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MSAI

MSAI 508 – NATURAL LANGUAGE PROCESSING

Project Proposal: **Multilingual Chatbot for Industrial Robotics Support with ROS Integration**

1. Introduction The increasing complexity of industrial robotics necessitates efficient and accessible technical support. This project proposes a multilingual chatbot capable of assisting users in Filipino/Tagalog, English, and Japanese. The chatbot will provide text-based support for troubleshooting, system diagnostics, and operational guidance. By integrating with the Robot Operating System (ROS), the chatbot will also assist in tasks related to robot kinematics and dynamics, making it a valuable tool for engineers and operators.

Industrial robots are widely used in manufacturing and automation, but language barriers and complex documentation often hinder efficient troubleshooting and maintenance. Inspired by advancements in multilingual NLP models and intelligent assistants in industrial settings, this project aims to provide real-time, language-adaptive support, enhancing user engagement and operational efficiency.

2. Literature Review A review of existing literature highlights advancements in industrial robotics, NLP-based chatbots, and multilingual AI models:

- **Multilingual Chatbots in Industry:** Studies such as Chen et al. (2023), "A Speech-Enabled Virtual Assistant for Efficient Human–Robot Interaction in Industrial Environments," emphasize the role of conversational AI in enhancing human-robot interaction and reducing task completion times.
- **LLM-Based Industrial Assistants:** Research on large language models (LLMs) in manufacturing, such as Colabianchi et al. (2024), "Assessment of a Large Language Model-Based Digital Intelligent Assistant in Assembly Manufacturing," demonstrates how AI-powered assistants can reduce cognitive workload and improve process efficiency.
- **Humanized Task-Oriented Dialogue Systems:** The "ToD4IR" framework (Li et al., 2022) introduced an industrial robot-specific dataset (IRWoZ) and optimized NLP models for task-oriented dialogue, improving robot interaction through human-like conversation.
- **Responsible Multilingual NLP Models:** Liu & Fu (2024), "Responsible Multilingual Large Language Models: A Survey of Development, Applications, and Societal Impact," highlight challenges in linguistic diversity and the need for adaptive, cross-lingual AI solutions in technical environments.

While these studies demonstrate significant advancements in industrial AI, few have focused on ROS-integrated multilingual chatbots tailored for robotics support. This project aims to fill this gap by combining multilingual NLP with ROS functionalities.

3. Methodology

- **NLP Model Selection:** Evaluate and fine-tune an appropriate NLP model (e.g., GPT, mBERT, or Transformer-based) for multilingual support in industrial robotics.
- **Chatbot Development:** Implement a conversational AI system trained with domain-specific datasets (e.g., IRWoZ, technical documentation, and ROS manuals).
- **ROS Integration:** Establish real-time communication between the chatbot and ROS to provide robot kinematics and dynamics assistance.
- **Deployment:** Develop a user-friendly web/desktop interface using frameworks like Flask, FastAPI, or Electron.
- **Testing and Evaluation:** Conduct usability studies, benchmarking against chatbot performance metrics (e.g., BLEU scores, accuracy, task success rate).

4. Expected Outcomes

- A functional multilingual chatbot tailored for industrial robotics support.
- Seamless integration with ROS for enhanced robot diagnostics and operational assistance.
- Improved accessibility for engineers and operators through an intuitive interface.
- Contribution to multilingual AI research in industrial applications.

5. Project Timeline

6. Resources and Tools

- **Software:** Python, Hugging Face Transformers, TensorFlow/PyTorch, ROS, Flask/FastAPI
- **Hardware:** GPU-enabled systems for training, robotic hardware for testing (if available)
- **Datasets:** Public NLP datasets, technical manuals, and industrial robotics documentation

7. Risk Management and Challenges

- **Data Issues:** Limited availability of domain-specific multilingual datasets, mitigated by synthetic data generation.
- **Model Performance:** Ensuring accurate translations and intent recognition in highly technical queries.
- **Technical Challenges:** ROS integration complexities, requiring iterative development and debugging.

8. Conclusion This project aims to bridge the communication gap in industrial robotics by providing a robust multilingual chatbot integrated with ROS. By leveraging AI and automation, the system will enhance productivity and ease technical support for industrial robots. Future

improvements may include speech recognition, expanded language support, and adaptive learning based on user interactions.

9. References

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