GENERATING VISUALISED FLOW-BASED PROGRAMMING FOR ROBOTS USING VERBAL/LANGUAGE-BASED USER DESCRIPTIONS

CHALLENGE OWNER

The Challenge Owner KABAM Robotics was founded in December 2020 to address global labour shortage and rising manpower costs. The company aims to revolutionise the security industry by leveraging robotic connectivity technologies to build intelligent security, facility management robots and connectivity software for smart buildings and cities.

While headquartered in Singapore, KABAM has a significant presence globally, including the USA, Australia, and various parts of Asia, with a team of 90-100 people across the globe. They serve various high-profile clients in physical security and property management. Their clients operate across retail, hospitality, and public spaces such as airports, train stations and hospitals, demonstrating the versatility and effectiveness of KABAM's robotic solutions.

KABAM’s core products include:

- Co-Lab. An indoor security robot with features like autonomous navigation, obstacle avoidance, self-recharging capabilities, and 360-degree video streaming.
- Halo. An outdoor security robot designed for autonomous navigation, obstacle avoidance, self-recharging capabilities, and 360-degree video streaming.
- Smart+. A software solution providing automated reports and alerts, integration with building infrastructure, real-time camera feeds, video analytics, and incident management systems

This sector-wide ROS-I Startup Challenge is organised by the ROS-Industrial (ROS-I) Consortium Asia Pacific and the Advanced Remanufacturing and Technology Centre (ARTC) which is led by the Agency for Science, Technology and Research (A*STAR), in partnership with Nanyang Technological University Singapore.

ROS-Industrial Consortium Asia Pacific and its organising partner ARTC, aim to accelerate innovation in the robotics sector by focusing on the unique integration of cutting-edge ROS capabilities in manufacturing. The challenge will feature 2 problem statements from the industry that will proliferate the adoption of Robot Operating System (ROS)-based solutions in industrial applications. It will also facilitate collaboration between startups and ROS-I’s technical teams to provide joint innovative creations to leading global enterprises from ROS-I’s consortium.

To Note: Participants should approach this challenge with the intent to utilise A*STAR’s intellectual property to resolve the problem statement and give due consideration to license, post-challenge.

CONTEXT

KABAM’s robots are programmed to perform tasks or a sequence of tasks, called missions, depending on customer needs. Currently, KABAM’s customer success team conducts customer interviews to understand the needs and desired functionality of the robot in order to translate the intent into a mission for the robots to execute. KABAM currently uses a linear, sequential mission system editor which requires their employees to programme the missions on behalf of the customer who are often not tech savvy. Customers who are experienced and possess technical knowledge can use the same mission system editor to create their missions independently, but the process is still clunky.

KABAM's current system presents the following challenges:

- Resource intensive. Developing robot workflows to execute missions requires significant time and skill, to interface with both customers and the site. The customer success team has to handhold customers through the whole process, which currently takes hours.
- Difficult to scale. As the sophistication of missions increases, there is a need to introduce complex functionalities such as triggers, which are developed by KABAM's engineers. Due to the wide range of user needs, changes in missions and instruction sets, KABAM employees have to attend to each change.
- Lack of feedback loop. Currently, the robots are able to identify when a mission fails and to generate a ticket for it. However, they are unable to learn from past refinements or prompt users for the reason behind the mission failure and refine the process flow based on it.

Thus, KABAM is looking for a solution where users including KABAM employees, customers and distributors, can generate and edit process flows easily and independently to replace the current mission system editor. This would enable users to be more independent and confident to programme their robots to perform missions, allowing the customer success team to focus on managing the robots' operations.

PROBLEM STATEMENT

How might we use verbal/language-based descriptions to generate visualised flow-based programming to allow users to edit process flows independently to improve efficiency and increase robot utilisation?

WHAT ARE WE LOOKING FOR?

The Challenge Owner is looking for a solution where users can give instructions using voice or text inputs to generate visualised flow-based programming (refer to Image 1) for robots. The user should be able to refine the visualised process flow by either editing it directly, or providing further prompts to the solution. There are currently many development tools that can visualise the process flows and facilitate editing, KABAM is open to incorporating them as part of the solution.

