

Appendix - Wi-IAT Paper

November 19, 2021

A APPENDIX

A.1 Screenshots of Mobile Apps

In Figure 1, the first image presents the interface of a robot, smart cameras, and smart speakers apps which have three options on screen to be used by students, staff, or stall people to get a requested job done. The second image presents the interface of a students, employees, and stall people app where a drop-down menu is designed to be used by these users to send a request to a particular device to get assistance or request a job to be done. The third and fourth image in Figure 2 represent the interface of the administration's mobile app through which they can impose policies on smart devices.

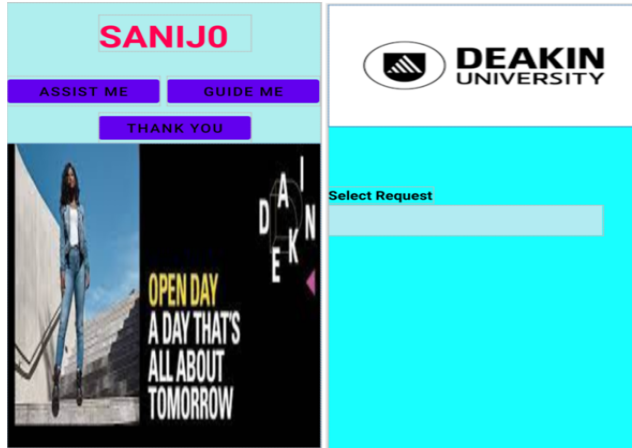


Figure 1: Robot App (first), Student, Employee and Stall Person App (second)

A.2 More Robot Behaviour Examples

Figure 3 shows the robot functions for the coffee shop. While moving to the coffee shop, the robot encountered a hurdle which it handled by altering the

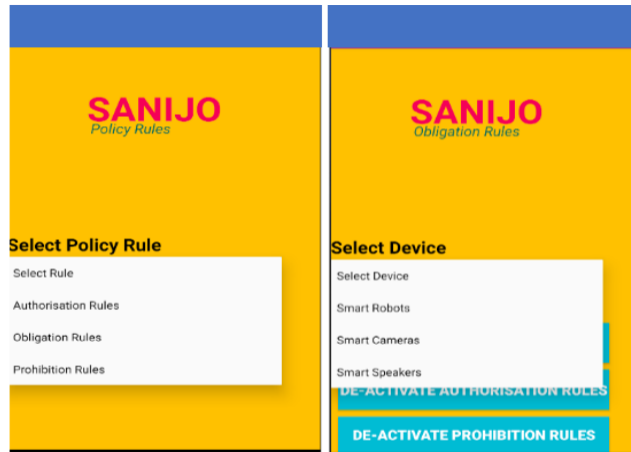


Figure 2: SANIJO Admin App

path successfully. Students or staff members can send a request to a third robot to guide them to a specific location. The robot takes a guiding request and starts moving to the location.



Figure 3: Robot moving to the coffee shop (first), Robot encountered an obstacle (second), Robot handled the obstacle and arrived at coffee shop (third), Robot moving to food stall (fourth)

Figure 4 shows the robot performing the request: guide-user. Note that the robot informs the students that it would like them to go to the cafe (showing transparency in its actions). After informing, the robot started guiding the students to the cafe and, on arrival, the robot left the cafe after asking the students to enjoy themselves politely (implementing the obligation of showing respectful behaviour). Likewise, the staff can request the fourth robot to start

a presentation process in which the robot recognises a student’s face first, for security-check-in purposes, before showing them a presentation on school rules. In this way, each robot interacts with multiple users, but while interacting, it adheres to socio-ethical policies.



Figure 4: Robot taking guide-user request (first), Robot moving to the location (second), Robot arriving at the location (third)

A.3 Core Functions And the Socio-Ethical Policy Rules

Table 1 presents the core functions of each smart device and the preferred socio-ethical policy rules applicable to those core functions. For example, robots can take users to different locations, and so, the policy rule applicable to this core function of robots is guide-user but stay within the terms of the set authorisation rules. Also, while guiding, robots are obliged to handle failures (in an operational sense). Similarly, each core function of an actuator is outlined in table one with the policies applicable to them.

