Evaluating the Effectiveness of NAO Robots as Tools for Promoting Education, Diversity and Inclusivity.

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A report of the 6-week Robot in Residence programme at the Goethe Institute, Lagos.
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ABSTRACT

This report documents a six-week residency program held at the Goethe Institut, Lagos and aimed at programming a NAO robot to reflect inclusivity, diversity, and the culture of the global south in the development of AI systems and solutions. The robot was programmed to identify Nigerian tribal marks, explain their significance, and engage in dialogue with users on the topic. The robot was also able to engage in conversations about African proverbs and riddles. The programming was done with Python and QiChat on the NAO Choreographe software. The report details the methodology, results, and findings of the project, including the challenges encountered and the implications for the development of AI systems and solutions. The report concludes with a summary of achievements and future directions for research and development in the field. The project highlights the potential of NAO robots in promoting cultural understanding and breaking down cultural barriers, as well as the importance of collaboration with cultural experts and users in ensuring accurate and respectful responses. The inclusion of the word "education" in the title emphasizes the potential of NAO robots in enhancing learning outcomes, while also promoting diversity and inclusivity in educational settings.

KEYWORDS: NAO robot, inclusivity, diversity, the culture of the global south, AI systems and solutions, Nigerian tribal marks, African proverbs, riddles, Python, QiChat, methodology, results, challenges, implications, cultural understanding, collaboration, accuracy, respectfulness, intercultural communication.

ACKNOWLEDGEMENT

INTRODUCTION:

The purpose of this six-week residency was to program a NAO robot to reflect inclusivity, diversity, and the inclusion of the Global South in the conversation around the development of AI systems and solutions. During the course of the residency, various conversation applications were developed using Python and QiChat on the NAO Choreographe software. These applications focused on African proverbs, riddles, and Nigerian tribal marks, and were designed to enable the robot to identify tribal marks, explain their significance, and engage users in a dialogue on the topic. The Robot in Residence programme is a tour of key African countries (Including Senegal, Ghana, Nigeria, Cameroon and South Africa) by the NAO robot while individual developers programs the robot to perform certain tasks in the respective locations.

The NAO robot is a humanoid robot created by SoftBank Robotics. It is equipped with various sensors and cameras that enable it to perceive its environment and interact with humans. The NAO Choreographe software is an integrated development environment (IDE) that allows programmers to create applications for the NAO robot using drag-and-drop interfaces and Python scripting.

The development of conversation applications for the NAO robot posed various challenges, including the need to develop a deep understanding of African proverbs, riddles, and tribal marks, as well as the need to program the robot to identify and interpret these cultural artefacts accurately.

This report documents the progress made during the residency, the learning curves encountered, and provides recommendations for future work. The report is structured as follows: Section II describes the methodology used, including the programming tools and techniques used and the strategies employed to overcome the challenges faced. Section III presents the results and findings of the project, including the conversation

applications developed, the NAO robot's ability to identify tribal marks and user interactions with the robot. Section IV provides a discussion of the results, learning curves, and recommendations for future work. Section V concludes the report by summarizing the achievements of the residency, the implications of the project, and directions for future research.

METHODOLOGY:

The programming tools and techniques used for this project included Python and QiChat on the NAO Choregraphe software. Python is a high-level programming language that is widely used for scientific computing and artificial intelligence applications. QiChat is a dialogue-authoring language that is used to create conversational scenarios for NAO robots. NAO Choregraphe is an integrated development environment (IDE) that enables programmers to create applications for the NAO robot using drag-and-drop interfaces and Python scripting.

The programming process involved several stages, including research, design, implementation, and testing. The research stage involved gaining a deep understanding of African proverbs, riddles, and tribal marks. This understanding was used to design conversation applications that would enable the robot to identify and interpret these cultural artefacts accurately.

The design stage involved creating tribal mark images that would be used to train the robot and also involved designing conversation scenarios that would prompt the robot to respond appropriately to user input.

The implementation stage involved using Python and QiChat to program the conversation applications on the NAO Choregraphe software. Python scripts were used to handle complex computations, while QiChat scripts were used to design the conversation scenarios.

The testing stage involved testing the conversation applications to ensure that they functioned as intended. This involved testing the robot's ability to identify tribal marks, interpret their significance and engage in a natural dialogue with users.