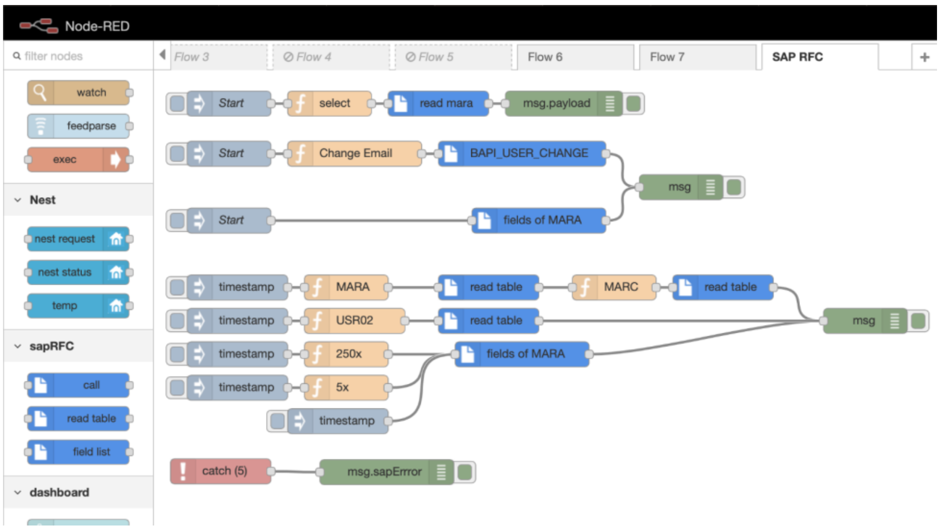

Image 1: Example of a visualised flow-based process flow using the development tool Node-RED. Source: Node-RED

The solution should meet the following criteria:

- Able to interpret language statements. Engage with the user through either voice or text inputs, to interpret statements referring to objects in the real world, specific to deployment sites e.g. stairs, infodesk, elevators, etc. For the purposes of the prototype, the solution will need to be contextualised to robot platforms and deployment sites.
- Seek clarification. To avoid AI hallucinations, the solution should be able to identify information gaps when it encounters unknowns and prompt the user for clarification.
- Generate visualised and editable flow-based programming. The output of the process flow should be visualised on a user interface, making it easy to programme and edit.
- Accommodate complexities. Generate missions across a range of complexities, from basic process flows (e.g. standard template process as foundation to generate more instructions) to fully customised and complex missions involving triggers.
- Version control and history. Users should be able to undo or redo actions and access past versions of the generated process flows.
- Embeddable into existing Smart+ web app. Ideally, users should be able to access the solution through KABAM's current Smart+ web app.
- Language compatibility. KABAM's current robot solutions are available in English, Spanish, Mandarin and Cantonese. For the purposes of the prototype, the solution should be operable minimally in English.
- Robot compatibility. The solution should be compatible with any robot that works with the Smart+ web app, i.e., not just with KABAM robots but also third-party systems that KABAM works with including cleaning robots and delivery robots.

Optional but good to have features:

- Potential to extend to public users. If the solution is robust enough, there can be opportunities to extend to public users to interface with the robots directly e.g., members of public are able to speak directly to the robots and have them perform missions immediately in cases of emergencies.

OVERALL PERFORMANCE REQUIREMENTS

- Usability. Users should be able to generate and edit visualised process flow easily and independently without technical programming knowledge.
- Speed. The time required between the user's first engagement with the system to having the first iteration of the process flow should not take more than 15 minutes for basic missions. More time may be taken for complex missions.
- Accuracy. The solution should be sophisticated enough to understand the users' intended process flow or clarifications to produce an accurate process flow with minimal iterations required. There should be low failure rate where robots are unable execute a mission within a period of time or be met with obstacles due to poorly conceived missions.

There are no restrictions on the geographical location of the problem solvers who may choose to apply to this challenge. However, the problem solvers who are keen to utilise A*STAR's funding for technology development must register / have registered a private limited company in Singapore. . The prototype must also be demonstrated in Singapore.