A.4 Socio-Ethical Policy Applied to Core Functions

Authorisation Rules: The authorisation rules are applicable to all three actuators, i.e., robots, smart cameras and smart speakers. Each authorisation rule, i.e., “communicate-with-users”, “security-check-in”, “guide-users” and “safety-measures”, is decoded in different styles by each device. The authorisation rules are outlined below:

- *Communicate with Users:* As mentioned, on the one hand, if the surrounding environment is quiet, the robots and smart speakers are allowed to communicate with the users using their voices, and smart cameras are allowed to display videos (sound will be clear to users in a quiet place)

Smart Device	Core Function	Policies Applicable to Device's Core Function		
		Authorisation	Obligation	Prohibition
Robots	Interacting with users	Communicate-with-Users	Be-Respectful Be-Transparent-in-Actions	Harm-User Stay-With-Low-power
	Recognise users' face	Security-Check-in	Be-Privacy-Respecting Be-Accountable Secure-Data Be-Transparent-in-Actions	Harm-User Stay-With-Low-power
	Take users to different locations	Guide-Users	Handle-Uncertainty	Move-Out-of-Range Stay-With-Low-Power Have-Long-Communication
	Detects trash on floor	Safety-Measures	Be-Respectful Handle-Uncertainty	Harm-User Move-Out-of-Range Stay-With-Low-power
Smart Camera	Capture videos/photos	Guide-Users Safety-Measures	Be-Privacy-Respecting Be-Transparent-in-Actions Handle-Task-Failure	Harm-Users Move-Out-of-Range Stay-With-Low-Power Have-Long-Communication
	Display video/photo	Communicate-with-Users	Be-Respectful Transparent-in-Actions Secure-Data Handle-Task-Failure	Stay-With-Low-Power
	Stream live	Guide-Users	Be-Privacy-Respecting Be-Transparent-in-Actions Be-Accountable Handle-Task-Failure	Harm-Users Move-Out-of-Range Stay-With-Low-Power Have-Long-Communication
	Detect user's face	Security-Check-in	Be-Respectful Be-Accountable Secure-Data Be-Transparent-in-Actions	Stay-With-Low-power
Smart Speaker	Playing music	Guide-Users Safety-Measures	Be-Privacy-Respecting Be-Transparent-in-Actions Handle-Task-Failure Be-Accountable	Harm-Users Move-Out-of-Range Stay-With-Low-Power Have-Long-Communication
	Telling Jokes	Communicate-with-Users	Be-Respectful	Harm-Users Stay-With-Low-Power Have-Long-Communication
	Detect users' voice	Security-Check-in	Be-Respectful Be-Accountable Secure-Data Be-Transparent-in-Actions	Stay-With-Low-power

Table 1: Socio-Ethical Policy Rules Applicable to Devices' Core Functions

using average pixel resolution for the users. On the other hand, if the environment is noisy, robots and smart speakers are permitted to communicate with users by displaying text on their screens, and smart cameras are also authorised to display photos in high pixel resolution for their users. This interpretation is required because it can be hard for users to understand the sound of smart devices in noisy areas.

- *Security Check In:* If the surroundings are crowded, the robots are authorised to recognize the person's face with high focus and display the text of approval. Smart cameras are allowed to increase the focus and detect the person's face before finally displaying the message of approval; and smart speakers are also allowed to detect the user's voice with high focus and display the message of approval. Conversely, if the surroundings are vacant, the robots are authorised to recognize the user's face with average focus and approve recognition using their voices. Smart cameras are also authorised to detect the user's face with average focus and approve it through their voices. Similarly, smart speakers are permitted to detect the user's voice with average focus and approve it by using its sound.
- *Guide Users:* The robots are allowed to direct users by displaying the map first, then saying "follow me," and finally moving to the location, whether

the location is far or near. The smart cameras are allowed to instruct users on how to properly capture photos, and if the user is too close to the camera, it is allowed to advise them to keep their distance. Similarly, if a user is far from the camera, they are again allowed to advise them to keep their distance. This rule is interpreted by smart speakers by guiding users to appropriate or inappropriate music. If the music being played by the speaker is inappropriate, then it is allowed to confirm with the user before playing it. Otherwise, if the music being played is appropriate, it is allowed to play without notifying the user.

