The AI Data Robotics Association

Harnessing Generative AI in Manufacturing: Use Cases and the Imperative for Robust AI Testing and Validation
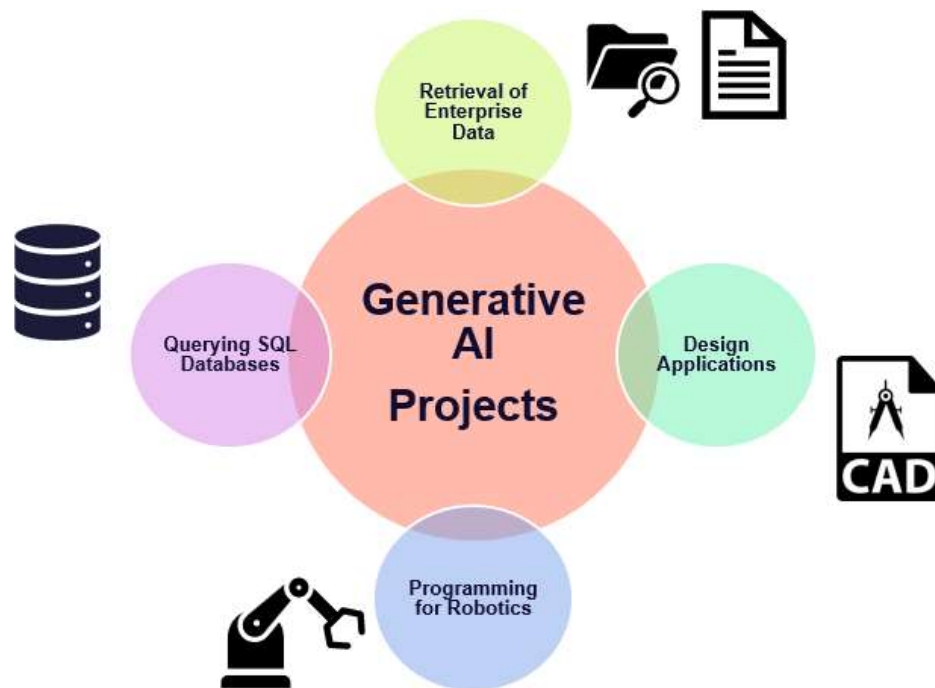
Name: Dr Mostafizur Rahman

Date: 05/11/2024

mtc where progress happens

AIM-NET

Generative AI for Design Applications

mtc

Challenge

Text-to-CAD model generation, in which a Generative AI solution translates the user's text descriptions of the model into CAD representations, leveraging the capabilities of pre-trained LLM.
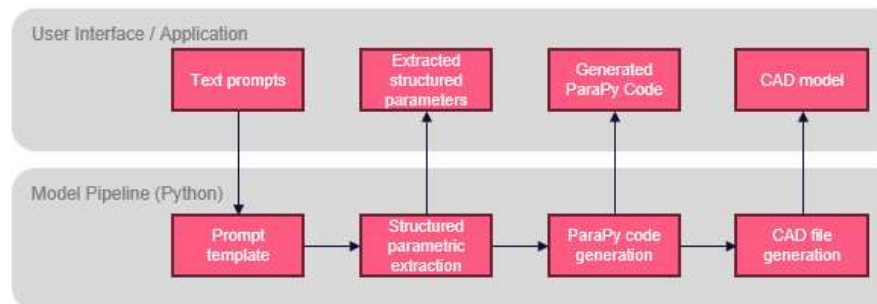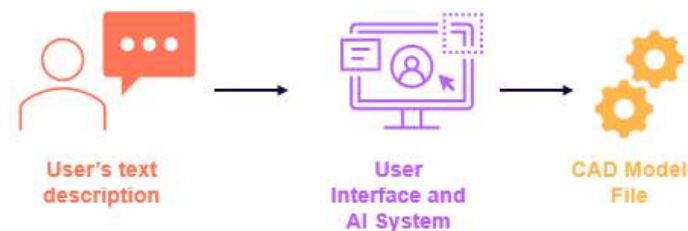
Solution

The solution employs LLM-based agents to dynamically execute the following three stages:

1. **Structured Parameter Extraction:** provides a higher level of accuracy for the code generation step.