The programming challenges encountered during the residency included the need to develop a deep understanding of African culture and the challenges associated with programming a robot to engage in culturally sensitive conversations. Challenges related

to the sonar and visual input systems also affected the process. These challenges are enumerated as follows:

1. Limited documentation and programmer's support for the NAO robot. Though are available user manuals and basic guides to programming the robot, however, these are limited and not sufficient for professional engagements on the robot.
2. The Speech Recognition options with the NAO are available for key European, and Asian languages and Arabic. This poses a particular challenge to using speech recognition modules of the robot for data input as accents pose a challenge to the programmer. The distinctive way of pronouncing a word, especially one associated with a particular country, area, or social class affects the user experience with the robot.
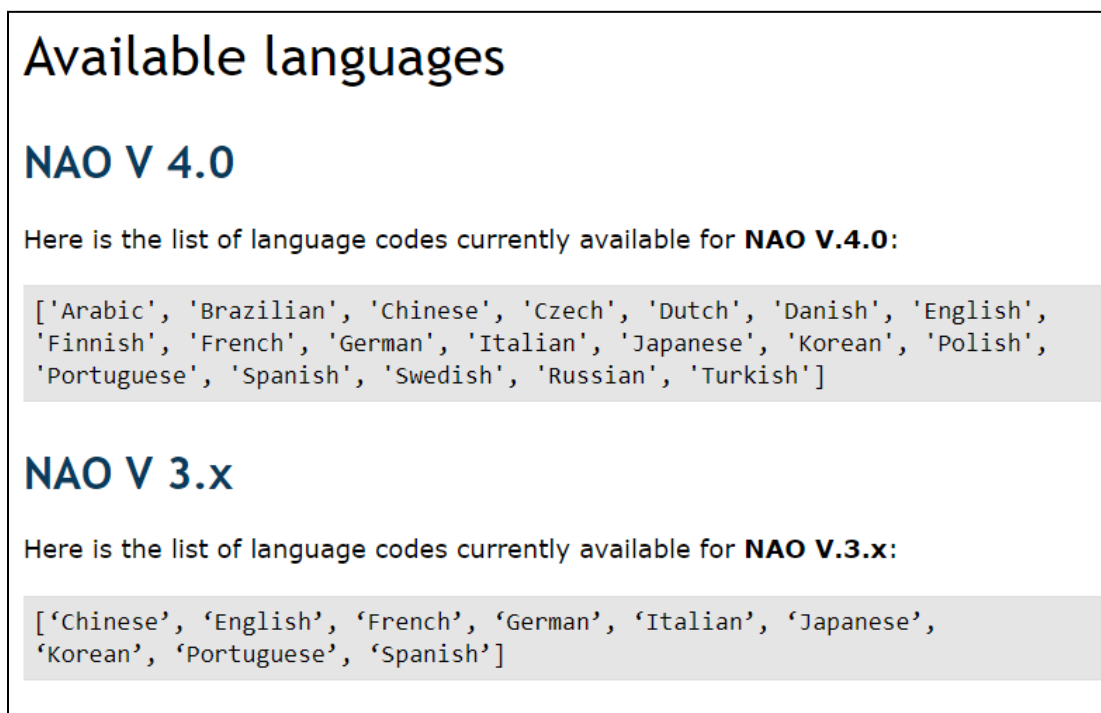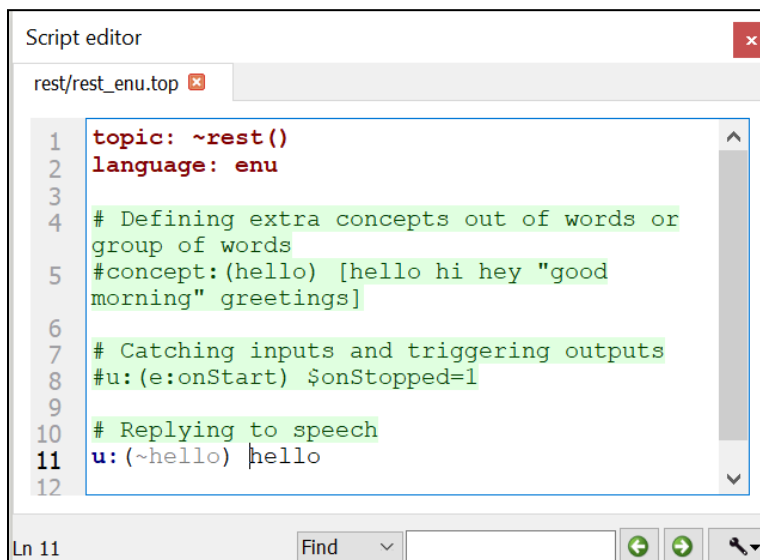
Available languages