- *Safety Measures:* The robots are allowed to display a message about keeping the floor clean if the environment is crowded and noisy. Similarly, robots are also allowed to use their voices to alert us to keep waste clear when the environment is quiet and empty. Similarly, smart cameras are permitted to increase the focus and switch off the flash light to capture the video if the environment is crowded and noisy. If the environment is quiet and vacant, then smart cameras are allowed to use an average focus and switch off the flash light to capture the video. Furthermore, smart speakers are also permitted to take precautionary measures to keep the volume stable and play classic music if the users are elderly. Likewise, if the users are young people, then smart speakers are allowed to play their preferred music at an average volume.

Each actuator performs its core function, but while doing so, it adheres to authorisation rules and interprets each authorisation rule in its own unique way.

Obligation Rules: The obligation rules are also applicable to all three actuators, i.e., robots, smart cameras and smart speakers. Each obligation rule, such as “be-respectful,” “be-privacy-respecting,” “be-prudent,” “be-transparent-in-actions”, “secure-user-data”, “handle-task-failures”, “be-patient”, and “uphold trust” is interpreted differently by the actuators. Some actuators might have the same interpretation of some of the obligation rules. Each obligation rule is outlined below:

- *Be Privacy Respecting:* By displaying questions on robots’ screens, robots get approval from the user before carrying out any action in indoor locations to not disturb others. If the location is outside (crowded), the questions are asked by the robots using their voices as part of a consensus-seeking process. If the setting is crowded, smart cameras interpret this rule by applying video manipulation to a high focus before capturing the video. Conversely, if the environment is not crowded, then smart cameras again apply video manipulation but to an average focus before capturing the video. Furthermore, smart speakers interpret the “respect privacy” rule by not recording music preferences while playing classical or pop music.
- *Be Respectful:* If the situation is crowded, the robots, smart cameras, and smart speakers decode this rule by displaying welcome messages on their

screens before carrying out any action, and if the situation is vacant, then the robots, smart cameras, and smart speakers greet the users using their voices before carrying out their respective actions.

- *Be Transparent in Actions:* If the situation is crowded, all actuators, i.e., robots, smart cameras and smart speakers, display text on their screens to keep the user informed of each action; if the situation is vacant, all actuators inform users of each action using their voice.
- *Secure Data:* If the request to display the data is from authorised users, then all actuators interpret this rule by displaying the data to authorised users. Otherwise, if the request is from an unknown person or stranger, then all actuators must not display data to them.
- *Handle Task Failures:* The robots interpret this rule by altering the path if any obstacle comes in their way. Otherwise, if they have multiple assisting, guiding, or observing requests, then the robots invite other robots to complete the requests together. Smart cameras and smart speakers interpret this rule by reporting to the owner if their screen is not clear, or there is a network failure.
- *Be Prudent:* The robots interpret this rule by taking a decision on finding an appropriate route while taking guiding requests or moving around. If the environment is crowded, the robots must find an appropriate route to guide the user to the specific location. Otherwise, if the environment is vacant, then robots guide users along normal routes. Similarly, smart cameras must take autonomous decisions on increasing or decreasing pixel resolution. If the environment is crowded, then smart cameras must increase focus to stream longer; otherwise, they must use average focus to stream in vacant surroundings. Smart speakers interpret this rule by taking autonomous decisions on users' requests to play music. If there are a high number of playing music requests, then smart speakers must play music subsequently, otherwise they can play prioritised music.