2. **ParaPy Code Generation:** takes the user's text description and extracted parameters to generate the ParaPy Python code.

3. **CAD Generation:** executes the generated ParaPy code to generate the CAD model file in a standardised format.

Benefits

- Automation of CAD design **significantly reduces the time required for manual design,** enabling fast and more efficient delivery of design projects / products.

- Faster decision-making and refinement, **as rapid iteration and testing of different design concepts** are feasible with Generative AI.

User's text description → **User Interface and AI System** → **CAD Model File**

User Interface / Application

| Text prompts | Extracted structured parameters | Generated ParaPy Code | CAD model |

Model Pipeline (Python)

| Prompt template | Structured parametric extraction | ParaPy code generation | CAD file generation |

Natural Language Programming for Robotics (NaLaPRo)

mtc

Challenge

Widely publicised recent developments in AI (e.g., GPT-4) have shown rapid advances in natural language processing. This project sought to understand the potential of using **LLMs to program robots** removing barriers to usage and adoption.
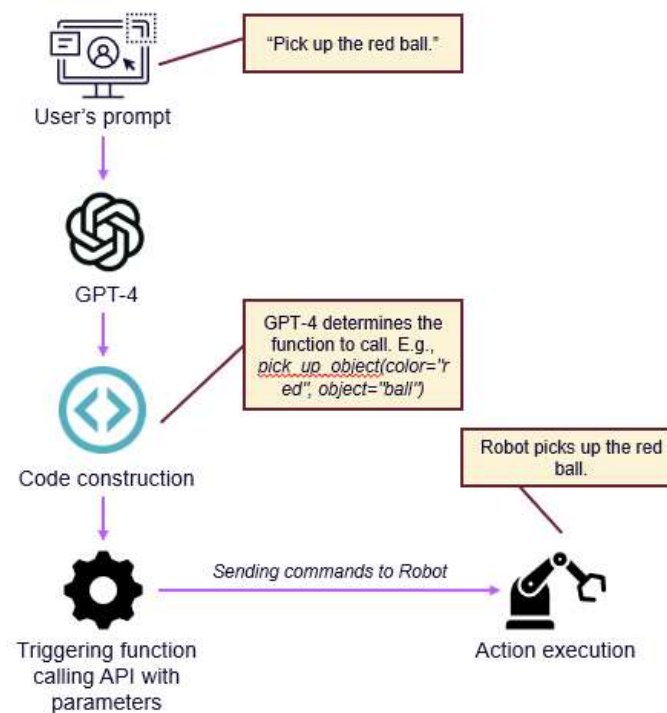
Solution

The project is seeking to develop a communication ecosystem using the Robot Operating System (ROS2) framework, connecting a skills knowledge base, an LLM (i.e. GPT-4) and a collaborative robot arm.

Following the development of the ecosystem, the capabilities of **the system will be tested to compete "standard manufacturing use-cases"** under the instruction of an operator who isn't trained in robotics.

Benefits

Natural language robot programming could have a massive impact in the robotics industry by:

- **Reducing the training and skill requirement** for robot programming
- **Reducing the time required** to program a robot system

"Pick up the red ball."

User's prompt

GPT-4

GPT-4 determines the function to call. E.g., *pick_up_object(color="red", object="ball")*

Code construction

Robot picks up the red ball.

Triggering function calling API with parameters

Sending commands to Robot

Action execution

AIM-NET

118

LLM-based Metrics Dashboard

Challenge

To reduce the need of **interfacing with a database of specific querying languages**, staff in the workshop can use an LLM powered metrics reporting application that converts text to SQL queries and provides summarisations. A demonstrator that showcases AI capabilities with SQL data is developed.

Solution

An SQL database containing data on performance metrics of the workshop floor to which an LLM will query and provide a qualitative report. Three functional tasks were defined:

1. **Text to SQL task:** to take the user prompt and generate an SQL command that fulfills the requirements of that prompt.

