and provide a summary of discussions that occurred with partners during this reporting period.