NAO V 4.0

Here is the list of language codes currently available for **NAO V.4.0**:

```
['Arabic', 'Brazilian', 'Chinese', 'Czech', 'Dutch', 'Danish', 'English',
'Finnish', 'French', 'German', 'Italian', 'Japanese', 'Korean', 'Polish',
'Portuguese', 'Spanish', 'Swedish', 'Russian', 'Turkish']
```

NAO V 3.x

Here is the list of language codes currently available for **NAO V.3.x**:

```
['Chinese', 'English', 'French', 'German', 'Italian', 'Japanese',
'Korean', 'Portuguese', 'Spanish']
```

Fig 1: Image showing available languages for NAO version 3.x and version 4.0

3. Still connected with the documentation is the assumption that all programming will be done with Python or the "drag and drop" boxes in the choregraphe IDE, however, this researcher observes that the Dialogue Box within the IDE uses a particularly different scripting language: QiChat. QiChat is a scripting language used for programming NAO robots. It was developed by Aldebaran Robotics, a French robotics company that was later acquired by SoftBank Robotics. The language was created specifically for the NAO robot and is designed to be easy to use, even for non-programmers.

QiChat is based on the concept of chatbots, which are computer programs designed to simulate conversation with human users. The language allows developers to create dialogues and conversation scenarios for the NAO robot, which can then be triggered by specific events or user interactions. One of the main features of QiChat is its ability to handle natural language input. The language includes built-in algorithms for processing and interpreting human speech, allowing the NAO robot to respond to questions and prompts in a way that feels more natural and intuitive to users. QiChat is typically used in conjunction with the NAO Choregraphe software, which provides a visual programming environment for designing and testing NAO robot behaviours. The language is designed to be flexible and extensible, allowing developers to create customized dialogues and behaviours for the NAO robot to suit a wide range of applications and use cases.

```
Script editor                                              ×

rest/rest_enu.top ×

1   topic: ~rest()
2   language: enu
3
4   # Defining extra concepts out of words or
    group of words
5   #concept:(hello) [hello hi hey "good
    morning" greetings]
6
7   # Catching inputs and triggering outputs
8   #u:(e:onStart) $onStopped=1
9
10  # Replying to speech
11  u:(~hello) hello
12

Ln 11                        Find   ∨
```

Fig 2: The Scrip Editor for the QiChat

4. The limited research resources for the cultural aspect of the work. There are limited research materials covering the totality of tribal marks occurrences in Nigeria. Hence the researcher has to limit the scope of the research to the Yoruba people of West Africa.
5. The visual sensors for facial recognition present a problem of accurate and useful data capture in certain cases. This was observed to be connected with the chroma or contrast of the target image. It was observed that lighter-complexioned targets have a higher chance of being recorded by the visual sensors of the Facial Recognition module. Hence, in this study, the

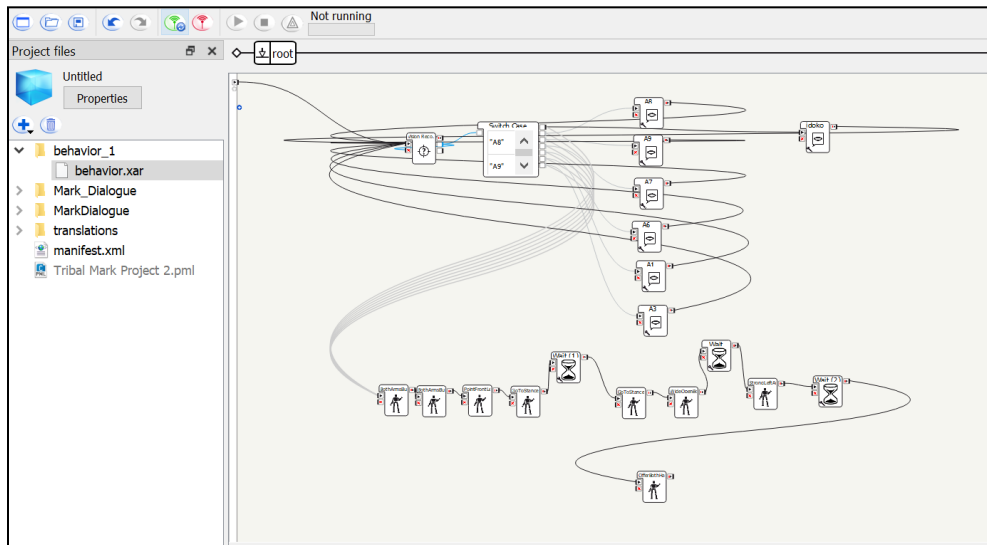researcher used the Vision Recognition module instead in connection with the Vision Recognition database.