2. **Execution of the generated SQL query:** to execute and retrieve the query results.

3. **Text Generation task:** to qualitatively explain the query results.

Both a Fixed LLM pipeline containing two LLMS for each of the NLP tasks that are carried out sequentially as well as using LLM agents are being investigated.

Benefits

- Enables **easier access of business data** without the need for knowing query languages.

- **Reducing the time needed to retrieve performance reports** or analysis due to the presence of an automated pipeline that can accept many types of analysis-based prompts.
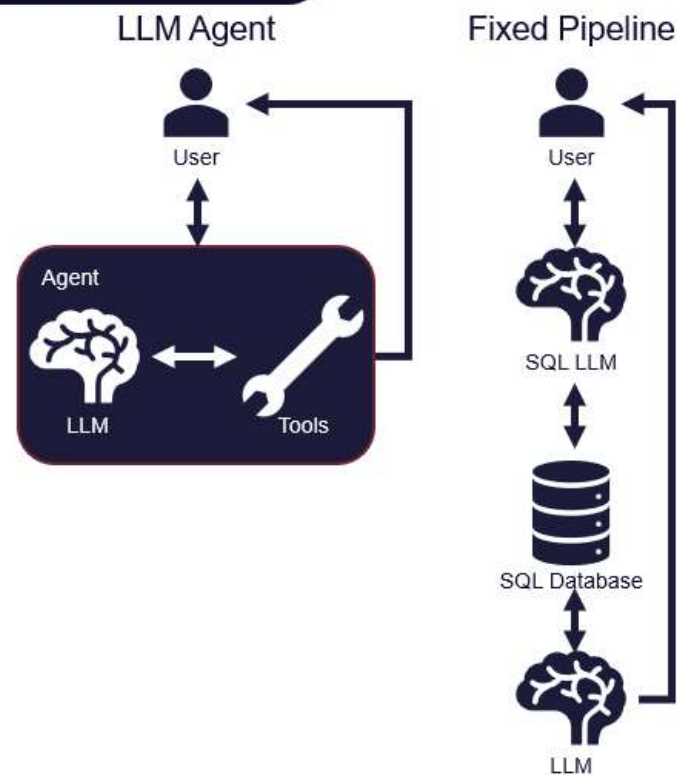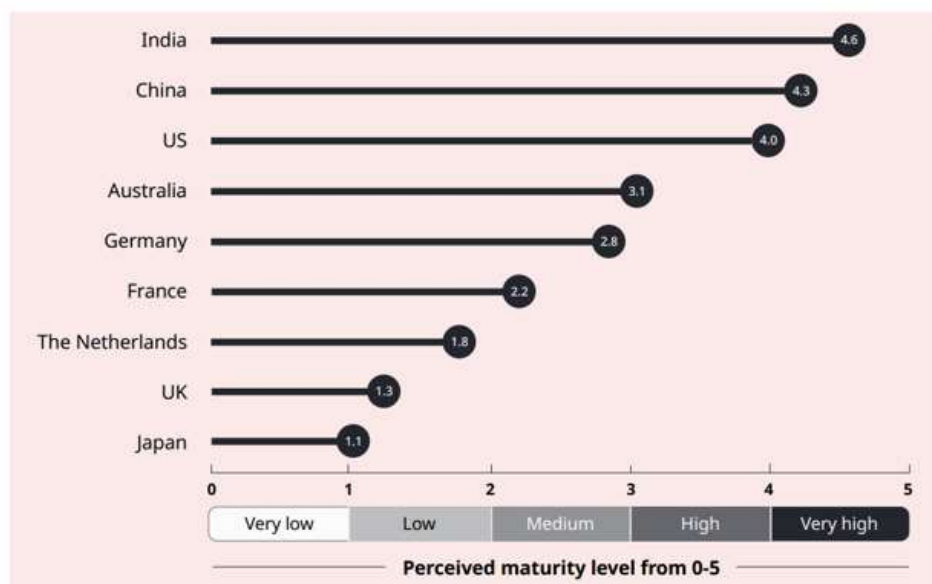
STAGNANT ADOPTION

BSI study on AI maturity

UK holds a low AI maturity score compared to other countries.