METRICS OF SUCCESS

- Increased productivity. 10 to 30% reduction in time taken for development work and assisting customers to programme their missions. It currently takes between four to ten man hours for the setup.
- Employee satisfaction. 10 - 30% increase in employee engagement score and achieve high user satisfaction among employees as they are able to spend time on more meaningful tasks.

- Customer retention and robot utilisation. 30 - 50% increase as customers experience higher mission success rates and increase ease in mission creation, leading to higher robot utilisation rates.

POSSIBLE USE CASES

1. Customer creates mission independently. Sam is a site operator working at a train station. He wants to programme the robot to execute a security mission to patrol the platform and report any abnormal activities. He is onboarded to the new programming tool by KABAM's customer success team. He goes into the Smart+ web app to access the mission creation tool, which shows him sample statements, and he inputs the statements he believes encapsulates his intended mission for the robot. The mission creation tool prompts Sam for further clarification, including definitions of some terms he used, before generating the first iteration of the visualised process flow. Sam analyses it and gives the system a thumbs down to indicate that the process flow is not what he needs. The tool generates a different process flow. Sam assesses that it is 90% right and edits it manually to finalised the exact mission he wants.

   Sam applies the mission to the robot which begins patrolling. The robot meets an obstacle on site and reports the mission failure, prompting Sam to edit the mission to account for the obstacle. Sam notices that he made an error previously and edits the process flow. The process flow is refined and reapplied to the robot which then completes a perfect mission.

2. On-site mission creation and execution. Elly is a member of public, visiting a new mall with her family. She notices that it is time to nurse her child and she is looking around to find the nearest nursing room. As she is unfamiliar with the mall, she walks up to a robot and asks where is the nursing room. The robot receives her verbal instructions and prompts Elly for clarification on which nursing room she would like to go to. Elly responds that she would like to get to the nearest nursing room on level two. The robot receives the clarification and generates the mission backend. The robot proceeds to guide them to the nursing room on level two.

WHAT'S IN IT FOR YOU

- SGD50,000 of prize money for each winner of this challenge (see Award Model)
- SGD150,000 A*STAR funding for technology development*
- 3-year ROS-Industrial Consortium Membership
- Access to IMDA's PIXEL corporate innovation hub and complimentary innovation consultancies (e.g. Design Thinking, Digital Storytelling) for the prototype development and commercialisation
- Opportunity to commercialise solution for deployment and adoption by ROS-Industrial consortium members

**To access the A*STAR funding for technology development problem solvers must register / have registered a private limited company in Singapore to utilize the funding.*

EVALUATION CRITERIA

The evaluation process shall take place over two stages. Proposals shall be evaluated based on the evaluation criteria set out for the first stage. Thereafter, shortlisted proposals shall be subjected to a second stage evaluation in the form of an interview / pitch, and the scoring shall be based on a re-defined assessment criteria for the selection of the challenge finalist(s).

Solution Fit (30%)	Relevance: To what extent does the proposed solution address the problem statement effectively?

Solution Readiness (30%)	Maturity: How ready is the proposed solution to go to the market? Scalability: Is there any evidence to suggest capacity to scale?
Solution Advantage (20%)	Quality of Innovation: Is the solution cost effective and truly innovative? Does it make use of new technologies in the market, and can it potentially generate new IP?
Company Profile (20%)	Business Traction: Does the product have user and revenue traction? Team Experience: Do the team members possess strong scientific/technical background?

AWARD MODEL

30% of the prize money will be awarded to each selected finalist at the start of the POC/prototype development process. The remaining 70% will be awarded after completion of the POC/prototype solution, based on milestones agreed between Challenge Owner(s) and the solver. Prize money will be inclusive of any applicable taxes and duties that any of the parties may incur.

Note that a finalist who is selected to undertake the prototype development process will be required to:

- Enter into an agreement with Challenge Owner(s) that will include more detailed conditions pertaining to the prototype development;
- Complete an application form with IMDA that will require more financial and other related documents for potential co-funding support.

DEADLINE

All submissions must be made by **13 Sep 2024, 1600 hours (SGT/GMT +8)**. Challenge Owner(s) and IMDA may extend the deadline of the submission at their discretion. Late submissions on the OIP, or submissions via GeBIZ, will not be considered.