Prohibition Rules: The prohibition rules are also applicable to all three actuators, i.e., robots, smart cameras and smart speakers. Each prohibition rule, such as “harm users”, “stay with low power”, “move out of range of the permitted area” and “have long communication” is interpreted differently by the actuators. Each prohibition rule is outlined below:

- *Harm Users:* The robots interpret this rule by not going too close to the user; if they are communicating with the user or moving around. Similarly, smart cameras decode this rule by not using flash light while capturing the photo or the video. Furthermore, smart speakers execute this rule by not increasing the volume if they are playing music or telling jokes.
- *Move Out of Range:* The robots interpret this rule by not moving out of the range of permitted areas without permission, either when they are

on duty or off duty. Similarly, smart cameras execute this rule by not focusing on the surroundings (keeping the capturing area in range) while capturing the photo or video. Moreover, smart speakers decode this rule by not playing pop-music if the preference is classical music. Similarly, if the preference is pop-music, then smart speakers are not allowed to play classical music.

- *Stay with Low Power:* The actuators are not allowed to perform their duties if their power is low to threshold. For example, robots are prohibited from taking new requests if they are communicating with users or moving around. Similarly, smart cameras do not capture photos or stream video and smart speakers also do not take new requests for playing music if they are already completing previous requests, including playing music or telling jokes.
- *Have Long Communications:* To interpret this rule, robots are not allowed to talk irrelevant if they are guiding the user or entertaining the user. Similarly, smart cameras are prohibited from taking irrelevant photos/videos if the environment is vacant and smart speakers are prohibited from playing irrelevant music or telling irrelevant jokes.

A.5 Administrative Policy Applied to Core Functions

Table 2 shows the core functions and applicable policy rules. They apply a different set of rules from the socio-ethical policy.

		Policies Applicable to Device's Core Function		
		Administrative Policies		
Smart Device	Core Function	Authorisation	Obligation	Prohibition
Robots	Overlook users	Observe-User	Maintain-Volume Be-Prompt-In-Actions Protect-Self	Enter-Private-Locations Talk-To-Strangers
	Bring items for the users	Assist-User	Maintain-Volume Be-Prompt-In-Actions Protect-Self	Enter-Private-Locations Talk-To-Strangers Disturb-Unnecessarily
	Play music or comedy videos/movie	Entertain-User	Maintain-Volume	Disturb-Unnecessarily
	Show information to user	Present-To-User	Maintain-Volume Be-Attentive	Talk-To-Strangers Disturb- Unnecessarily
	Alert on hazard	Assist-User	Alert-To-Fire-Alarms Be-Prompt-In-Actions Protect-Self	Enter-Private-Locations
Smart Camera	Overlook users	Observe-User	Maintain-Volume Be-Prompt-In-Actions	Talk-To-Strangers
	Stream event	Assist-User	Maintain-Volume	Talk-To-Strangers Disturb- Unnecessarily
	Capture/Display video/photo	Present-To-User Entertain-User	Maintain-Volume Be-Prompt-In-Actions Protect-Self	Talk-To-Strangers Disturb- Unnecessarily
	Detect user's face	Observe-User	Maintain-Volume Be-Prompt-In-Actions Be-Attentive	Talk-To-Strangers Disturb- Unnecessarily
	Alert on hazard	Assist-User	Alert-To-Fire-Alarms Be-Prompt-In-Actions	NA
Smart Speaker	Overlook users	Observe-User	Maintain-Volume Be-Prompt-In-Actions	Talk-To-Strangers Disturb- Unnecessarily
	Play music	Assist-User	Maintain-Volume Be-Prompt-In-Actions	Talk-To-Strangers Disturb- Unnecessarily
	Detect users' voice	Observe-User	Maintain-Volume Be-Prompt-In-Actions Be-Attentive	Talk-To-Strangers Disturb- Unnecessarily
	Tell jokes	Entertain-User	Maintain-Volume Be-Prompt-In-Actions	Talk-To-Strangers Disturb- Unnecessarily
	Alert on hazard	Assist-User	Alert-To-Fire-Alarms Be-Prompt-In-Actions	NA

Table 2: Administrative Policy Rules Applicable to Devices' Core Functions