✚ Low **confidence** levels in AI technology.

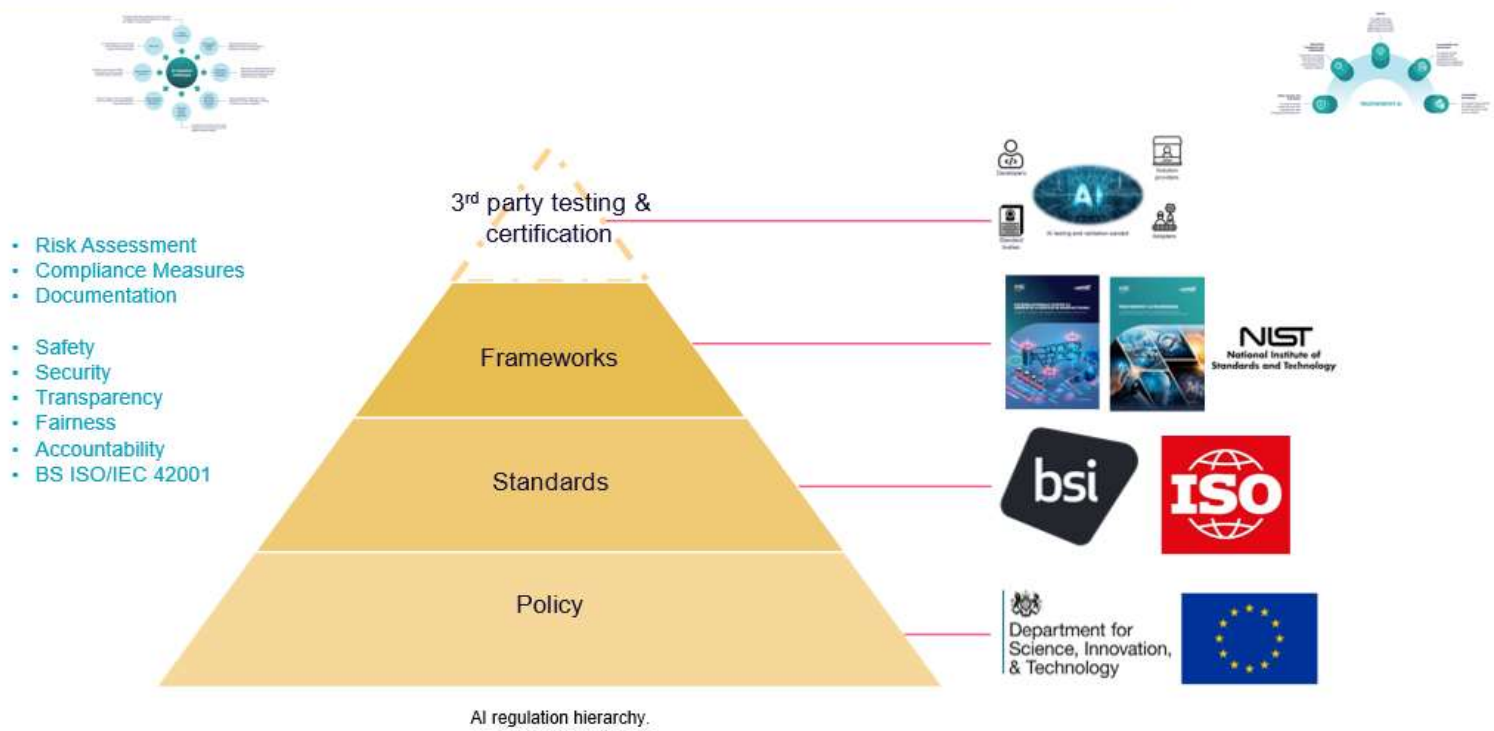✚ Low **adoption rate** into industry.