Fig 3: The Choreographe IDE interface

To overcome these challenges, the programmer worked closely with cultural experts and incorporated user feedback into the design and implementation of the conversation applications. This also informs the wide use of the QiChat scripting within this project as an easier option for full Python usage thus reducing the turnaround time of the execution.

III.   RESULTS AND FINDINGS:

The residency program aimed to program a NAO robot to reflect inclusivity, and diversity, and explore the cultural relevance of the Global South in the development of AI systems and solutions. The following are the main results and findings of the project:

1. Feasibility of programming a NAO robot to engage in culturally sensitive conversations: The developed conversation applications demonstrated the robot's ability to identify tribal marks, explain their significance, and engage users in a dialogue on the topic. Users could also engage in conversations on African proverbs and riddles. The results of the user testing were positive, with users reporting that the robot was able to engage in natural and informative

conversations on the topics. These results indicate that it is possible to program a NAO robot to engage in culturally sensitive conversations with users.

2. Importance of collaboration with other development teams on the NAO Robot Tour Residences: Because of the limited documentation on the NAO robot, it became necessary to have collaborative arrangements with the individual programmers thus reducing the turnaround time for achieving their individual tasks.

3. The project demonstrated the importance of collaboration with cultural experts in programming a NAO robot to engage in culturally sensitive conversations. The cultural experts provided valuable insights into the specific Nigerian culture used for the study, which was incorporated into the design and implementation of the conversation applications. This collaboration ensured that the robot's responses were accurate and respectful of Nigerian cultures.

4. The potential of NAO robots in promoting inclusivity and diversity: The project demonstrated the potential of NAO robots in promoting inclusivity and diversity in the development of AI systems and solutions. The developed conversation applications showcased African culture and enabled users to engage with the robot in a meaningful way. The project also highlighted the potential of NAO robots in promoting cultural understanding and breaking down cultural barriers.

5. The potential of NAO robots in education: The developed conversation applications on African proverbs, riddles, and tribal marks have potential educational value. They can be used in schools and other educational settings to teach students about African culture. NAO robots can provide an interactive and engaging way for students to learn about different cultures.

In all, the residency program demonstrated the feasibility of programming a NAO robot to engage in culturally sensitive conversations with users. The project also highlighted the importance of collaboration with cultural experts in ensuring that the robot's responses were accurate and respectful of African culture. The potential of NAO robots in promoting inclusivity and diversity in the development of AI systems and solutions was also demonstrated. It also accentuates the feasibility of the deployment of the NAO robot for pedagogical purposes.

IV. DISCUSSION:

We will discuss the results and findings in light of the objectives of the project.

1. Achievements and Progress Made: The residency program has been successful in achieving its objectives. The NAO robot was programmed to identify tribal marks, explain them, and engage in dialogue with users on the topic. The robot was also able to engage in conversations about African proverbs and riddles. The programming was done with Python and QiChat on the NAO Choreographe software. The conversation applications developed were able to provide accurate and respectful information on African culture. In addition, the robot was able to provide an interactive and engaging way for users to learn about different cultures.