✚ Little **trust** in AI technology.

83% globally say it is important for businesses to implement policies and processes regarding the safe and ethical use of AI.

Country	Perceived maturity level from 0-5
India	4.6
China	4.3
US	4.0
Australia	3.1
Germany	2.8
France	2.2
The Netherlands	1.8
UK	1.3
Japan	1.1

Very low — Low — Medium — High — Very high
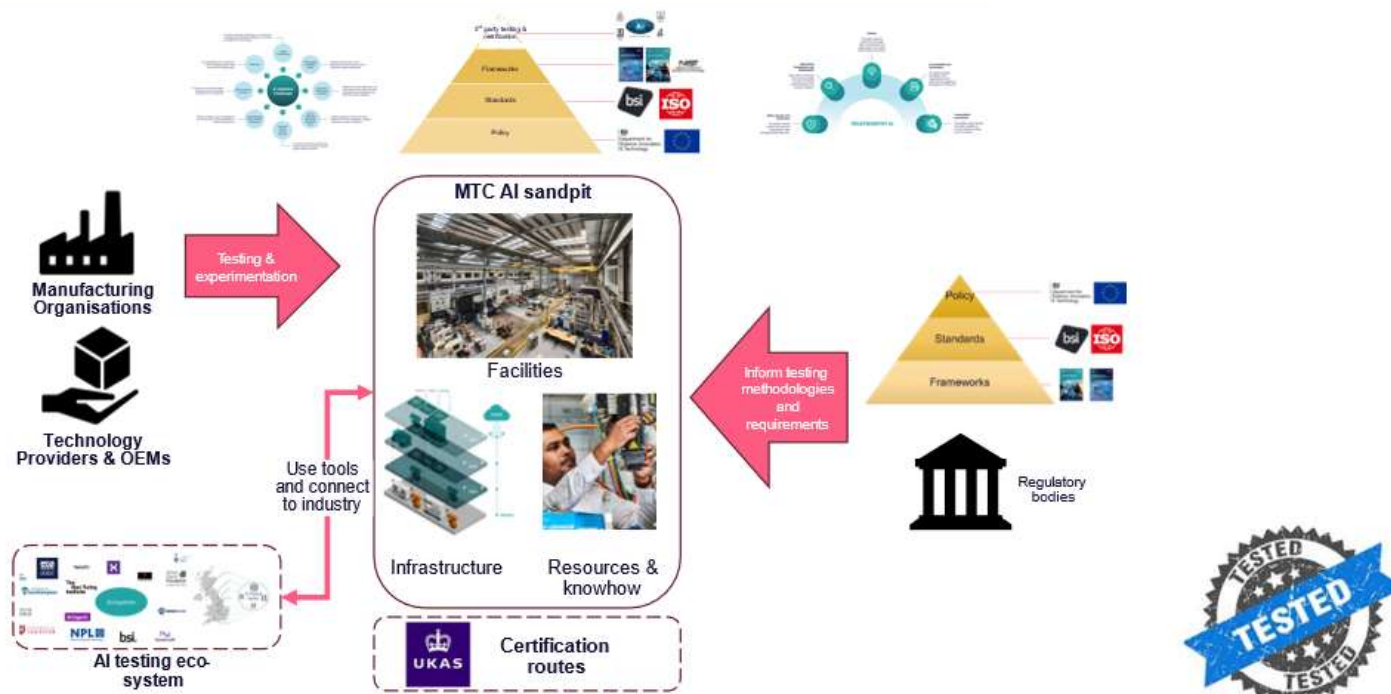
Perceived maturity level from 0-5

BSI's International AI Maturity Model Aggregate scores across 15 different categories, including investment, training, trust and communications.
Source: https://www.bsigroup.com/siteassets/pdf/en/insights-and-media/campaigns/trust-in-ai.pdf

AIM-NET

AI regulation hierarchy.

The AI testing and validation sandpit.

FIND OUT MORE

mtc

Whitepapers – Free Access:

https://www.the-mtc.org/mtc-whitepapers

AIM-NET