2. Learning Curves and Challenges Faced: The programmer encountered several challenges during the residency program. The first challenge was in developing a deep understanding of African culture to ensure that the robot's responses were accurate and respectful. The team had to collaborate with cultural experts to gain valuable insights into African culture, which were incorporated into the design and implementation of the conversation applications. The second challenge was in incorporating user feedback into the design and implementation of the conversation applications. Users' feedback was essential in ensuring that the robot's responses were relevant and engaging. The third challenge has to do with the limited available documentation for this exercise. Unlike other frameworks like Android programming, for instance, there are several open-source solutions that address the same problem. However, being a proprietary technology the NAO Robot faces the challenge of lack of robust online community of users which can be an immense asset for technologies like this.
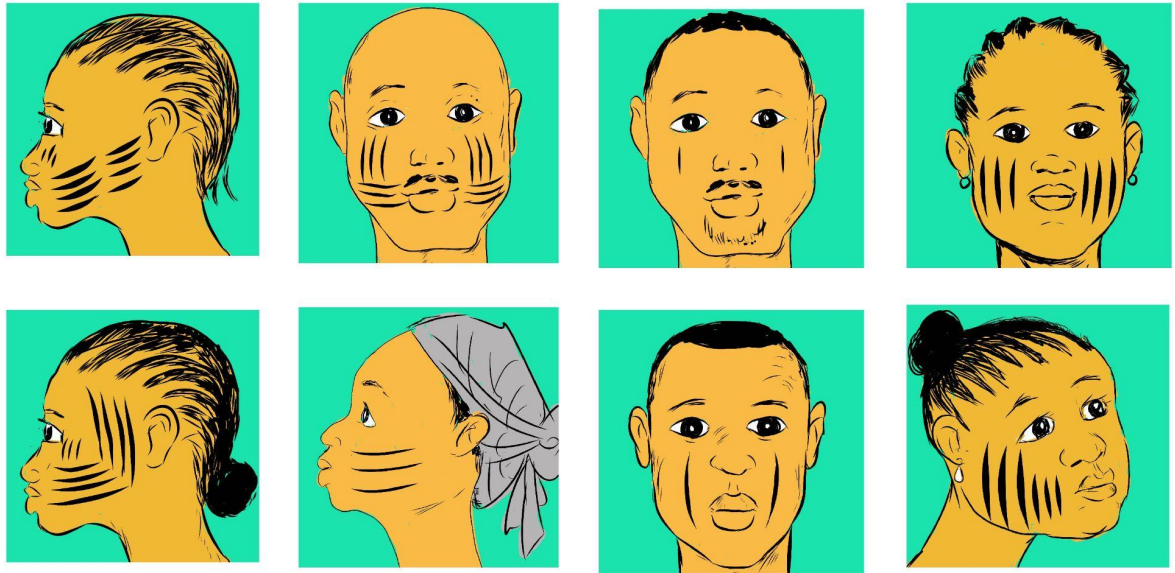
Fig 4: Images of the tribal marks used in the study

3. Recommendations: The residency program has provided valuable insights into the potential of NAO robots in promoting inclusivity, diversity, and the culture of the Global South in the development of AI systems and solutions. Based on the results and findings, the following recommendations are proposed:

   ● There is a need for further collaboration with cultural experts in programming NAO robots to engage in culturally sensitive conversations. Cultural experts can provide valuable insights into the nuances of different cultures, which can be incorporated into the design and implementation of conversation applications.

   ● There is a need to involve users in the development process of conversation applications. User feedback is essential in ensuring that the robot's responses are relevant and engaging.

   ● There is a need to consider the addition of widely spoken Global South languages in the framework of the NAO engine. This will assist with the speech recognition module implementation of the robot in the Global South.

   ● There is a need for further research on the potential of NAO robots in education. NAO robots can provide an interactive and engaging way for students to learn about different cultures. Further research can explore the potential of NAO robots in promoting intercultural understanding and breaking down cultural barriers.

The residency program has demonstrated the potential of NAO robots in promoting inclusivity, diversity, and the culture of the global south in the development of AI systems and solutions. The project has highlighted the importance of collaboration with cultural experts and users in ensuring that the robot's responses are accurate and respectful. However, challenges in programming a NAO robot to engage in culturally sensitive conversations must be addressed to ensure that the robot's speech recognition input systems, visual recognition input system and machine responses are accurate and respectful. With further research and development, NAO robots can play a key role in promoting cultural understanding, enhancing educational outcomes and breaking down cultural barriers.

V. CONCLUSION:

A. Summary of Achievements: The NAO robot was programmed to identify tribal marks, explain them, and engage in dialogue with users on the topic. The robot was able to do this. It was also able to engage in conversations about African proverbs and riddles. The programming was done with Python and QiChat on the NAO Choreographe software. The conversation applications developed were able to provide accurate and respectful information on African culture. In addition, the robot was able to provide an interactive and engaging way for users to learn about different cultures.

B. Implications of the Residency: The residency program has significant implications. Apart from shifting attention around the development of AI systems and solutions to the Global South, it also raises the question of the critical intersection between art, culture and technology. It has brought the conversation around the design and use of technology as an integral part of creative expression and vice versa. Also, the project has highlighted the importance of promoting inclusivity, diversity, and the culture and language of the Global South in the development of AI systems, infrastructure and solutions. The project has demonstrated the potential of NAO robots in promoting cultural understanding and breaking down cultural barriers. The project has also highlighted the importance of collaboration with cultural experts and users in ensuring that the robot's responses are accurate and respectful.

C. Future Directions: The residency program has laid the foundation for future research and development in the field of AI systems and solutions. It has demonstrated the potential of NAO robots in promoting cultural understanding and breaking down cultural barriers. Future research can explore the potential of NAO robots in education and other areas of social interaction. Further research can also explore the potential of NAO

robots in promoting intercultural understanding and breaking down cultural barriers in other contexts.

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